

FIELD STUDIES OF DIRECTIONAL PREFERENCES OF THE REED WARBLER (*Acrocephalus scirpaceus*) AND THE SEDGE WARBLER (*A. schoenobaenus*) ON AUTUMN MIGRATION ALONG THE EASTERN AND SOUTHERN COAST OF THE BALTIC SEA AND IN WESTERN PART OF UKRAINE

Agnieszka Trocińska, Agu Leivits, Czesław Nitecki and Igor Shydlovsky

ABSTRACT

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During migration birds behave directionally, therefore the aim of this study was to learn of directional preferences of migrating Reed and Sedge Warblers at several stations, located in different places on the bird migration route, thus giving information about large-scale migration pattern. Birds were tested with a new field method that enables to study directional behaviour of night migrants also during daytime. Data were collected at several stations located at the coast: Häädemeeste (58°06'N, 24°29'E – Estonia), Druzno (54°07'N, 19°24'E – eastern part of Polish Baltic coast), Bukowo/Kopań (54°28'N, 16°25'E – the Operation Baltic station, central part of Polish Baltic coast), as well as at one inland station: Cholgyni (49°58'N, 23°28'E – Ukraine). As different number of tests was studied and data from different years were pooled together, an overview and a very simplified pattern of migration at each site rather than a detailed model was obtained. Both species have shown differentiation of directional preferences and the results were in accordance with other data like recoveries. The Reed Warbler displayed clear tendency towards west, but in all 4 localities, eastern directions were also significant. In the Sedge Warbler, western and southwestern directions dominated at Häädemeeste and Druzno, while eastern ones – at Cholgyni, however, at the rest of the stations, these directions were also significant. As it could be expected, the pattern of headings in both species at several stations was similar, with the exception of Cholgyni station. Surprisingly, the Reed Warbler expected to migrate southeastwards, showed there preferences towards west, what was also supported by recoveries.

A. Trocińska, Bird Migration Research Station, University of Gdańsk, Przebendowo, 84-210 Choczewo, Poland, E-mail: bioat@univ.gda.pl; A. Leivits, Nigula Nature Reserve, Aia 22-18, Kilingi-Nomme 86305, Estonia, E-mail: agu@kilingi.ee; C. Nitecki, Dept. of Vertebrate Ecology and Zoology, University of Gdańsk, Legionów 9, 80-441 Gdańsk, Poland; I. Shydlovsky, Zoological Museum of the Ivan Franko National University of Lviv, Grushevsky str. 4, Lviv 79005, Ukraine; zoomus@franko.lviv.ua

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INTRODUCTION

Bird migration studies are the one to understand continental and intercontinental movements of birds, to discover and describe migratory flyways followed by them. To find this, several questions about bird migration have to be answered: „where to?”, „where from?” (answered at species level, but still open at population level) and „which way?” birds migrate. The other one is „how?” they do this, which is posed in studies on mechanisms of bird migration. To answer the first three questions, usually bird catching/ringing, analyses of recoveries *etc.* were involved. In this study, we used orientation tests to check bird preferences on migration. Usually orientation experiments have been used to study bird navigation/orientation mechanism, rarely they have been used to test migrating birds (Muheim and Jenni 1999), but even then, the results found disorientation of tested birds. A new field method developed by Busse (1995) gives a new opportunity. Birds tested with this method have shown local migratory directions consistent with their migration routes. This has encouraged us to use the method at several stations to learn on a larger area how the birds behave and whether there are any differences between the stations. Thanks to cooperation of several stations working within SEEN Network that joined the programme of orientation studies, this analysis was possible. Quite numerous species and common for all the stations were the Reed Warbler and the Sedge Warbler. Moreover, any inter-species differences should be revealed as these two species are closely related. Because all the stations are from Central and East Europe, we focused also on the SE flyway to check to what extent birds passing the stations direct to SE.

METHODS

Data collection

Data were collected at several stations located at the coast: Häädemeeste (58°06'N, 24°29'E – Estonia), Druzno (54°07'N, 19°24'E – eastern part of Polish Baltic coast), Bukowo/Kopań (54°28'N, 16°25'E – the Operation Baltic station, central part of Polish Baltic coast), as well as at one inland station: Cholgyni (49°58'N, 23°28'E – Ukraine). Birds were caught with mist-nets on their autumn migration. They were ringed, measured and tested according to a new field method given by Busse (1995) used to studying directional preferences of nocturnal migrants during the day. A flat cage, that is a cylinder with sides covered by transparent foil, divided into 8 sectors, and top covered with netting that allows birds to see the sky, is used (Fig. 1). The cage is placed precisely along the N-S axis, in the centre of non-transparent, uniformly coloured open cylinder that prevents a study bird from seeing any landmarks other than the sky. Flat cage seems to be more natural for bird as this design does not force an individual to hope on the slope sides as it is in Emlen's

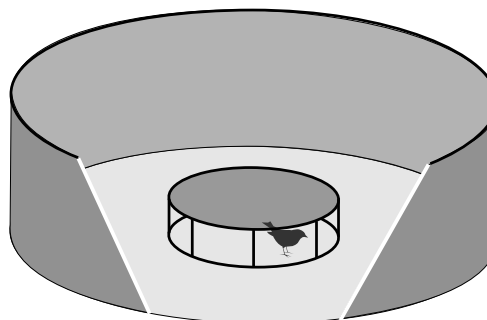


Fig. 1. Orientation experiment set.

cage (Emlen and Emlen 1966). Standardised test-time was 15 minutes (after few years of tests, it was reduced to 10 minutes but still all results are recalculated into 15 min. session). After this time, a tested individual is released and the results of bird activity *i.e.* scratches and holes made either with claws or beak are counted immediately afterwards. This procedure enables to process fully up to 6 individuals in one hour. Tests are made during the day-time, as it was proved by Busse (1995) and later by Nowakowski and Malecka (1999) for the Robin (*Erithacus rubecula*) – a typical nocturnal migrant, that at the daytime both activity and directionality of the tested birds were higher than at night. Nowakowski and Malecka (1999) also showed that robins tested during day and night presented a remarkable similarity (differences statistically insignificant) in the distribution of preferred directions. Testing birds during the day is a great advantage over the previous methods, because birds included in the experiments are not kept for a long time (exceeding 1 hour) before the test and their migratory behaviour is not disturbed because of the needs of the experiment.

Data analysis

Results of the tests were counted with a 45° precision (8 sectors). Then, data were computerized with programme ORIENT (available from the Bird Migration Research Station, University of Gdańsk, Poland). The programme facilitated the preparation of all data into a standard form that could then be used by different spreadsheet programmes. We used Quattro Pro 6.0 for Windows that allowed making radar (circular) graphs in adequate format. Tests with less than 30 signs (scratches either with bill or claws) per experiment were excluded from the data set. The most important assumption and a novelty in the data analysis is that the method assumes multi-vector model of bird behaviour, which means that each bird could indicate one or more preferred directions, both situated on a line (axial) or at different angles (Busse and Trocińska 1999). This assumption is based on the hypothesis presented earlier (Busse 1992) that an individual that is an inter-population hybrid („population” in migratory sense) can have two or more naviga-

tional programmes. Consequently, some statistics used in the circular distributions were not applied. The Rayleigh test, used to test data distribution, had to be rejected as it requires unimodality (Zar 1984), and *Chi*-square test was used instead. Initially, all data were checked with *Chi*-square test and all non-significant distributions (random distribution of signs) were excluded from further analysis. The procedures given and discussed by Busse and Trocińska (1999) were applied: the data were calculated in percents and smoothed. For each individual a simplified distribution of its headings was elaborated (*i.e.* local vectors: their direction and length). To get more comprehensible pattern of the headings, a special reversing procedure was used. This procedure means adding 180° to the angle of the vector heading backwards to standard direction of migration in the season *i.e.* in autumn – adding 180° to all the northern directions shown. It is based on the assumption given above that bird behaviour can be axial, so opposite vectors are of the same value (logically and biologically) and can be added. Data for all individuals of each species were summed up and these data were used to draw radar graphs of distributions of headings for the study species.

RESULTS

Number of tests made was different at the studied stations (Table 1). In over 88% of all tests, distribution of the signs was not random (*Chi*-square test, $p < 0.05$). Both the Reed and Sedge Warbler have shown differentiation of directional preferences (Fig. 2, 3).

Table 1
Number of tests of the studied species

Station:	Häädemeeste	Druzno	Bukowo	Cholgyni
<i>Acrocephalus scirpaceus</i>	1996	1996	1996-1998	1996-1998
<i>N</i> tests	14	37	41	44
Statistical significance: <i>Chi</i> -square test $p < 0.05^*$	12 (12)	32 (32)	36 (36)	42 (41)
<i>Acrocephalus schoenobaenus</i>	1996	1996		1996-1997
<i>N</i> tests	14	38		65
Statistical significance: <i>Chi</i> -square test $p < 0.05^*$	14 (14)	34 (34)		59 (58)

* in brackets: number of tests when $p < 0.01$

In the Reed Warbler generally western directions dominated (Table 2): Häädemeeste – WSW (46% of tested birds), Druzno – SSW (58%), Bukowo/Kopań – WSW (30%), Cholgyni – WSW (36%). In all 4 localities, eastern directions were significant: SSE – on average 24% of tested birds; ESE – 23% in Bukowo/Kopań, 13-15% in Häädemeeste, Druzno and Cholgyni.

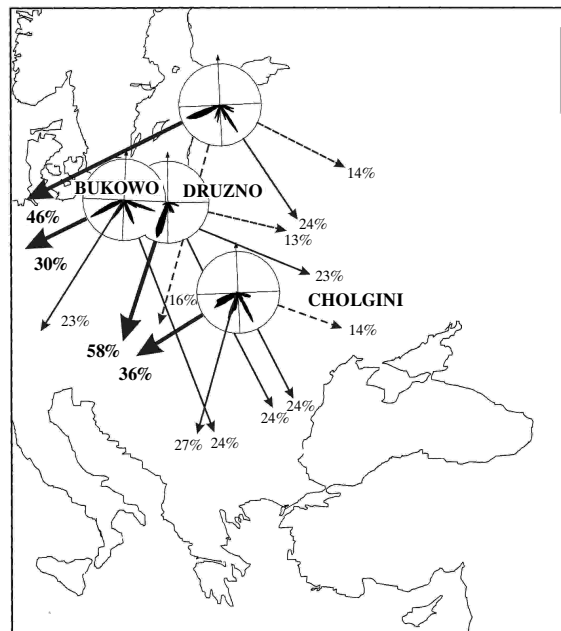


Fig. 2. Simplified, reversed distribution of headings of the Reed Warbler.

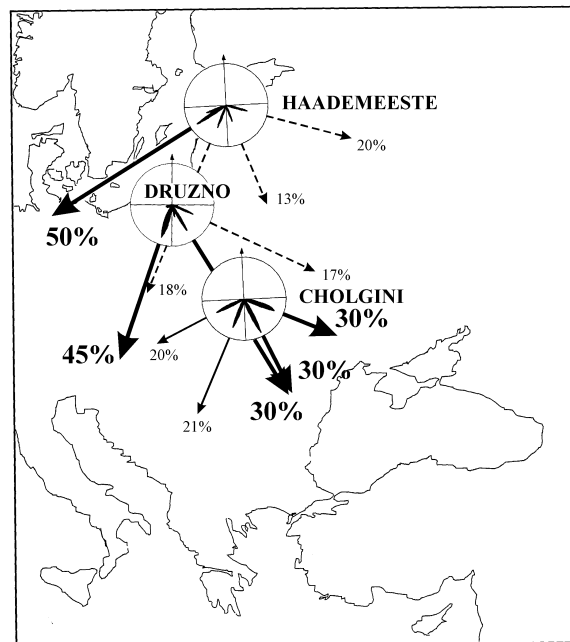


Fig. 3. Simplified, reversed distribution of headings of the Sedge Warbler.

Table 2
Directional preferences of the studied species (%)

Station:	Häädemeeste	Druzno	Bukowo	Cholgyni
<i>Acrocephalus scirpaceus</i>				
ESE	14.44	12.64	23.35	13.84
SSE	23.71	24.18	23.82	23.67
SSW	15.53	57.76	22.71	26.96
WSW	46.32	5.41	30.12	35.53
<i>Acrocephalus schoenobaenus</i>				
ESE	20.10	17.06		29.66
SSE	12.78	30.38		29.47
SSW	17.62	44.92		20.78
WSW	49.50	7.64		20.09

In the Sedge Warbler, western and southwestern directions dominated at Häädemeeste (WSW – 50% of tested birds) and Druzno (SSW – 45%) – see Table 2. Eastern directions dominated at Cholgyni – in total 60% of tested birds, but also at the rest of the stations these directions were significant: SSE – Druzno (30 % of tested birds), ESE – Häädemeeste (20%).

Both species have shown similar pattern of headings at Häädemeeste and especially at Druzno, other than at Cholgyni, where western directions dominated in the Reed Warbler and eastern in the Sedge Warbler.

DISCUSSION

The aim of this study was to learn of directional preferences of the species at several, different stations, located in different places on the bird migration route, thus giving information about large-scale migration pattern. As different number of tests was studied and data from different years were pooled together, an overview and a very simplified pattern of migration at each site rather than a detailed model was obtained. This problem was discussed in detail by Busse *et al.* (2001). Even though, results we got with this very simple method are in accordance with other data. The Reed Warbler is known as a trans-Saharan migrant that winters mainly in the Sudan-Zambezi region. West, Central and North European populations migrate southwestwards, while those from the Czech Republic, Hungary and further east migrate southeastwards (Zink 1973, Hagemeijer and Blair 1997). Birds ringed in Austria (1 indiv.) and Hungary (2 indiv.) were found in Israel in 1998-1990 (Shirihai 1996). In this study, tested individuals also displayed clear tendency towards West. This is supported by several recoveries of birds ringed at Polish stations Druzno, Mierzeja Wiślana (54°21'N, 19°19'E) and Bukowo/Kopań and found in

Germany (4 indiv.), the Netherlands (1 indiv.), Belgium (10 indiv.), Switzerland (3 indiv.), France (2 indiv.), Spain (5 indiv.), Morocco (1 indiv.), as well as ringed in Gumbartitsy (60°41'N, 32°56'E – Russia) and found in Germany, Denmark, Belgium and France (Noskov and Rezvog 1995). It is of interest to note a pattern found at Cholgyni station (dominance of W directions), as it could be assumed that, similarly to the Czech Republic and Hungary, more birds passing this station should head southeastwards. However, there are two recoveries of birds ringed at this site (in fact the only ones that we have) and found in Slovenia (the first one – ringed in Cholgyni 7 August 1999 and found in Vrhnika (45°58'N, 14°18'E) on 20 August 1999), and the second – ringed in Cholgyni on 23 August 2000 and found on Cerksnisko Jezero (45°46'N, 14°22'E) on 10 September 2000. At every station, southeastwards directions were present, but no recoveries from these stations that could help to explain this fact were found.

The Sedge Warbler winters in Africa from Senegal to Ethiopia and South Africa. South Scandinavian and western European populations appear to winter in West Africa, while Finnish and eastern European – in Central and eastern Africa (Dowsett *et al.* 1988 after Hagemeijer and Blair 1997). This separation was also reflected in the results of orientation tests at different stations. Birds tested at two coastal stations displayed a tendency towards west, while at Cholgyni – eastern directions were dominant. Unfortunately, available recoveries of this species are scarce. Birds ringed in Estonia (2 indiv.) and Latvia (1 indiv.) were recovered SSW – at Druzno and Mierzeja Wiślana (54°21'N, 19°19'E), but also 2 individuals ringed in Estonia were caught at Cholgyni. Dominating SSW direction found at Druzno is strongly supported by the recoveries of birds ringed at Druzno and recovered in Austria (1 indiv.) and Hungary (2 indiv.), as well as by a map of recoveries given by Glutz and Bauer (1991). Lack of similar recoveries for the Reed Warbler, showing the same heading pattern at Druzno, is very difficult to explain on the basis of this study. It would be very interesting to use *e.g.* biometrical analysis to distinguish populations of this species passing this specific station. Although at Cholgyni station eastern directions dominated, the only one recovery is from the west – from Hungary. Nevertheless, it has to be remembered that number of recoveries depends not only on a number of ringed birds passing certain area but also on density of human population and cultural traditions in that region (Payevski 1973, Kania and Busse 1987, Spina 1999). Southeastern and eastern parts of Europe are areas with very low number of recoveries, but it does not mean that birds do not migrate in those directions. Eastern directions present in different proportions at all stations could be supported by the Sedge Warbler that was ringed in Finland and recovered in Israel (Shirihai 1996).

As it could be expected, pattern of headings of both species at several stations was similar, with the exception of Cholgyni station. Surprisingly, the Reed Warbler expected to migrate southeastwards, showed preferences towards west, what was also supported by recoveries. With quite limited data used in this analysis, it is very difficult to discuss this problem. It would be very interesting to test more birds of both species at this station. Besides, some more extensive studies *e.g.* biometrical

analysis could be useful in solving the problem. It is also of interest to note that the pattern of headings uniform at one station (e.g. at Druzno in both species) can be very complicated and look like crossroads at the other station (the Reed Warbler at Bukowo/Kopań).

Getting more data on regular basis for sure would enrich and clear up the pattern obtained by now, as it was shown by Busse *et al.* (2000) that short and accidental sampling gives only rough estimation of the local pattern of migration.

SUMMARY

Although the method used in this study is very simple and with a limited data gives only an overall picture, some characteristics still can be found – getting the same information with the recoveries simply could take years. Results give an idea of a migratory system:

1. at each station – differentiated pattern of headings (1) shows that most probably several different populations pass the stations – the number of the directions shown, however, cannot be interpreted as the number of the populations passing the stations, because of low precision of the method (8 sectors); (2) given as proportions of different directions suggests relative proportions of migration directions and pattern of migration of the studied species.
2. in the region – if results from several stations are compared. Results of this study showed that in most cases, different patterns found at the stations were consistent with existing knowledge of bird migration in this part of Europe, although it also revealed some differences that should be more carefully studied. Extensive studies on bird migration in East and Central Europe as well as further along the SE flyway could be of great importance as to enlarge our knowledge on bird migration in whole Palaearctic.

All these should be carefully studied with other more detailed methods like, for example, biometrical analysis. Application of the Busse's method should also be studied as it can be very quick, and simple tool of investigation of migration at different places on the migratory routes.

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