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MIGRATION DYNAMICS AND DIRECTIONAL PREFERENCES OF PASSERINE MIGRANTS IN AZRAQ (E JORDAN) IN SPRING 2008

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ABSTRACT

Stępniewska K., El-Hallah A., Busse P. 2011. *Migration dynamics and directional preferences of passerine migrants in Azraq (E Jordan) in spring 2008*. Ring 33, 1-2: 3-25.

Azraq ringing station is located in the Azraq Wetland Reserve in the eastern part of Jordan, on the Eastern Palearctic Flyway. It covers different types of habitat: reedbeds and a dry area with tamarisks (*Tamarix sp.*) and nitre bushes (*Nitraria billardierei*). In total, from 18 March till 28 April 2008, we caught 2767 birds from 64 species. Three species dominated distinctly, constituting 58% of total number of caught birds: the Reed Warbler (*Acrocephalus scirpaceus*) – 570, the Chiffchaff (*Phylloscopus collybita*) – 535 and the Lesser Whitethroat (*Sylvia curruca*) – 488 birds. The catching dynamics reveals the highest numbers of birds in the beginning of the studied period. The total number constantly decreased till 6 April and then subsequently increased. The first high peak of the dynamics at the end of March was due to intensive migration of Chiffchaffs and Lesser Whitethroats. The second one at the end of April was caused by pronounced migration of Reed Warblers and Blackcaps. High numbers of migrants in the beginning and at the end of the catching period reveal that we did not cover the whole migration season in Azraq, so it is necessary to begin the study much earlier and to finish later there.

We performed also 1169 directional preferences tests using Busse's orientation cage, mostly for the Reed Warbler. Directional preferences of tested birds reveal clear dominance of NW headings – towards European breeding grounds. The NE headings towards Asian breeding grounds were also present. There was a low share of reversed headings, especially SE. We suppose that birds showing NW headings could migrate from wintering grounds in Africa across the most southern coasts of the Arabian Peninsula; these flying to the NE seem to have crossed Egypt and then fly along the Arava Valley. Many species presented in this paper, like the Red-backed Shrike (*Lanius collurio*), could show loop-migration, flying in spring more eastern than in autumn.

High numbers of caught and observed birds, including habitat-specialists like numerous *Acrocephalus* warblers, reveal that the Azraq Wetland Reserve is a very important place for Palearctic migrants during their migration through desert areas of the Middle-East.

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INTRODUCTION

The Middle East is a very important area for migratory birds. Twice a year, in spring and in autumn, huge numbers of birds of many Palearctic species fly there between their breeding grounds in Eurasia and wintering grounds in Africa (Moreau 1972, Newton 2008). In addition, this is also the wintering area for some of the medium-distant migrants (Hagemeijer and Blair 1997, Cramp 1998). A major part of the Middle East is covered by deserts or semi-deserts. For this reason birds commonly use there natural oases or anthropogenic places like gardens, plantations, cultivable lands as well as reedbeds by fishponds and sewage farms to rest or stopover (Hasseb *et al*. 2004, Ożarowska *et al*. 2011, Stępniewski *et al*. 2011). One of the best known attractive places for birds in Jordan is Azraq Wetland Reserve, belonging to areas of the Ramsar Convention on Wetlands. This reserve was established in 1978 by the Royal Society for the Conservation of Nature and covers 12 km^2. The oasis is located in a natural depression in the Jordanian Eastern Desert. In the 1960s, water began to be pumped to support Amman (the capital city) booming population. The natural springs dried up, so nowadays there are maintained artificial springs. Nevertheless, this is still a very important place for migrants because of the ponds and luxuriant vegetation. For this reason, in autumn 2002 Azraq Ringing Station was established there as a member of the SE European Bird Migration Network (SEEN).

The main factors affecting migration in the Middle East are the desert conditions and the trade wind system (Bruderer 1999). The knowledge on directional preferences of passerines from the eastern Mediterranean basin and Middle East is still lacking, particularly from the spring passage. Up to now, these issues have been investigated almost entirely in Israel or Egypt (*e.g.* Biebach *et al*. 2001, Bruderer 2001, Komenda-Zehnder 2002, Dinevich and Leshem 2010) using different methods, such as orientation tests, visual observations or radar monitoring. Results from those data allow to fill in gaps in the knowledge about flyway routes through the areas with very low recovery rates (Ożarowska *et al*. 2004). Moreover, we can gain information on the migration routes of birds in respect of big geographical barriers, such as the Mediterranean Sea or the Sahara and Arabian Deserts, and determine if they are similar or different in spring and autumn (Pearson and Lack 1992).

In this paper, we present results of our research in Azraq during spring migration in 2008. The aim of this study was to describe seasonal dynamics of Palearctic migrants and their directional preferences during spring migration with an attempt to indicate their arrival and departure routes.

MATERIAL AND METHODS

Study area and fieldwork

The study was conducted in the Azraq Wetland Reserve (31°50’N, 36°49’E), close to the eastern border of Jordan (Fig. 1), 100 km to the east of the capital of Amman. The data were collected from 18 March to 28 April 2008. Birds were caught in 41 mist-nets (the number was stable during the whole catching season), in three types of habitat: 1) pure reedbeds and reedbeds with admixed tamarisk (*Tamarix sp.*) bushes near natural or ancient-artificial ponds, 2) tamarisk bushes and 3) nitre bushes (*Nitraria billardierei*) in a semi-desert area. Close to the reserve there were orchards with date palms (*Phoenix dactylifera*), peaches (*Prunus persica*) and pomegranates (*Punica granatum*). Around the reserve and Azraq village there is a desert covered with black basalt stones, without or with low shrub vegetation only.

Fig. 1. Location of Azraq in Jordan

Due to high temperatures in the mid-day, nets were opened from dawn till 11.00 *a.m.* / 12.00 *p.m.* and then from 5.00 *p.m.* till dusk.

We applied the standard SEEN methodology including constant mist-netting, ringing, taking standard set of biometric measurements and orientation tests of randomly selected nocturnal migrants in Busse's cage (Busse 1995, 2000). The cage is divided into 8 sectors, covered with a stripe of transparent foil at the side wall and a piece of netting at the top. It is placed inside a higher, non-transparent screen to prevent the bird from seeing any landscape marks. A tested bird is put into the cage for 10 minutes and then released. The activity of the bird is expressed by holes and scratches on the foil, which are counted in each sector immediately after the release of the bird and then noted down in a special form. The stripe of foil is replaced by a new one always before the next test. Test were performed only in the morning hours, up till 11.00 *a.m.*

Data analyses

Seasonal dynamics graphs for the number of species caught per day (see Fig. 2), all caught birds (see Fig. 3) and for the most numerous species were prepared (see Fig. 4). House Sparrows (*Passer domesticus*) were not ringed, so for this species we did not perform any analyses. Seasonal dynamics cover the period from 19 March till 27 April, because the first day of catching (18 March) began in the evening and the last (28 April) was finished before noon. In order to obtain a more general pattern of number dynamics, we smoothed the numbers using a 5-day moving average according to the formula:

$$C_w = (a + 2b + 3c + 2d + e) / 9$$

where:

C_w – moving average of birds' numbers in day c,

a, b, c, d, e – numbers of birds caught in five consecutive days.

The data from orientation tests for the most frequently tested birds were elaborated using a non-standard calculation procedure proposed and improved by Busse and Trocińska (1999). This method is based on accepting multimodal circular distributions of preferred directions by migrants. Calculations were performed using original ORIENT v. 4.6 software (available from the authors). Inactive birds (less than 20 marks in total) and those whose distribution of headings did not differ significantly from randomness (χ^2-test) were excluded from further analyses (47 indiv.). Directional preferences were presented for each species as circular 16-sector radar graphs, prepared in Corel Quattro Pro for raw (see Fig. 5) and reversed data (see Fig. 6). The reversed patterns are based on the assumption of axial behaviour of tested migrants, which means that southern headings in spring are reversed in relation to the normal spring directions, so they should be added to the northern headings – it means adding 180° to the southern vectors (Busse and Trocińska 1999). For the analyses, each graph was divided into four main sectors along the N-S and W-E axes: sector I (around NE directions), II (around SE), III (around SW) and IV (around NW). For each of these sectors (for raw and then for reversed data) a percentage of displayed directions was calculated (see Table 2). At the end, for each species we calculated the proportion of northern to southern headings on the two axes (see Table 3). Retraps were excluded from all analyses.

RESULTS

Seasonal dynamics

In total, from 18 March till 28 April 2008 we caught 2767 birds from 64 species (Table 1). Three species dominated distinctly, constituting 58% of caught birds: Reed Warbler (*Acrocephalus scirpaceus*), Chiffchaff (*Phylloscopus collybita*) and Lesser Whitethroat (*Sylvia curruca*). For at least several species we identified different subspecies (marked with an asterisk and described in the title of Table 1).

Daily diversity of caught species fluctuated from 7 – in the middle of the catching period till 23 – on 24 April, at the end of the catching period (Fig. 2).

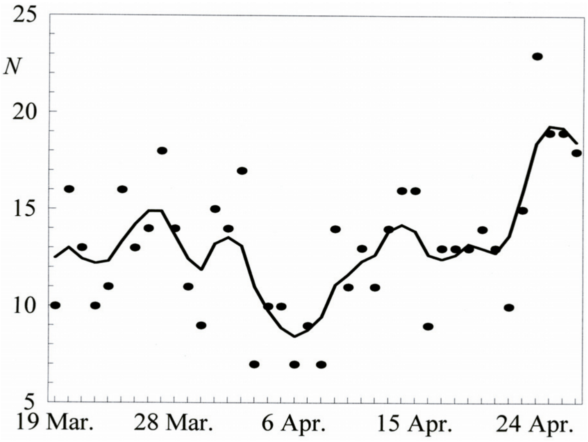


Fig. 2. Dynamics of daily numbers of caught species. Dots – raw data; line – data smoothed once.

A total seasonal dynamics for all species revealed two distinct migration peaks (Fig. 3): higher at the beginning, with the highest daily number of birds – 178 on 19 March, and lower – at the end of the catching period. In the middle of the catching period, on 6 April, there was the lowest number of migrants – only 22 birds; this breakdown is visible at the majority of presented dynamics graphs.

The first peak was constituted mainly by the early migration of particularly two species, *i.e.*: Chiffchaff and Lesser Whitethroat. The Bluethroat (*Luscinia svecica*) and the Spanish Sparrow (*Passer hispaniolensis*) also migrated early (Fig. 4). Afterwards their numbers decreased – slowly for the Lesser Whitethroat, but rapidly and exponentially for the Chiffchaff. These four species migrated at the earliest. The end of migration of the Chiffchaff, Spanish Sparrow and Bluethroat fell within the period of work.

Table 1

List of caught species and their numbers (from 18 March to 28 April). Because the Isabelline Shrike (*Lanius isabellinus*) and the Turkestan Shrike (*L. phoenicuroides*) have been separated only recently and in the field we did not identify the subspecies of each individual, they are presented as one species.

	Number of birds		Number of birds
*Acrocephalus scirpaceus**	570	*Cettia cetti*	5
Phylloscopus colllybita	535	*Lanius isabellinus/phoenicuroides*	5
Sylvia curruca	488	*Oenanthe oenanthe*	5
Sylvia atricapilla	222	*Saxicola maura*	5
*Hirundo rustica**	123	*Irania gutturalis*	4
*Phoenicurus phoenicurus**	84	*Otus scops*	4
Passer domesticus	83	*Turdus merula*	4
Lanius collurio	82	*Erithacus rubecula*	3
Acrocephalus schoenobaenus	68	*Sylvia borin*	3
Riparia riparia	52	*Sylvia cantillans*	3
*Phylloscopus trochilus**	41	*Sylvia rueppeli*	3
*Sylvia communis**	39	*Anthus trivialis*	2
Luscinia megarhynchos	38	*Buteo buteo*	2
Jynx torquilla	32	*Cecropsis daurica*	2
*Luscinia svecica**	32	*Oenanthe hispanica*	2
Acrocephalus arundinaceus	31	*Phylloscopus sibilatrix*	2
Passer hispaniolensis	27	*Remiz pendulinus*	2
Phylloscopus orientalis	16	*Streptopelia senegalensis*	2
Acrocephalus palustris	14	*Upupa epops*	2
Luscinia luscinia	14	*Accipiter brevipes*	1
Pycnonotus leucotos	14	*Acrocephalus melanopogon*	1
Lanius nubicus	12	*Alcedo atthis*	1
Iduna pallida	10	*Anthus campestris*	1
Sylvia crassirostris	9	*Ficedula hypoleuca*	1
*Sylvia melanocephala**	8	*Hippolais icterina*	1
Sylvia nisoria	8	*Ixobrychus minutus*	1
Turdus philomelos	8	*Oenanthe cypriaca*	1
Cercotrichas galactotes	7	*Oenanthe isabellina*	1
Locustella luscinioides	7	*Phoenicurus ochruros*	1
Lanius senator	6	*Rhodospiza obsoleta*	1
Muscicapa striata	6	*Saxicola rubicola*	1
Saxicola rubetra	6	*Streptopelia decaocto*	1

An asterisk (*) marks species for which there were identified different subspecies, *i.e.*: Reed Warbler (*Acrocephalus scirpaceus*) – nominative and *fuscus*; Barn Swallow (*Hirundo rustica*) – nominative and *transitiva*; Redstart (*Phoenicurus phoenicurus*) – nominative and *samamisicus*; Willow Warbler (*Phylloscopus trochilus*) – nominative and *yakutensis*; Whitethroat (*Sylvia communis*) – nominative and *icterops*; Bluethroat (*Luscinia svecica*) – nominative and *cyanecula*; Sardinian Warbler (*Sylvia melanocephala*) – nominative and *momus*.

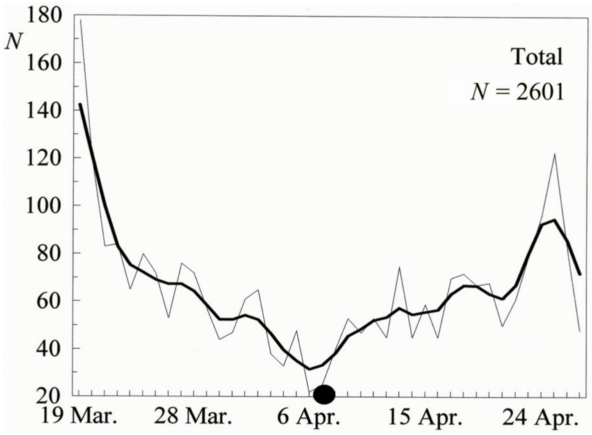


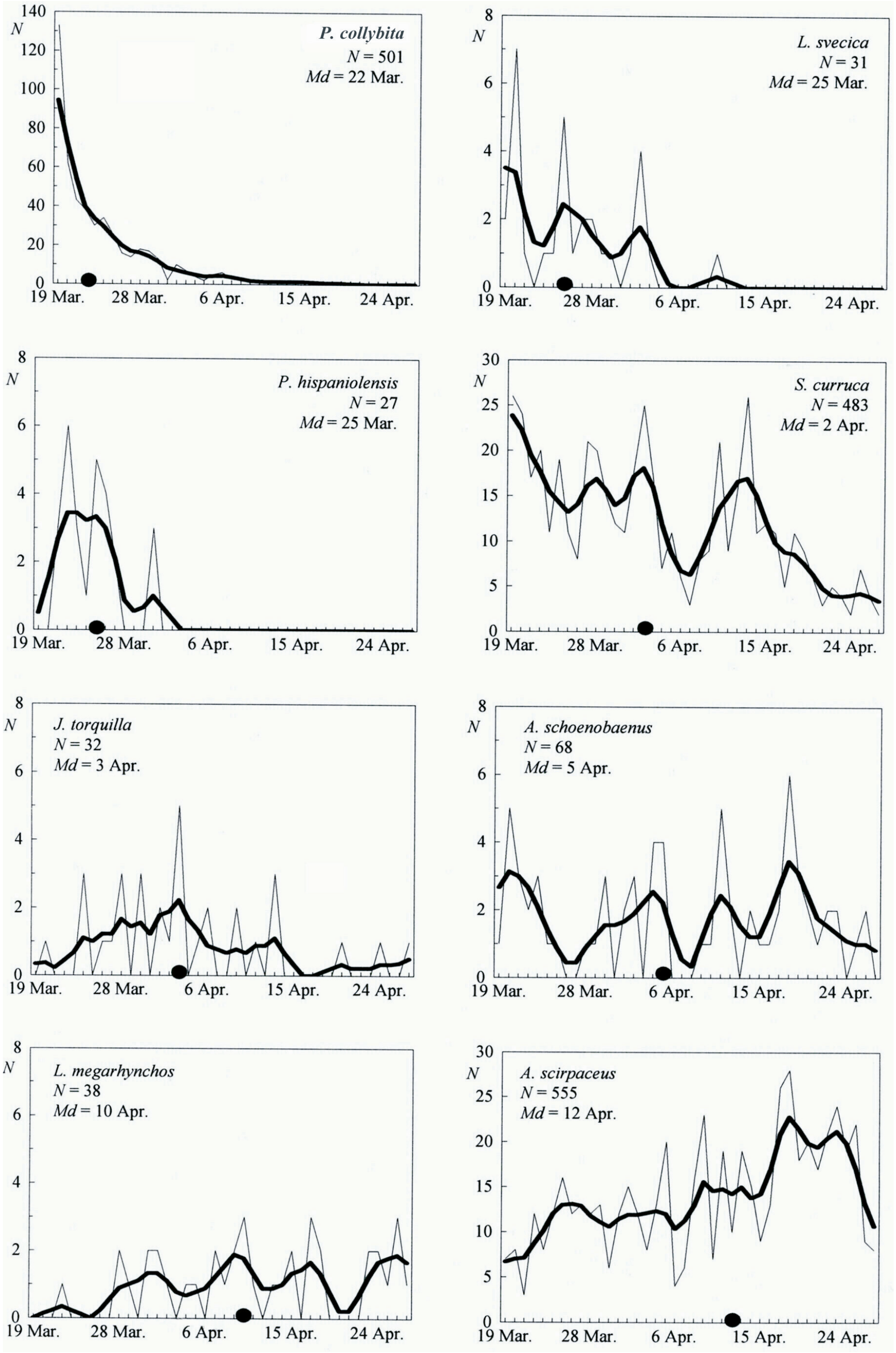
Fig. 3. Total seasonal dynamics, excluding the House Sparrow (*Passer domesticus*). Median date marked by black dot. Thin line – raw data; thick line – data smoothed once.

For the Blackcap (*Sylvia atricapilla*) and especially for the Reed Warbler, we covered neither the beginning nor the end of their migration. Their numbers increased through the catching period – gradually for Reed Warbler and rapidly for Blackcap (after 6 April), with the peak at the same time around 20 April; then decreased – either slightly (Reed Warbler) or rapidly (Blackcap).

Passage of the Sedge Warbler (*Acrocephalus schoenobaenus*) was the most prolonged, without the main peak, but there were four almost equal waves of migration. We did not cover either distinct beginning nor end of its migration. Because of equal peaks, the migration dynamics of the Nightingale (*Luscinia megarhynchos*) resembled the one for the Sedge Warbler, but it seems that we covered only the beginning of its passage.

We caught the beginning of migration, but not the end, of the remaining species: Barn Swallow (*Hirundo rustica*), Great Reed Warbler (*Arcocephalus arundinaceus*), Redstart (*Phoenicurus phoenicurus*), Willow Warbler (*Phylloscopus trochilus*), Sand Martin (*Riparia riparia*), Whitethroat (*Sylvia communis*) and Red-backed Shrike (*Lanius collurio*). Their numbers increased gradually (like Great Reed Warbler) or rapidly (like Red-backed Shrike) through the study period. Together with the Reed Warbler, these species affected also the second peak of the total seasonal dynamics.

We could also compare dynamics within larger groups. The most distinct differences were visible in the genus *Phylloscopus* – the Chiffchaff migrated much earlier with a difference of one month between its and the Willow Warbler's median date of passage. In the genus *Sylvia*, the Lesser Whitethroat migrated first. The migration dynamics of the Blackcap and Whitethroat were more similar; the Whitethroat migrated as the last one. In the genus *Acrocephalus*, similar dynamics were visible for the Reed Warbler and Great Reed Warbler. The Sedge Warbler migrated first and the Great Reed Warbler – last. In the genus *Luscinia*, the Bluethroat migrated earlier than the Nigtingale. In swallows, there were similar dynamics with a small difference between median dates of their passage.


P. collybita
N = 501
Md = 22 Mar.
L. svecica
N = 31
Md = 25 Mar.
P. hispaniolensis
N = 27
Md = 25 Mar.
S. curruca
N = 483
Md = 2 Apr.
J. torquilla
N = 32
Md = 3 Apr.
A. schoenobaenus
N = 68
Md = 5 Apr.
L. megarhynchos
N = 38
Md = 10 Apr.
A. scirpaceus
N = 555
Md = 12 Apr.
N
0
20
40
60
80
100
120
140
2
4
6
8
5
10
15
25
30
19 Mar.
28 Mar.
6 Apr.
15 Apr.
24 Apr.

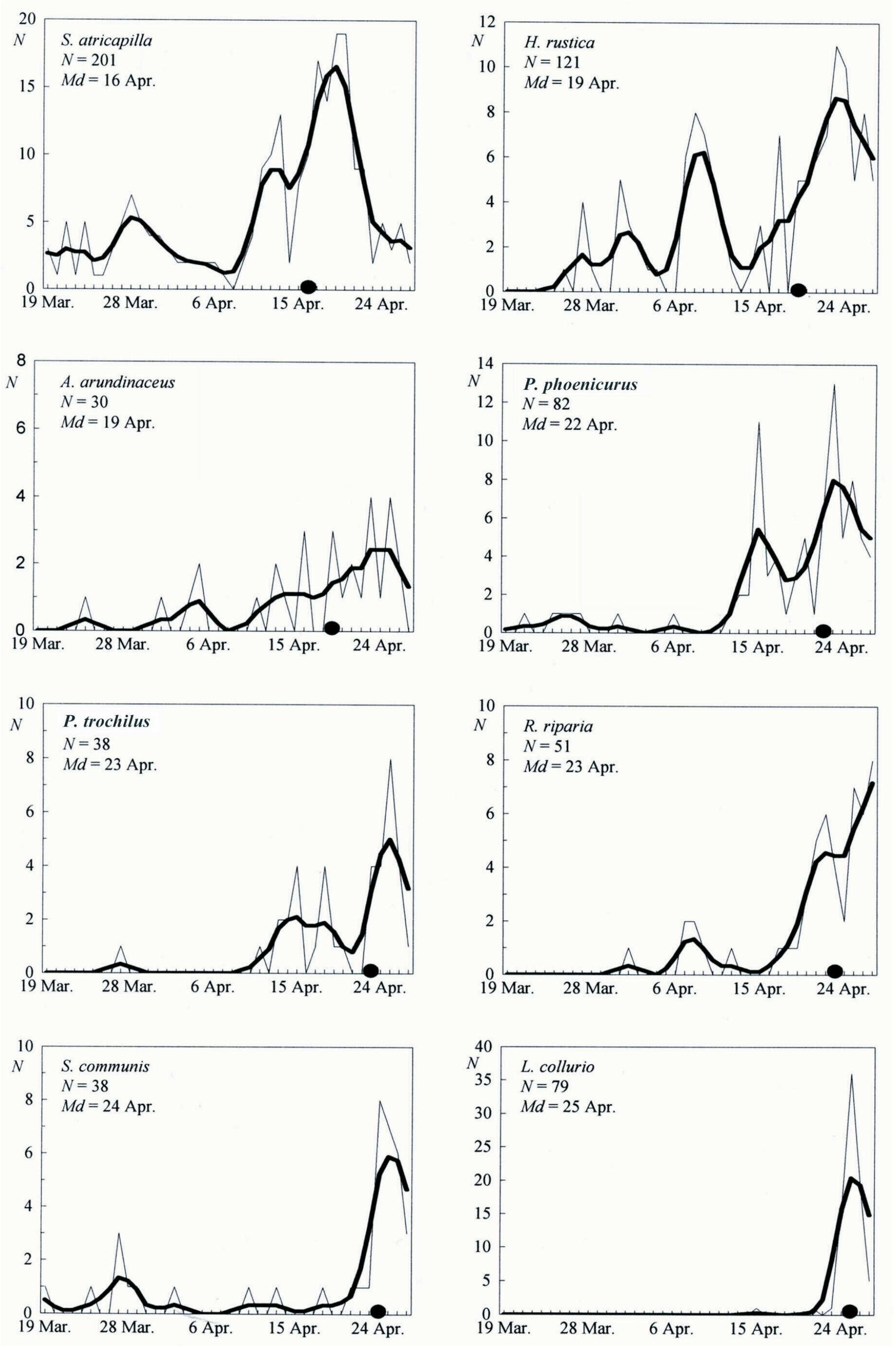
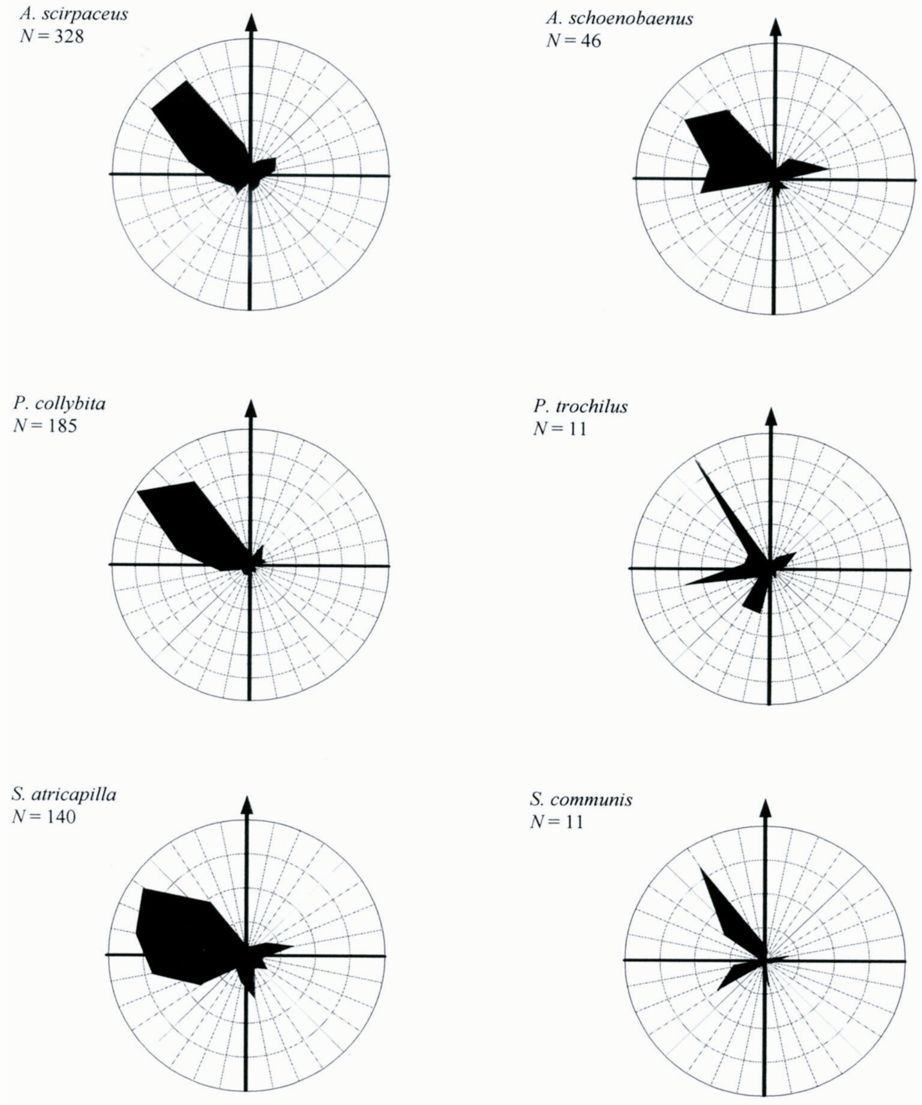


Fig. 4. Seasonal dynamics of the most numerous species. Thin line – raw data, thick line – data smoothed once. Median date marked by black dot. Charts arranged according to the median date of passage (from the earliest).

To sum up, the Chiffchaff migrated in Azraq as the earliest (median date – 22 March) and the Red-backed Shrike as the latest (median date – 25 April). Probably only for one species – the Wryneck (*Jynx torquilla*), almost the whole passage was covered. For almost all of presented species we could observe distinct waves of their passage and common low intensity of passage about 6 April.

Directional preferences

Altogether, we performed 1169 orientation experiments (1344 including retraps) on 34 species. The most frequently tested were: Reed Warbler, Chiffchaff and Lesser Whitethroat (Fig. 5 and 6). They constituted 74% of the tested birds.



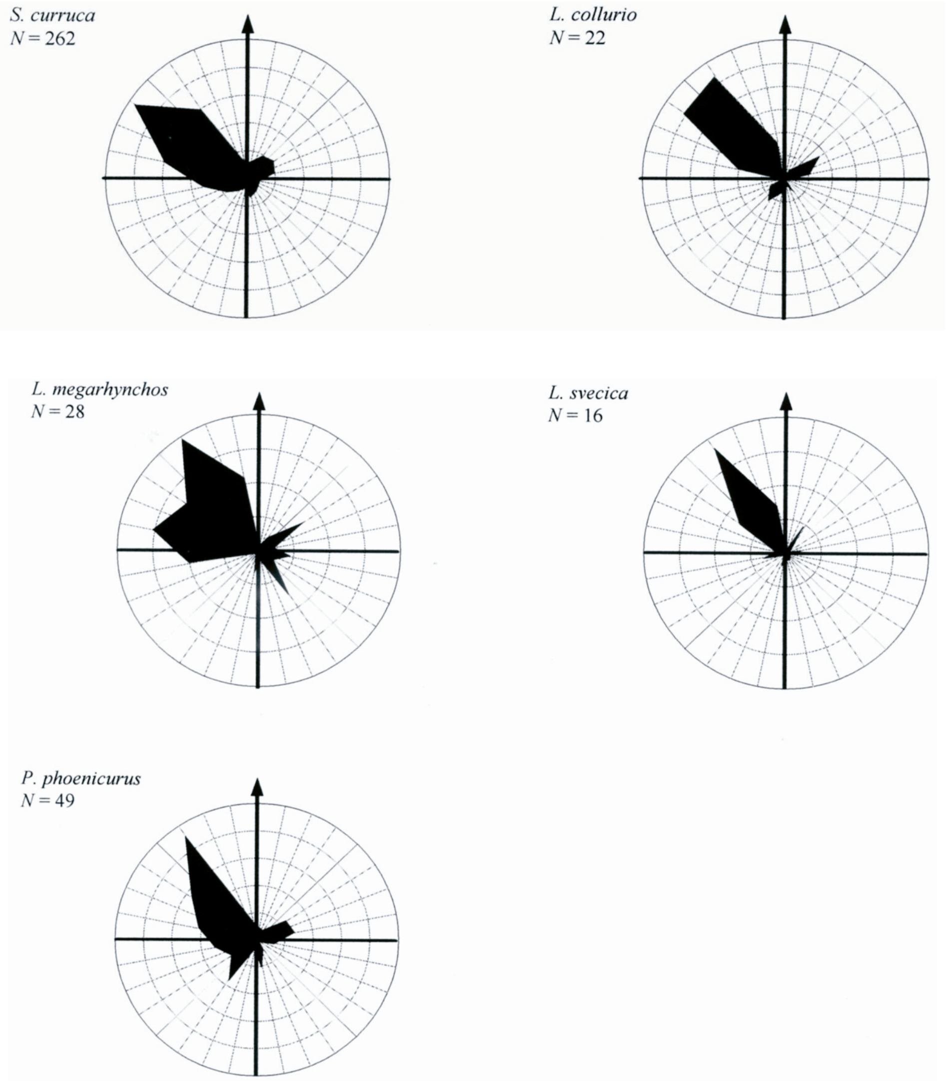
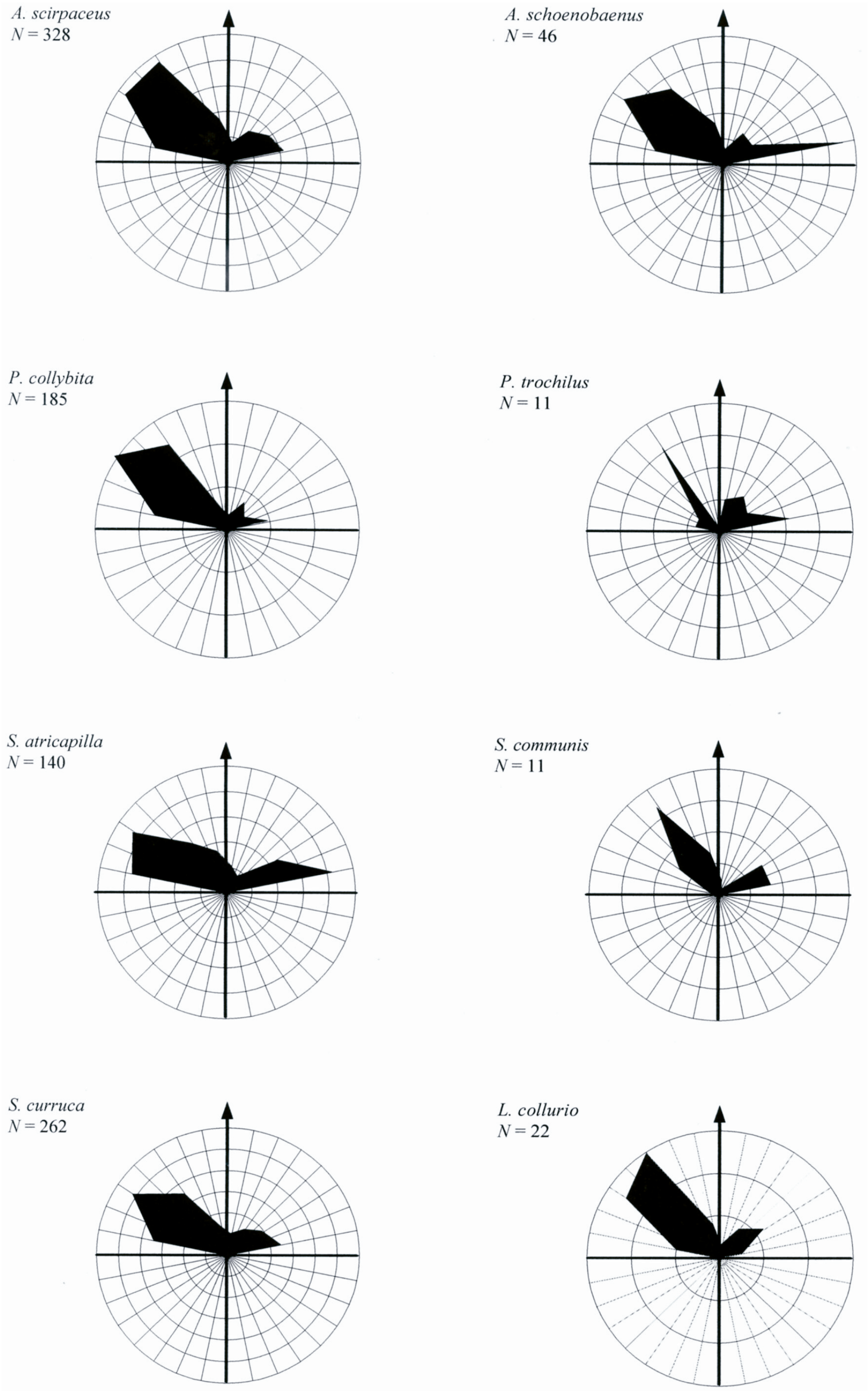


Fig. 5. Distributions of directional preferences of the most numerous tested species – raw data

For all presented species there was a striking similarity of directional preferences, with a distinct presence of NW headings (Fig. 5 and 6). Excluding the Willow Warbler, they dominated in each species (Table 2) and reached the largest share (70%) for the Chiffchaff. The second preferred were SW headings, with the largest share (41.5%) for the Willow Warbler, and third – NE, reaching the highest value (21.8%) for the Sedge Warbler. Headings to the SE had the least share of overall percentage.

Generally, the shares of opposite directions to the normal spring migration headings were low. It refers mostly to SE headings – they were the lowest for the Chifchaff, Bluethroat, Willow Warbler and particularly for the Red-backed Shrike (only 3.1%). It is worth noting that for the same species there were also the least


A. scirpaceus
N = 328
A. schoenobaenus
N = 46
P. collybita
N = 185
P. trochilus
N = 11
S. atricapilla
N = 140
S. communis
N = 11
S. curruca
N = 262
L. collurio
N = 22

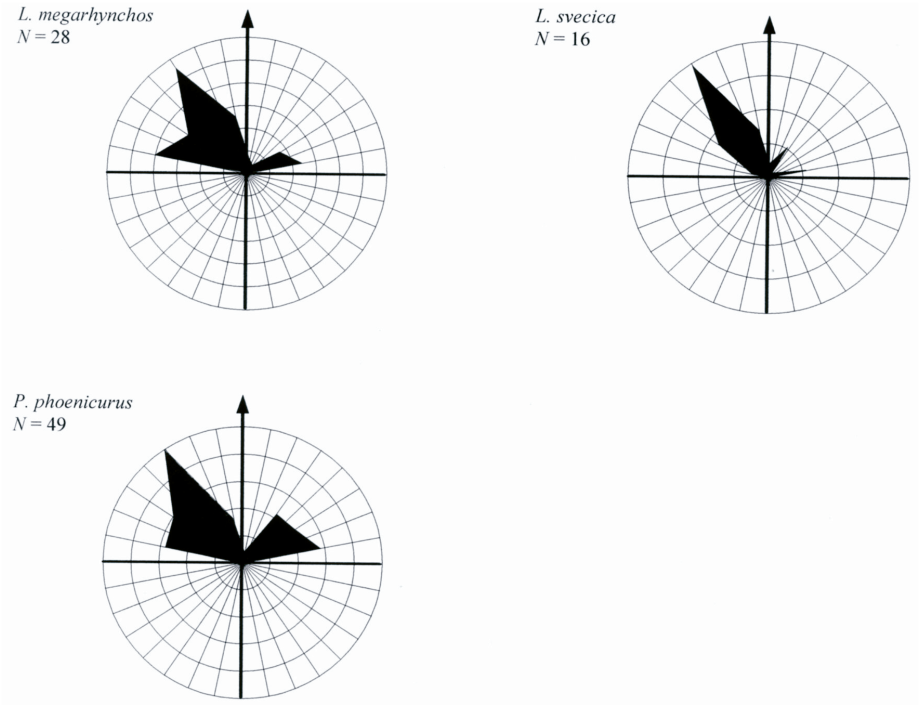


Fig. 6. Distributions of directional preferences of the most numerous tested species – reversed data

shares of SW headings – except for the Willow Warbler, for which this share was the largest among all of 11 presented species. For the reversed radar graphs there was, similarly to the raw data, a clear predominance of NW headings over NE ones in all cases – from 54.5% (Willow Warbler) till 75.0% (Chiffchaff).

It should be emphasized, that there was a distinct disproportion of northern and southern headings present on the NW-SE and NE-SW axes (Table 3). The share of northern headings for the NW-SE axis, contrary to the second one, was several times higher than that of southern directions for every species. The largest disproportion could be seen for the Red-backed Shrike (the share of NW headings is twenty two times as much as of the opposite SE headings) and the least – for the Blackcap (only three times). For the second axis, on the other hand, there was only slight predominance either of northern (particularly in the Red-backed Shrike and Bluethroat) or southern (particularly in the Willow Warbler and Whitethroat) directions.

In order to obtain a more general picture of migration we should also analyse the overall directional preferences of birds in Azraq (Fig. 7). This image is similar as the ones for individual species. There is the same, clear presence of NW headings (*cf.* Table 2). For the reversed data there is the highest share of NW headings, which is twice as much as NE headings. There is also a distinct disproportion of headings on the NW-SE and NE-SW axes. For the first one, the share of NW headings is almost six as much as the opposite SE headings. For the second axis the proportion of headings is very similar (Table 3).

Table 2
Share of directional preferences of tested birds in each of four main sectors in radar graphs. The largest value for each species is in bold.

Species	*N* of tests	Raw data Sector (%)				Reversed data Sector (%)	
		NW	SW	SE	NE	NW	NE
A. scirpaceus	328	**59.2**	15.2	9.9	15.4	**69.1**	30.9
S. curruca	262	**55.7**	15.8	10.6	17.9	**66.3**	33.7
P. colllybita	185	**70.0**	12.1	5.0	12.9	**75.0**	25.0
S. atricapilla	140	**44.7**	27.8	14.2	13.2	**58.9**	41.1
P. phoenicurus	49	**50.3**	23.2	11.3	15.2	**61.6**	38.4
A. schoenobaenus	46	**51.2**	17.8	9.2	21.8	**60.4**	39.6
L. megarhynchos	28	**58.1**	14.1	16.0	11.8	**74.1**	25.9
L. collurio	22	**68.8**	11.9	3.1	16.2	**71.9**	28.1
L. svecica	14	**69.5**	10.5	4.9	15.2	**74.3**	25.7
P. trochilus	11	40.8	**41.5**	4.7	12.9	**54.5**	45.5
S. communis	11	**52.6**	27.9	9.9	9.6	**62.5**	37.5
Total	1169	**57.2**	17.7	9.7	15.4	**66.9**	33.1

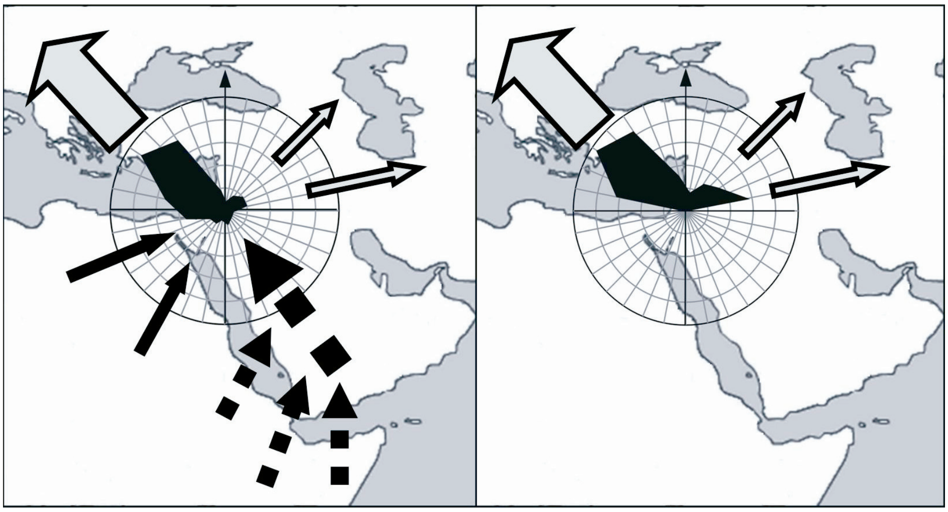


Fig. 7. Overall picture of directional preferences of all tested birds ($N = 1169$) for raw (left) and reversed (right) data. Presumable pattern of **arrival directions** (black solid arrows – based on the orientation results in Ibrahim (2011), black dashed arrows – based on the literature data, *e.g.* Pearson and Lack 1992) and **departure directions** (light grey arrows) of migrants are given.

Table 3
Proportion of northern to southern headings on two axes: NW-SE and NE-SW.
Values calculated according to the raw data from Table 2

Species	**NW**-SE	**NE**-SW
A. scirpaceus	6.0	1.0
S. curruca	5.3	1.1
P. colllybita	14.0	1.1
S. atricapilla	3.1	0.5
P. phoenicurus	4.5	0.7
A. schoenobaenus	5.6	1.2
L. megarhynchos	3.6	0.8
L. collurio	22.2	1.4
L. svecica	14.2	1.4
P. trochilus	8.7	0.3
S. communis	5.3	0.3
Total	**5.9**	**0.9**

Species observed in the field

Except 64 ringed species, we also observed 58 other species in the area of Azraq Wetland Reserve. These observations were made only occasionally – we did not make detailed counts, so below only a list of species without numbers is given: Grey Heron (*Ardea cinerea*), Purple Heron (*A. purpurea*), Great Egret (*A. alba*), Little Egret (*Egretta garzetta*), Cattle Egret (*Bubulcus ibis*), Squacco Heron (*Ardeola ralloides*), Night Heron (*Nycticorax nycticorax*), Bittern (*Botaurus stellaris*), White Stork (*Ciconia ciconia*), Glossy Ibis (*Plegadis falcinellus*), Garganey (*Anas querquedula*), Shoveler (*A. clypeata*), Osprey (*Pandion haliaetus*), Honey Buzzard (*Pernis apivorus*), Black Kite (*Milvus migrans*), Egyptian Vulture (*Neophron percnopterus*), Short-toed Eagle (*Circaetus gallicus*), Marsh Harrier (*Circus aeruginosus*), Hen Harrier (*C. cyaneus*), Pallid Harrier (*C. macrourus*), Long-legged Buzzard (*Buteo rufinus*), Golden Eagle (*Aquila chrysaetos*), Booted Eagle (*A. pennata*) – light and dark form, Hobby (*Falco subbuteo*), Quail (*Coturnix coturnix*), Moorhen (*Gallinula chloropus*), Coot (*Fulica atra*), Black-winged Stilt (*Himantopus himantopus*), Collared Pratincole (*Glareola pratincola*), Black-winged Pratincole (*G. nordmanni*), Spur-winged Lapwing (*Vanellus spinosus*), Common Snipe (*Gallinago gallinago*), Greenshank (*Tringa nebularia*), Green Sandpiper (*T. ochropus*), Wood Sandpiper (*T. glareola*), Common Sandpiper (*Actitis hypoleucos*), Ruff (*Philomachus pugnax*), Little Stint (*Calidris minuta*), Temminck's Stint (*C. temminckii*), Common Tern (*Sterna hirundo*), White-winged Tern (*Chlidonias leucopterus*), Rose-ringed Parakeet (*Psittacula krameri*), Nightjar (*Caprimulgus europaeus*), Egyptian Nightjar (*C. aegyptius*), Alpine Swift (*Apus melba*), Common Swift (*Apus apus*), Pied Kingfisher (*Ceryle rudis*), Blue-cheeked Bee-eater (*Merops persicus*), Bee-eater (*M. apiaster*), Crested Lark (*Galerida cristata*), Temminck's Lark (*Eremophila bilopha*), Crag Martin (*Ptyonoprogne rupestris*), Common House Martin (*Delichon urbica*), Yellow Wagtail (*Motacilla flava*) – probably *feldegg* and *thunbergii* subspecies, White Wagtail (*M. alba*), Ortolan Bunting (*Emberiza hortulana*), Sinai Rosefinch (*Carpodacus synoicus*), Golden Oriole (*Oriolus oriolus*).

DISCUSSION

Seasonal dynamics

In Azraq we caught large numbers of transient birds. The most common family was *Sylviidae*, as in previous ringing seasons in Azraq (Al-Omari *et al.* 2005, Al-Omari *et al.* 2007). The most numerous species were the same as in previous five spring seasons in 2002-2005 and 2007: Reed Warbler, Lesser Whitethroat, Chiffchaff and Blackcap (Al-Omari *et al.* 2005, Al-Omari *et al.* 2007). Except the Blackcap, the remaining species were the most abundant spring migrants also in Egypt (Ibrahim 2011).

Spring migration in Azraq is intensive, much more than in autumn (Al-Omari *et al.* 2005, Al-Omari *et al.* 2007), which is a general rule in the Middle East (Yom-Tov 1984, Shirihai 1996, Morgan and Shirihai 1997, Ibrahim 2011, Ożarowska *et al.* 2011). It is worth mentioning that the most numerous species ($N > 30$, see Table 1) have their breeding grounds spread widely in Europe, often reaching Siberia and western Asia (Harrison 1982, Hagemeijer and Blair 1997, Cramp 1998). Except for the Chiffchaff and Bluethroat, which can also winter in the Middle East (Porter *et al.* 1996, Shirihai 1996, Cramp 1998), these are generally the species whose wintering grounds are located mainly or exclusively in Africa. From more southern species (Mediterranean, Middle-Eastern or central-western Asiatic), the most numerous was the Spanish Sparrow; the remaining species from this group were caught rarely. This is clear evidence that the Middle East is an important area for many species during their migration between wintering and breeding grounds.

Fieldwork was started too late especially for the Chiffchaff. This is confirmed by the catching results from the previous spring seasons in Azraq (Al-Omari *et al.* 2005, Al-Omari *et al.* 2007), from Eilat in Israel located quite nearby (Morgan and Shirihai 1997) and from Egypt (Ibrahim 2011). Despite the early start of study in Azraq in 2005 (on 1 March), the peak of migration occurred exactly at the beginning of catching, so we do not know if the main peak of migration was caught. The passage of Chiffchaffs in Eilat starts in early February, with rapid growth in the middle of the month and the peak in the first half of March, so even later than in Azraq in 2005. Two things are similar and repeatable for dynamics in these two places – a rapid decrease of migration as the season advances and the end of passage in similar time frames (only single birds after 15 April). In Israel, this species is more abundant in the eastern part of the country (Shirihai 1996), which could mean that the spring passage could be strong eastwards, through Jordan. In Egypt, the Chiffchaff is also an early migrant, commencing its migration in mid-February and peaking in March (Goodmann and Meininger 1989). Nevertheless, the spring passage of this species in Egypt is less intensive than in Jordan – maximum daily number was only 19 (Hurghada – Ibrahim 2011), while 133 in Azraq.

Beside the Chiffchaff, also the Spanish Sparrow, Lesser Whitethroat and Bluethroat migrated through Azraq early. Contrary to the data from Israel, the last migrants of the Spanish Sparrow were caught at the end of March, while in Israel usually at the end of May, with three peaks of passage through mid-February till the end of April (Shirihai 1996). In Israel, the first to migrate is the eastern subspecies *transcaspicus* before the nominative one, migrating closer to the Mediterranean Sea, so it is possible that we caught only birds from the eastern populations.

Probably we did not cover the peak of migration also for the Lesser Whitethroat, although in previous seasons in Azraq this species peaked much later – at the end of March 2004 and 2005 (but in 2004 the second high peak appeared also after mid-April – Al-Omari *et al.* 2005). Migration of Lesser Whitethroats in Israel starts in the second half of February with a peak in the second half of March in Eilat. It seems that the pattern of migration of Lesser Whitethroats is changeable between years. In Egypt, it is the most numerous in March (Ibrahim 2011). Distinct waves of the seasonal dynamics could reflect different time of migration either of sex groups or maybe even subspecies (Shirihai 1996), which were not identified by us due to too high similarity among them (Svensson 1992, Shirihai 1996).

In the case of the Bluethroat, we could miss the main peak of its migration – the major wave of the passage of Bluethroats in Israel falls into the second week to the end of March (Morgan and Shirihai 1997). The passage of this species weakened gradually, but with distinct waves, till total expiring before mid April.

For the Sedge Warbler and Nightingale there were no visible predominant peak of their passage (in Eilat they peak at the end of March and beginning of April, respectively – Shirihai 1996). These quite equal intensities of passage through the whole catching season resemble the spring migration of the Sedge and Reed Warbler in Egypt (Ibrahim 2011, Ożarowska *et al.* 2011).

The Reed Warbler is the most common migrant species in the migration season in Azraq (Al-Omari *et al.* 2005, Al-Omari *et al.* 2007). It also breeds in the Middle East; we caught a few females with a brood patch or with an egg in the oviduct. The nominative and *fuscus* subspecies occur in the Middle East (Shirihai 1996, Morgan and Shririhai 1997, Cramp 1998) – we caught the first *fuscus* on 20 April. In previous spring seasons double-peaked dynamics, similar to the one in Israel, occurred (Al-Omari *et al.* 2005, Al-Omari *et al.* 2007). Shirihai (1996) and Morgan and Shirihai (1997) suggested that this is not due to the differentiation in timing between sex groups, but rather due to the migration of at least two discrete populations at a different time. It is interesting that one of these peaks in the spring of 2008 occurred in the same time (16-20 April) as in spring 2004 and 2005. We are not sure if we covered the highest peak of the Reed Warbler migration in the season – in 2005, when the study was conduced till mid May, it fell at the beginning of this month (Al-Omari *et al.* 2005, Al-Omari *et al.* 2007).

The migration of the Blackcap started with a small group of birds, what could be seen also for the Whitethroat, Redstart and Sand Martin. More intensive migration appeared much later. Morgan and Shirihai (1997) found that there are two distinct peaks in the migration of Blackcaps at Eilat – the first one in mid-April and the second in early May. They pointed at the migration of two, unrelated populations of

Blackcaps through Eilat – it is possible that the same phenomenon occurred also in Jordan. In comparison to the spring 2004 and 2005 in Azraq, we discovered the same pattern for the migration of Blackcaps in 2008: low daily numbers up to the beginning of April and then rapid growth with the peak exactly in the same time, between 16 and 20 April. It means that the pattern of migration for this species is repeatable like in the case of the Chiffchaff. In Eilat, similarly, Blackcaps were noted in the highest densities at the turn of April (Shirihai 1996). In Egypt, on the other hand, this migrant was scarce in spring (Ibrahim 2011). This could mean that this species in majority probably flies eastwards through the Arabian Peninsula.

The most common swallow in Azraq – the Barn Swallow, appeared at the end of March and showed distinct waves with higher and higher numbers through the season. It formed large flocks at dusk and roosted commonly in reedbeds in the reserve. Because in Israel it is a common migrant from the end of March till the third week of May, we probably missed a major part of its passage (Morgan and Shirihai 1997). A gradual increase in numbers of migrating Barn Swallows resembles the situation in Hurghada (Ibrahim 2011). The second quite numerous species, the Sand Martin, appeared later in Azraq. The main passage of this species in Israel begins in the third week of April and maximum numbers fall in the beginning of May (Shirihai 1996). A rapid increase of passage from mid April was also noted at coastal Egyptian stations – Hurghada and Wadi Gemal (Ibrahim 2011).

The passages of the Willow Warbler and Redstart were similar, with a smaller peak about mid-April and then growth at the end of April. They are quite similar to the results from Hurghada, with main passage in the second half of April (Ibrahim 2011). In the case of the Willow Warbler, there is a clear difference in timing of migration as compared to the closely related Chiffchaff – *i.e.* the spring migration of Willow Warblers through the Middle East occurs later, which is also the rule in Europe (Shirihai 1996, Cramp 1998).

The Whitethroat was one of the latest spring *Sylvia* species. Single individuals appeared during almost the whole catching period. Just at the end of April, there followed a rapid increase in their numbers, resembling the passage in Hurghada; however, this species was scarce at the other inland stations in Egypt (Ibrahim 2011). It is surprising why Whitethroats were caught in Azraq and Hurghada so late, if in Israel they migrated much earlier, with a peak in the second half of March (Shirihai 1996).

The Red-backed Shrike, on the other hand, is a very late migrant also in Israel (with a peak in mid-May). In Azraq, these birds appeared rapidly and in high numbers at the end of April during days with very hot SE winds from the Arabian Peninsula. This species is known from performing the loop migration – it crosses in spring Africa and the Middle East further east than in autumn (Pearson and Lack 1992, Morgan and Shirihai 1997, Cramp 1998).

It seems probable that only for the Wryneck we caught almost the whole passage. This species migrates through Israel mainly between the third week of March and the third week of April (Shirihai 1996).

The migration of the majority of presented species is characterized by distinct waves. Some of these waves were common for many species – this could reflect influence of the same factor during their migration. The most distinct and also common decrease occurred on 6 and 7 April; it was caused by bad weather during these days (strong NE and then NW wind). This stopped the migration of the majority of species presented here. For the latest migrants there was a common increase of their numbers around 24 April, probably also caused by weather, bringing a new wave of migrants. Waves could also reflect differentiation in timing of migration between populations, as well as age and sex groups, which was proved generally for many Palearctic species, also in the Middle East (Shirihai 1996, Morgan and Shirihai 1997).

Directional preferences

Despite differentiation between seasonal dynamics, the directional preferences of the presented species were surprisingly similar to each other with a clear dominance of NW headings towards Europe. Moreover, they were multimodal, suggesting that the stream of migrants consisted of birds migrating into different wintering quarters and breeding grounds (Busse 1987, Busse 2001, Formella and Busse 2002, Ibrahim 2011). Tested birds showed also axial behaviour; reversed (southern) headings, opposite to the northern, were interpreted as directions from which they come to Azraq (Formella and Busse 2002, Zehtindjiev *et al.* 2003).

The strong share of north-western headings suggests routes towards European breeding grounds through Cyprus, Balkans and Turkey (Fig. 7). This could be an evidence against the commonly accepted phenomenon that spring migration towards Europe leads mainly around the eastern Mediterranean coast than across the sea (*e.g.* Shirihai 1996). Directions towards Asian breeding grounds, much more pronounced at reversed graphs, could show crossing of Mesopotamia and area around the Caspian Sea, leading towards eastern areas. Clear presence of NW and NE directions was also reported in spring in Israel by Ożarowska *et al.* (2004) and Dinevich and Leshem (2010). The high repeatability of directional preferences pattern could be an evidence of a strong influence of the same geographical factors in the areas through which different species migrate.

The southern headings of tested birds could indicate the directions from where birds have just arrived (Zehtindijev *et al.* 2003). If so, in Azraq we have two directions of origin: the first – from the Arabian Peninsula and then towards Europe (assuming axial behaviour, see Trocińska and Busse 1999), and the broad second – through the Arava Valley (then towards Asia), leading from wintering grounds in Africa or, like for the Chiffchaff or Bluethroat, even in the Middle East (Fig. 7).

Clearly pronounced NE headings in spring were found in Egypt and Eilat in Israel (Ibrahim 2011). If birds migrate on a broad front through Africa and then through the Middle East, a part of them could encounter Jordan afterwards. It is interesting why NE headings at Eilat have lower angle (are closer to the N axis) than these in Azraq (with larger angle, closer to the E axis). In Eilat, this could be caused by funnelling by the narrow Arava Valley, bordered by high mountains. With the northward progress of migration, these mountains end before the Dead Sea region, so then migrants could fly north-eastwards more easily. Ożarowska *et al.* (2004) also reported NE headings for the Blackcap and Lesser Whitethroat in Eilat, but these directions dominated only in the Chiffchaff.

A precise description of the route of birds migrating from somewhere in Africa and then passing through the Arabian Peninsula, is less easy. Studies of migrants in this vast area are still lacking and mainly refer to large soaring birds, like raptors (Shirihai 1996). Nevertheless, there are some spring recoveries of passerines from there, which support the existence of the spring flyway towards Europe through the Arabian Peninsula. Individuals of the Barn Swallow, Lesser Whitethroat, Marsh Warbler, Red-backed Shrike, Thrush Nightingale and Willow Warbler ringed in the Czech Republic, Italy, Slovakia or Sweden were recovered in Jemen, Saudi Arabia or Iraq (Hendenström and Pettersson 1987, Cramp 1998, Cepák *et al*. 2008, Fransson and Hall-Karlsson 2008, Spina and Volponi 2008). For these species, it is also mentioned that their spring migration follows a more eastern route through the Middle East than in autumn.

Pearson and Lack (1992) divided north-eastern Africa (Sudan, Ethiopia and Somalia) into four sectors from west to east. They found that Palearctic species migrate in autumn or in spring on a broad or narrow (more eastern or western) fronts. Moreover, a number of species perform loop movements, crossing the Arabian Peninsula further east in spring than in autumn. The species, such as the Whitethroat and particularly the Red-backed Shrike and Lesser Grey Shrike, are more abundant during spring migration at the most eastern part of north-eastern Africa than in autumn, crossing in spring the Red Sea at its most southern coasts and even the Aden Bay. The loop migration of the Red-Backed Shrike is confirmed by the results of spring catching in Egypt – during nine spring catching seasons (2001-2008), at five stations there was caught only one individual, whereas, during autumn seasons, there were caught above 300 individuals in total (Ibrahim 2011). The Red-backed Shrike in spring is almost absent in Egypt, but quite numerous in nearby Israel (Shirihai 1996). As was reported by Goodmann and Meininger (1989), some birds fly around much of Egypt along the Sinai Peninsula and then migrate towards the Arava Valley. The headings on the NE-SW axis in Azraq could be thus shown by birds crossing the most northern part of the Red Sea and then reaching Jordan, but distinct NW-SE headings – by a larger group of birds showing loop migration along the Arabian Peninsula.

Some species (*e.g.* Sedge Warbler, Reed Warbler, Great Reed Warbler, Blackcap and Garden Warbler) are absent in Somalia and east Tanzania in autumn, but present in spring (Pearson and Lack 1992). Another species, such as the Barn Swallow, Yellow Wagtail and Blue-cheeked Bee-eater, migrate in spring through north-eastern Africa on the same broad front as in autumn. All this supports our findings that birds exhibiting NW direction could migrate from Africa by crossing the Red Sea somewhere at its more southern part and then flying along the Arabian Peninsula towards Europe. Orientation results from Egypt given by Ibrahim (2011) support crossing the Red Sea by migrants – there was a considerable share of NE headings among birds tested in spring at all Egyptian stations, inland and coastal at the Red Sea. Moreover, there exists also a distinct route along the coast of the Red Sea in Hurghada and Wadi Gemal. As was suggested by Shirihai (1996), some birds following the leading line of the Red Sea turn by the Sinai Peninsula and then migrate towards the Arava Valley in order to go round the Mediterranean Sea, reaching Israel and Jordan.

Another interesting thing is why the proportions of northern and southern headings on the NW-SE and NE-SW axes are so different. As was mentioned above, in Azraq there is a very low share of the reversed directions, especially SE. The nature of reversed migration is still not well recognized – it is supposed that it could be caused by weather conditions, age, fatness, endogenous factors or geographical barriers (*e.g.* Åkesson *et al.* 1995, Komenda-Zehnder *et al.* 2002, Zehtindjiev *et al.* 2003). In our paper we focused on the last reason.

Towards SE from Azraq there are large sandy deserts of the Arabian Peninsula – contrary to SW directions, where there is close to the many types of vegetation in the Arava Valley. This could explain why there is a much lower share of SE headings than that of SW direction. Bruderer (1994) claims that reverse migration in southern Israel is even more pronounced in autumn than in spring, suggesting that birds in autumn are prone to return to (previously experienced) better habitats, while in spring most of them have experienced the desert before. If so, the birds that migrate in Azraq towards Europe through the Arabian Peninsula (along the SE-NW axis) are determined to fly exactly in the right direction – moving backward to the large geographical barrier of the Arabian Desert would be very dangerous for them. Birds migrating from the Arava Valley (along the SW-NE axis), on the other hand, had crossed the Sahara Desert earlier and did not have such unfriendly habitat immediately behind them like the birds coming from the Arabian Peninsula. This could also explain why the proportions of NE and opposite SW headings are quite alike.

The directional preferences of birds in Azraq are similar to a general radar graph from Eilat (Ibrahim 2011). There was also a very low proportion of southern directions there. The only difference was the predominance of NE headings in Eilat, but the difference between NE and NW was much smaller than in Azraq there. Similar pictures from spring migration in Eilat are reported also by Ożarowska *et al.* (2004). They revealed a very small share of southern headings for the Lesser Whitethroat, Blackcap and Chiffchaff. In Egypt, however, it was otherwise. The general radar graphs of raw data at Egyptian spring stations were characterized by considerable shares of southern headings (Ibrahim 2011).

It is clearly visible that migrants in Azraq fly mostly towards European breeding grounds. The breeding areas of the majority of species presented here spread also in Asia, but it is possible that the most eastern Asiatic populations migrate there by even more eastern flyways (Cepák *et al.* 2008, Fransson and Hall-Karlsson 2008), maybe even along the eastern coast of the Arabian Peninsula and then the Persian Gulf.

The recoveries of birds ringed in Azraq or reported here with foreign rings are scarce, but they confirm the passage of birds from wide breeding areas through this region (Al-Omari *et al.* 2005, Al-Omari *et al.* 2007). According to these authors, up to now in Azraq there have been reported birds from: Denmark (one Lesser Whitethroat), Slovakia (one Chiffchaff), Romania (one Reed Warbler) and Israel (three Reed Warblers, one of them on 30 March 2008). There were also recoveries of birds ringed in Azraq and then caught in: Israel (one Chiffchaff), Bulgaria (one Reed Warbler) and even Great Britain (one Lesser Whitethroat). As was emphasized by Formella and Busse (2002) and Ożarowska *et al.* (2004), the ringing recoveries from eastern areas, which could better confirm the existing of eastern routes towards Asia, are still lacking due to very low, if any, ringing activity there – contrary to Europe. Nevertheless, a distinct share of NE headings at many SEEN stations located within a huge area of north-eastern Africa and Middle East demonstrated that the passage towards east-European and Asian breeding grounds really exist.

CONCLUSIONS

Seasonal dynamics and directional preferences of the most numerous species in Azraq give an interesting picture of passerine migration through this area. Timing of migration, shape of seasonal dynamics and directional preferences of many species presented here are often quite similar to results from nearby Israel or Egypt, from which a part of migrants could pass Jordan. Birds belonging to more northern or more southern Palearctic species, different subspecies, which occurred in Azraq, as well as the variation of preferred directions are an evidence that the migration routes of European and Asiatic populations cross each other in the Middle East. Our study provides information about the migration of small birds through this still poorly investigated area and indicates a necessity of more detailed studies. The richness of over 120 bird species ringed and observed in Azraq supports the strong need for the permanent protection of such places in the desert areas of the Middle East as important habitats for Palearctic migrants. The mosaic of wet and drier habitats, surrounded by a large desert, make the Azraq Wetland Reserve attractive for many species, including numerous habitat-specialists like *Acrocephalus* warblers. Those studies would give us an opportunity to extend our knowledge about bird migration system and migratory strategies of species on the still poorly known south-eastern flyway.

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AUTUMN MIGRATION OF PASSERINES IN BAHARIYA OASIS, EGYPT – WHERE DO THEY COME FROM AND WHERE DO THEY GO?

Krzysztof Stępniewski, Matthew L. J. White and Mary Megalli

ABSTRACT

Stępniewski K., White M.L.J., Megalli M. 2011. *Autumn migration of passerines in Bahariya Oasis in Egypt – where do they come from and where do they go?* Ring 33, 1-2: 27-36.

We present the results of studies on directional preferences of passerine migrants in Bahariya Oasis, Western Desert, Egypt. Fieldwork was conducted in August and September 2010. Birds were mist-netted, ringed and tested in Busse's orientation cage; in total 66 tests were analysed. The most pronounced direction was W, which was surprising and remains unexplained. Southern directions were also prominent, particularly SW; among the northern directions NW were distinct and NE less so. Our results are in line with those at other ringing stations in Egypt, suggesting a common migration pattern in this region. They also allow for tracking probable migration routes through Bahariya. Birds may arrive at the oasis from the Nile Delta and Mediterranean coast, then the majority head SW towards Lake Chad, while others may fly directly S or SE towards the Nile Valley. Bahariya Oasis appears to be an important crossing point of passerine migration routes across the Sahara and it is important to continue further studies in this area.

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Key words: autumn migration routes, directional preferences, Bahariya Oasis

INTRODUCTION

Every year as many as five billion birds fly from Eurasia to Africa in autumn and back in spring in what is probably the largest and most complex bird migration system in the world (Moreau 1972, Newton 2008). For the majority of migrating populations from central and eastern Europe and western Asia, the main flyway runs through the eastern Mediterranean and Middle East. Birds reach Africa in Egypt and then fly southwards across the Sahara Desert (Shirihai 1996, Newton 2008).

Egypt, located in the NE corner of Africa, is one of the most important areas for birds flying the SE route. The country has three main types of environment: sea coasts, the fertile Nile Valley, and deserts that cover about 96% of Egypt (Goodman and Meininger 1989). After crossing the Mediterranean or Middle East and reaching northern Egypt some birds follow the Nile or Red Sea coast; others, among them many small passerines, fly directly across the Sahara Desert, one of the most inhospitable places in the world, with only a small number of oases as potential stopover sites (Goodman *et al.* 1986, Biebach 1992).

Studies of passerine migration in Egypt have concentrated mostly on bird strategies for crossing the ecological barrier of the Sahara desert, focusing particularly on fuel accumulation and stopover strategies, as well as non-stop or intermittent flight (Biebach *et al.* 1986, Biebach 1992, Biebach *et al.* 2000, Hilgerloh and Raddatz 2009, Yohannes *et al.* 2009). Relatively few studies have dealt with directions of migration (Kiepenheuer and Linsenmair 1965, Biebach *et al.* 1991). Since 2001, when the Wadi El Rayan (S of Lake Qarun, Fayoum) ringing station was established, several SEEN (SE European Bird Migration Network) stations have operated in Egypt, recording data on migration dynamics and biometry of passerines (Ibrahim 2011, Ożarowska *et al.* 2011), as well as on directional preferences, using Busse's orientation cages (Ibrahim 2011). However, these stations operated around the Nile Valley or along coastal areas; until this study none operated in remote oases in the desert (Ibrahim 2011). In autumn 2010 the first SEEN station was established in Bahariya oasis in the Western Desert of Egypt. In this paper we present the results of orientation tests performed there as well as preliminary hypotheses on possible major migration routes through the oasis.

STUDY AREA

Bahariya Oasis in the Western Desert of Egypt is approximately 280 km south of the Mediterranean coast and 180 km west of the Nile Valley, separated from both by expansive areas of arid sand. The oasis forms a depression embedded in the Eocene limestone plateau (lowest point +80-90 m a.s.l.), partly encircled by steep escarpments (200-250 m a.s.l.). The total surface is 1800 km^2 (Goodman *et al.* 1986). There are a number of deep and shallow cased wells, the main source of water in the oasis, as well as several saline lakes, of which the largest is Lake El Marun. Agriculture in the oasis is widespread, with large date palm (*Phoenix dactylifera)* plantations and substantial areas of alfalfa (*Medicago sativa)* crops. The small oasis of El Heiz is about 40 km SW of the main area of Bahariya, separated by the "Black Desert".

Mist-netting of birds was conducted in two periods: 26-31 August near Lake Abu Yasser in El Heiz and 1-15 September near Lake El Marun in Bahariya Oasis proper (Fig. 1).

Lake Abu Yasser (28°01'N, 28°43'E) is a small lake located in El Heiz Oasis, 3 km SE of the Bahariya-Farafra road. The lake edges are marshy and partly overgrown

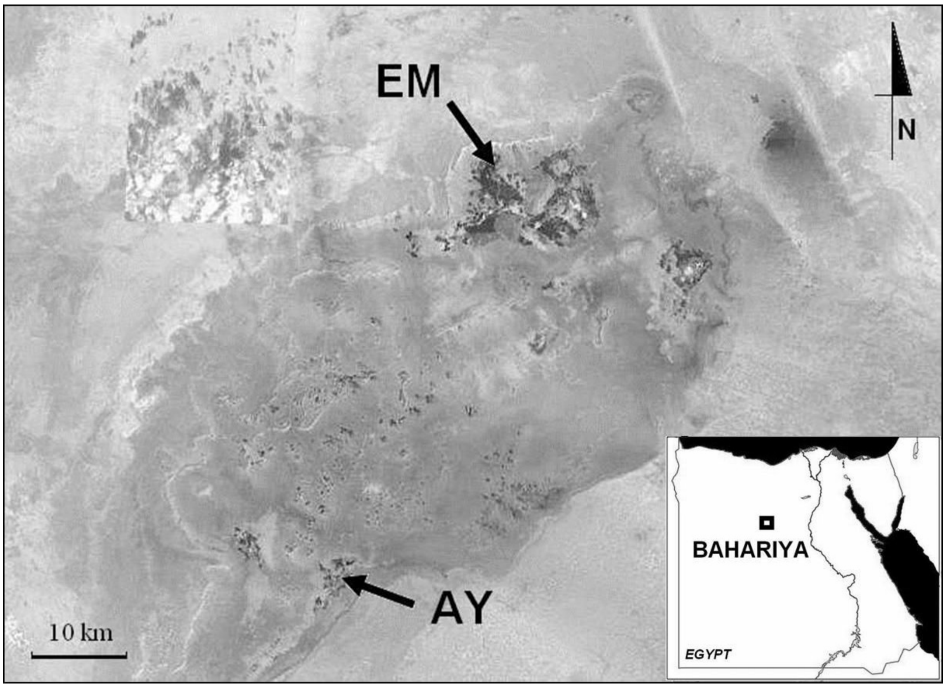

Fig. 1. Bahariya Oasis. The main area of the oasis with Lake El Marun in the upper part of the picture, El Heiz oasis in the lower. Note the escarpments surrounding the depression. Study localities: AY – Lake Abu Yasser, EM – Lake El Marun (source of photograph: GoogleEarth)

with rushes (*Juncaceae*) and reeds (*Phragmites australis*). The area beyond the western shore is cultivated with a mosaic of pasture and date palm groves. The lake is surrounded by bare and sandy areas, where only low level vegetation and sparse tamarisk (*Tamarix sp*). bushes grow. The nets (10) were placed among the rushes, reeds and tamarisks.

Lake El Marun (28°25’N, 28°53’E) is a larger saline lake located in the northern part of Bahariya Oasis, 6 km N of the town of Bawiti. In summer, there is less water overflow from wells, which creates large areas of bare, salt-covered ground; in some areas of the lake the edges are overgrown with thin belts of reeds and rushes. Vegetation in the vicinity of the lake is structurally diverse. In areas irrigated by wells, there are date palm groves and alfalfa plantations. Drier areas are sparsely covered with tamarisks, giving way to sandy desert habitats. The study area was situated near the NE shore of the lake. Nets (14) were placed in alfalfa crops watered by the nearby well-fed holding pond, in tamarisk bushes, apricot (*Prunus armeniaca*) trees and reedbeds. Insects appeared to be very abundant, particularly in alfalfa crops, which attracted many foraging passerine birds. For further details of passerine habitat associations and birds caught at both sites, see White *et al*. (in prep.).

METHODS

Mist-netting was conducted from dawn until 10.00 *a.m.* and from 4.30 *p.m.* until dusk; at mid-day temperatures reached around 40°C and bird activity was reduced. Caught birds were ringed and a standard set of measurements was taken (fat score, wing formula, wing and tail length; see Busse 2000). After recording the biometrics the birds were tested in Busse's orientation cage. This simple and quick method of testing directional preferences of migrating birds in the field was invented and developed by Busse (for details see Busse 1995). The bird is placed inside a cage constructed of two rounded wires joined by eight vertical sticks; the side wall (divided by the sticks into eight sectors) is covered by transparent foil and the top is covered by netting. The cage itself is placed (always in the same way along the N-S axis) inside a non-transparent rounded screen, so the bird can only see the sky. As the bird tries to escape, it makes indentations and scratches on the foil. After ten minutes the bird is released and the marks on the foil in each sector are counted separately.

The data were analysed with the program ORIENT v. 4.6 using the procedure that allows for multimodal distribution of headings (for detailed description see Busse and Trocińska 1999). Inactive birds (number of scratches lower than 20) and those whose distribution of headings did not differ significantly from randomness (tested by χ^2-test) were excluded from the analyses. The results are presented as 16-sector radar graphs based on a compass rose (drawn in Corel Quattro Pro); the headings show the summarized distribution of individual vectors of all the birds from the sample and the polygons are used to make the pictures clearer.

A phenomenon often occurring in the orientation experiments are reverse directions, *i.e.* opposite to normal direction of migration in a given season (Busse and Trocińska 1999). Two hypotheses explaining them have been postulated (Zehtindjiev *et al.* 2003): (1) they are reverse directions along the same axis of migration and for analyses they can be safely reversed by adding 180° (Busse and Trocińska 1999), (2) they reflect directions of arrival. In this paper we follow the second hypothesis and do not reverse the northward directions. This phenomenon requires further studies.

RESULTS

Altogether 71 orientation tests were conducted; five included inactive birds which were excluded from the analyses. The number of tests was not high (Table 1) due to relatively small numbers of caught birds. Therefore, we only analysed the total distribution of headings for all species (from both stations combined) as well as for the four species with the highest number of tests ($N > 6$).

Western directions were clearly dominant in Bahariya (Fig. 2): W and NW together constituted 47.2% of all the headings. SW was also distinct (19%), S and SE less so (14.6 and 9.2%, respectively). The least distinct directions were: NE (4.6%), N (2.9%) and E (2.4%).

Table 1
Numbers of orientation tests performed for each species at two study sites;
AY – Lake Abu Yasser, EM – Lake El Marun

	N of tests		
	AY	EM	Total
Phylloscopus trochilus	4	12	16
Motacilla flava	0	13	13
Cercotrichas galactotes	0	9	9
Lanius collurio	4	3	7
Acrocephalus schoenobaenus	3	2	5
Acrocephalus scirpaceus	0	5	5
Sylvia curruca	0	4	4
Iduna pallida	1	1	2
Ficedula albicollis	0	2	2
Luscinia luscinia	0	1	1
Muscicapa striata	0	1	1
Sylvia borin	0	1	1
Total	**12**	**54**	**66**

Directional preferences for individual species were rather diverse (Fig. 3), but western directions dominated for most, particularly for the Willow Warbler (*Phylloscopus trochilus*) and the Yellow Wagtail (*Motacilla flava*). The SW headings were

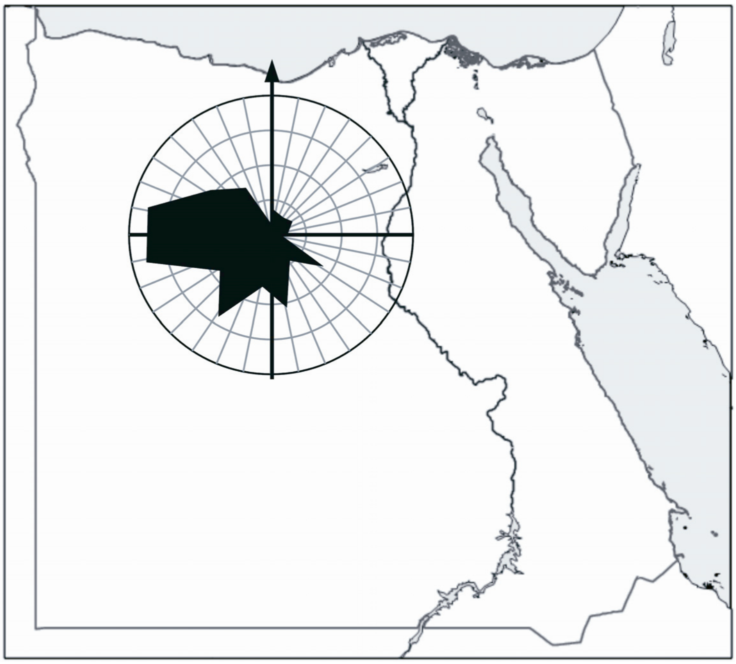

Fig. 2. Summarized distribution of preferred directions of all tested birds (both stations combined)

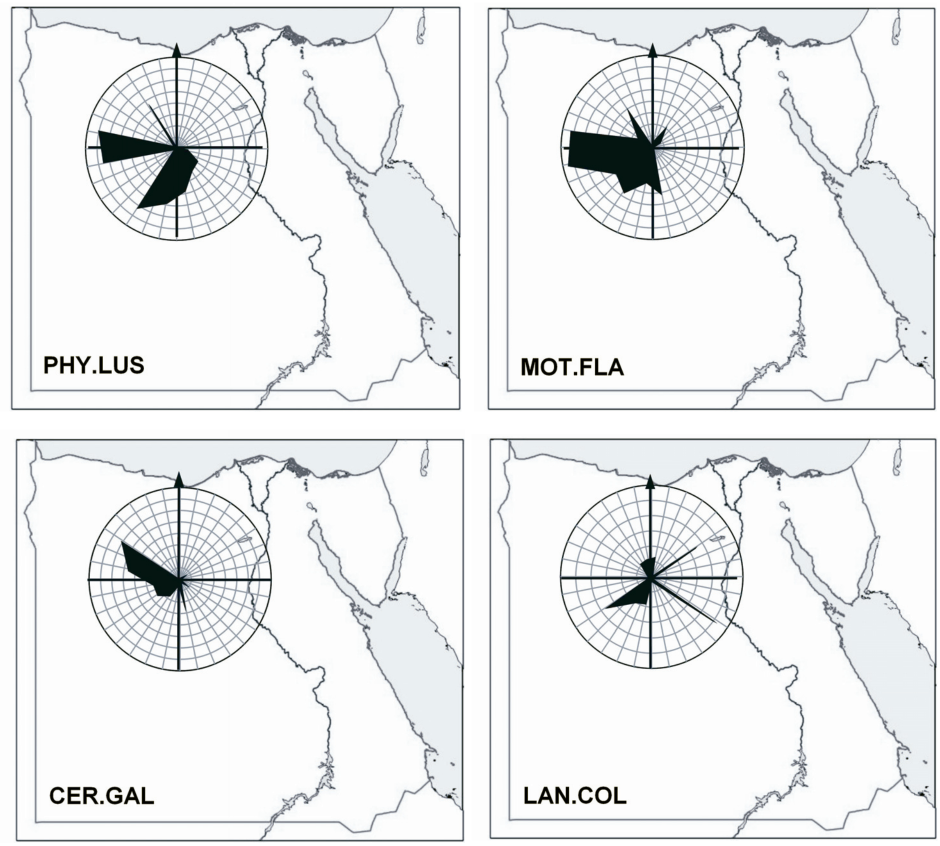

Fig. 3. Distributions of preferred directions for four species with the highest numbers of tests available (both stations combined); PHY.LUS – Willow Warbler, MOT.FLA – Yellow Wagtail, CER.GAL – Rufous-tailed Scrub Robin, LAN.COL – Red-backed Shrike

also strong for all the species except the Rufous-tailed Scrub Robin (*Cercotrichas galactotes*), for which the NW was the strongest. The SE and NE directions, although subordinate, were also clearly visible, particularly for the Red-backed Shrike (*Lanius collurio*), but SE also for the Willow Warbler.

DISCUSSION

Before analysing the results of the orientation experiments in Bahariya, it has to be noted that the number of tests is relatively very low, resulting from low levels of catching. In extensive studies of directional preferences of birds the number of tests should reach at least several dozen or even more (Formella and Busse 2002, Adamska and Rosińska 2006). Also, we did not cover the entire period of migration, which in Bahariya lasts through September and October (Biebach *et al.* 1986, Goodman and Meininger 1989). Therefore, the results obtained should be treated as rough and preliminary rather than detailed and thorough.

The western direction was the most prominent heading shown, which was surprising and unexpected. It was pronounced mostly in the Willow Warbler and Yellow Wagtail, which were the species with the highest number of birds tested. This direction is very difficult to explain, as it points directly at the barren desert and is perpendicular to the proper migration axis (N-S). In the W-NW direction, about 300 km from Bahariya, is another oasis, Siwa. Almost all of the tested species (including the four most numerous) have been seen during autumn migration there (Goodman *et al.* 1986), but it seems improbable that birds would perform such eastward or westward "jumps" between oases rather than migrate south. Therefore, the western direction remains unexplained and requires further studies. Such unexpected western headings were sometimes noted in Europe as well (Zehtindjiev *et al.* 2003).

The northern, reverse headings, presumed by us to show the directions of arrival, can be divided into separated groups: NE and NW. The NE headings, although few, are quite visible and probably reflect the direction from the Nile Delta. Their low level is in accordance with results from Azraq Oasis in Jordan, where the proportion of southern, reverse headings during spring migration in 2008 was also very low (Stępniewska *et al.* 2011). Having just crossed a large ecological barrier, the desert, birds are apparently not eager to go back. In Central Europe there is a lack of serious ecological barriers, therefore the proportion of reverse headings is sometimes quite high (Formella and Busse 2002, Adamska and Filar 2005). The NW headings are more prominent and may reflect flights from the Mediterranean coast. These directions are most pronounced in the Rufous-tailed Scrub Robin. This is the only species tested, apart from the Eastern Olivaceous Warbler (*Iduna pallida*), that regularly breeds in Bahariya (Goodman *et al.* 1986). It is possible that local birds could be among the individuals tested and hence the NW headings were influenced by some local unknown factors.

Finally, the southern directions, expected during autumn migration, are quite prominent in Bahariya. They can be divided into three groups: SW, S, and SE. The SW direction, the most pronounced, points presumably to the area around Lake Chad. This large (although recently much shrunken) inland lake, split between Chad, Niger, Nigeria and Cameroon, is an African Important Bird Area, with vast populations of migrant birds (Scholte and Robertson 2001). Almost all of the tested species, except the Thrush Nightingale (*Luscinia luscinia*), Eastern Olivaceous Warbler and Collared Flycatcher (*Ficedula albicollis*), have been found at Lake Chad, being common or even (Yellow Wagtail) very abundant (Gustafsson *et al.* 2003). Moreover, recoveries of Reed Warblers (*Acrocephalus scirpaceus*) ringed in Austria confirm the occurrence of birds from central Europe (flying the SE route through the Balkans and Egypt) at Lake Chad (Dowsett-Lemaire and Dowsett 1987). Rufous-tailed Scrub Robins (*ssp. galactotes*, present in Bahariya), on the other hand, were rather rare at Lake Chad (Gustafsson *et al.* 2003) and this corresponds with a low share of SW headings for this species. Therefore, we presume that the SW direction reveals migration towards Lake Chad. With regard to the two less common southern headings, the SE direction seems to point to the Nile Valley, and the S direction indicates migration southwards across the Sahara to the Sahel.

The pattern of directional preferences obtained in Bahariya is in accordance with the results from other SEEN stations in Egypt (Ibrahim 2011). At all stations, SW and SE directions are clearly visible, as well as reverse directions NW and NE. At the Wadi El Rayan station, which is the closest to Bahariya, a third, southern direction occurs as well. This suggests a common pattern of nocturnal passerine migration in Egypt. Our results are also consistent with the observations of passage conducted by Biebach *et al.* (1986) and Biebach *et al.* (1991) in the Western Desert, where the mean observed direction of migration was S to SW. Observations performed at the Egyptian and Libyan coast of the Mediterranean Sea demonstrated that, in spite of domination of S and SW directions, the SE direction was also prominent (Kiepenheuer and Linsenmair 1965). Thus, birds starting from the coast and heading SE could reach Bahariya. Finally, birds heading S and SW would have the best wind conditions. In autumn, prevailing winds over the Western Desert blow from the N and (more to the S) from NE (Erni *et al.* 2005). Birds flying in the directions mentioned above would benefit most from a tailwind, which is crucial for successful crossing of the Sahara (Biebach 1992, Erni *et al.* 2005).

We can try to predict possible major migrations routes through Bahariya (Fig. 4). Birds may reach the oasis either from the Nile Delta or from the Mediterranean coast, and the majority then head SW towards Lake Chad. Some birds travel directly southwards, and a minority, presumably only the individuals which travelled from the coast, fly SE to reach the Nile Valley. The western direction still remains a mystery as it is very difficult to find either its source or destination. Overall, it appears that Bahariya Oasis might be an important area of crossing points for passerine migration routes across the Western Desert.

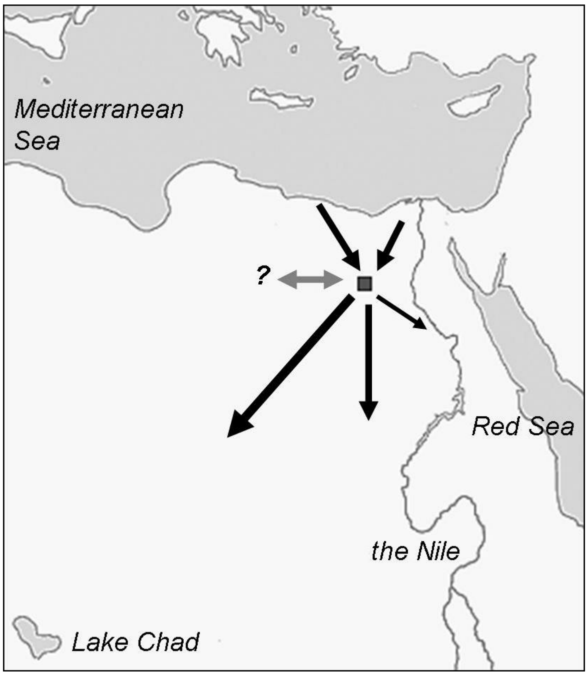

Fig. 4. Possible migration routes through Bahariya Oasis (dark square). Grey double arrow with question mark – "mysterious" western direction (either of departure or arrival).

Studies of directional preferences of migrants in orientation cages are of great value particularly in areas where ringing recoveries are lacking due to various factors (Ożarowska *et al.* 2004, Stępniewska *et al.* 2011). Combining these studies with research on fuelling and stopover strategies would enable us to develop a thorough model describing migration strategies of birds in a given area. Bahariya Oasis is an important stopover area for passerines which rest or refuel during their autumn passage across the Sahara (Biebach *et al.* 1986). It would therefore be of great importance to continue these studies, possibly through the whole migration period to gather a sufficient sample of data, and focus on variations of preferred directions during the season as well as relations between directional preferences and fuelling and stopover strategies.

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MONITORING PHEASANTS (*Phasianidae*) IN THE WESTERN HIMALAYAS TO MEASURE THE IMPACT OF HYDRO-ELECTRIC PROJECTS

Virat Jolli, Maharaj K. Pandit

ABSTRACT

Jolli V., Pandit M.K. 2011. *Monitoring pheasants* (*Phasianidae*) *in the Western Himalayas to measure the impact of hydro-electric projects*. Ring 33, 1-2: 37-46.

In this study, we monitored pheasants abundance to measure the impact of a hydro-electric development project. The pheasants abundance was monitored using “call count” and line transect methods during breeding seasons in 2009-2011. Three call count stations and 3 transects were laid with varying levels of anthropogenic disturbance. To understand how the hydro power project could effect the pheasant population in the Jiwa Valley, we monitored it under two conditions; in the presence of hydro-electric project (HEP) construction and when human activity significantly declined. The Koklass Pheasant (*Pucrasia macrolopha*), Cheer Pheasant (*Catreus wallichi*) and Western Tragopan (*Tragopan melanocephalus*) were not recorded in Manjhan Adit in 2009. During 2010 and 2011 springs, the construction activity was temporarily discontinued in Manjhan Adit. The pheasants responded positively to this and their abundance increased near disturbed sites (Manjhan Adit). The strong response of pheasants to anthropogenic disturbance has ecological application and thus can be used by wildlife management in the habitat quality monitoring in the Himalayan Mountains.

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Key words: call count, anthropogenic disturbance, pheasant, monitoring, hydro-electric project

INTRODUCTION

Birds have been used extensively in environment and habitat quality monitoring. The family *Phasianidae* is sensitive to human exploitation (Fuller and Garson 2000, Nawaz *et al.* 2000). These birds are used as the barometer for the success and failure of wildlife conservation (McGowan *et al.* 2009). They capture the complexities of the ecosystem and yet remain simple enough to be easily and routinely monitored. They remain confined to their particular habitat and usually inhabit relatively pristine and undisturbed area having understory vegetation (Ramesh 2003). Literature available on pheasants reveal that species such as the Himalayan Monal (*Lophophorus impejanus*), Koklass Pheasant (*Pucrasia macrolopha*), Cheer Pheasant (*Catreus wallichi*) and Western Tragopan (*Tragopan melanocephalus)* have strong preference for their habitat and even little change in their habitat may affect them. Grazing pressure has negative impact on pheasants abundance (Bhattacharya *et al.* 2007). Their sensitiveness is one of the reasons for their dwindling population.

Hydro power development has gained momentum in past few decades in the Indian Himalayan Region. The Indian Himalayas are a source of many perennial rivers. These rivers have been exploited extensively for harnessing hydro power. Indian government is planning to set up a number of hydro power projects in the Himalayas to meet its ever increasing energy requirements. Central Electricity Authority (CEA) formulated a Preliminary Feasibility Reports of 162 new hydro-electric schemes (47 930 MW). It is a matter of concern, because out of 162 schemes, 133 are in the Indian Himalayan Region (CEA 2009). These hydro projects often lie close to protected forests *e.g.* the Parvati Hydro Power Project is constructed near the Great Himalayan National Park. The presence of endemic and threatened bird species such as the Western Tragopan and Cheer Pheasant make this site important from a conservation point of view (BirdLife International 2001). The construction activities are likely to create disturbance in the adjoining regions of protected forests. Here, disturbance has been defined as “any relatively discrete event in time that disrupts ecosystem, community, or population structure and changes resources, substrate availability, or the physical environment” (White and Pickett 1985).

Koklass Pheasants and Himalayan Monals are usually found in oak and deodar, oak and pine or rhododendron forests (Ali and Ripley 1983). The first species is found in denser understory than the latter one (Gaston *et al.* 1983), but they are sometimes found feeding together in early spring (Gaston *et al.* 1981). The Cheer Pheasant inhabits precipitous hill sides or ravines covered with tall grass, scrub and oak forest (Kazmierczak 2009).

Pheasants are elusive birds and found in a difficult mountain terrain, which make them difficult to monitor using line transect (Ramesh 2003). Call counts of some pheasants, such as the Western Tragopan, Cheer and Koklass Pheasants, can be used in such cases. Counting the calls can give a useful index of the relative abundances of different populations in different areas (Severinghaus 1979, Gaston 1980, Duke 1990, McGowan 1990). We used this to monitor population of pheasants in a given area. We examined the following questions: (1) Does the pheasants abundance increases along a gradient of increasing disturbance (from forest to disturbed habitat types)? (2) Which species among pheasants responds the strongest to the habitat disturbance? This study will help the wildlife managers to better understand and monitor pheasant population in the Himalayan Mountains.

METHODS

Study area

The study area lies in the Jiwa Valley, encompassing Ecodevelopment Protected Area and the Great Himalayan National Park (GHNP). The site is situated in the North-Western Himalayas in the Kullu district of Himachal Pradesh, about 45 km to the south-east of Kullu. Its latitude and longitude are 31°49’20”-31°50’13”N and 77°20’24”-77°22’32”E, respectively (Fig. 1). The sites are situated on the Jiwa Nal, which originates from Khande Dhar (5445 m a.s.l.) at 4020 m. It traverses a distance of about 30 km in W-SW direction flowing through a very narrow valley with deep gorges before joining the Sainj Khad near Suind (1344 m a.s.l.) . It has a catchment area of 120 km^2 at the proposed trench weir site near village Manjhan (CISMHE 2000).

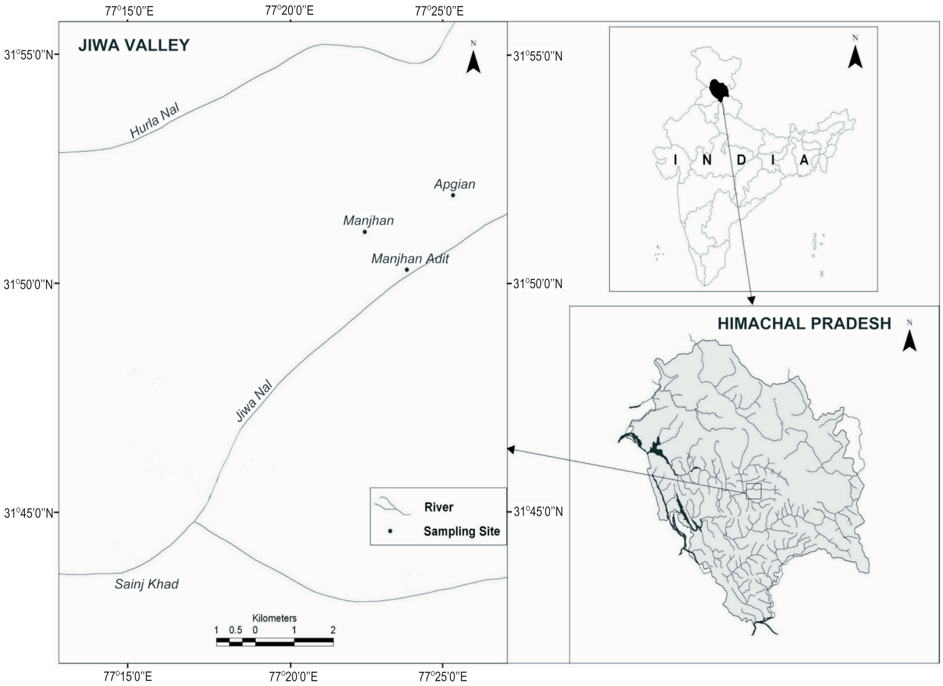

Fig. 1. Location of the study area

There are abundant semi-tropical forest vegetation including large tracts of dense pine woods, deciduous rhododendrons and ever green oaks, fir and spruce forests, *etc*. in addition to large mountain meadows and pastures. The area is a rich biodiversity zone of the Western Himalayas. The GHNP falls within one of the globally important Endemic Bird Areas (EBA 128: Western Himalayas) identified by the ICBP (now BirdLife International) Biodiversity Project (BirdLife International 2011). A total of

183 bird species including 51 non-passerines and 132 passerines have been recorded in this area. This accounts for 72% of non-passerines and 88% of passerines recorded in elevations above 1500 m in the rest of India. Moreover, the Great Himalayan National Park is under review to be included in the UNESCO's World Heritage List (UNESCO 2011).

Sampling design

We sampled three sites along the increasing habitat disturbance. The gradient was defined by land use. Manjhan Adit was identified as a disturbed site because of the the Parvati Hydro-Electric Project (PHEP). Village Manjhan is situated 3 km away from Manjhan Adit. The village was selected as one of the sampling sites because it is one of the best places for monitoring pheasant abundance in the Jiwa Valley. The GHNP has a hut near village Manjhan, which provides another advantage to stay in this area for a longer time. We selected another sampling site in Apgian, which is 7 km away from village Manjhan. It is located inside the GHNP and represents pristine habitat. The two sites lie within the Ecodevelopment Zone and the National Hydro Power Corporation Ltd. (NHPC) has been constructing trench weir canal near village Manjhan (CISMHE 2000). Thus, the study area was identified as an ideal location to evaluate human impacts on the pheasants abundance. We compared the pheasants abundance estimates between Apgian and Manjhan sites with that of Manjhan Adit.

Data collection

We travelled a total of 10 km track, starting from Manjhan Adit site to Apgian site, to conduct the presence/absence mapping for pheasants in April. Details such as the name, exact location and altitude range and general forest type was recorded using Magellan GPS. There were identified suitable call stations to be used for monitoring pheasant abundance.

We sampled three call stations three times a month in the spring season (with a total of 12 counts for each station). We conducted counts of the Koklass Pheasant, Western Tragopan and Cheer Pheasant from call stations, which were fixed circular areas with 300 m listening radii. This technique involved positioning observers at predetermined points across the study area. The observers plotted the apparent position of all calling individuals on a data-recording sheet. This protocol has been used in many studies on Himalayan pheasants (*e.g.* Garson 1983, Duke 1990, Khaling *et al.* 1998, Miller 2010). This gives an index of calling males per station in an area. Each trail contained one or two stations positioned 500 m apart to avoid listening overlap between observers. We sampled one call station each morning, with one observer measuring one station. To avoid sampling bias only one observer counted the calls and transect walk. In the morning of sampling, we positioned observers at the stations 15 minutes before first light to minimize disturbance to the pheasants (arrival time ranged from 5.30 *a.m.* in early April to 4.15 *a.m.* by late May and 6.00 *a.m.* in October and November due to seasonal light shift). We began sampling at the first audible call and ended one hour after sunrise, which is determined to be the most effective period for measuring both the Koklass Pheasant and Western Tragopan

(Ramesh 2003, Miller *et al.* 2008). Each call was recorded with respect to species, time, distance and cardinal direction. After sampling, observers compared the time and direction of calls to eliminate multiple accounts of the same birds from different stations, and no sampling occurred in adverse weather such as thick fog, heavy rainfall or strong winds, because these conditions alter normal pheasant activity and/or obscure the observers' ability to accurately measure bird presence (Khaling *et al.* 2002).

We sampled the Himalayan Monal with transect walks because this species is easily visible along trails but calls only sporadically throughout the day (Kaul and Shakya 2001). We carried out opportunistic survey with the help of GHNP staff to identify sampling sites in the Jiwa Valley. We interviewed local villagers and forest guards to get information regarding pheasant habitats. In each sampling sites, we laid transect. As it was difficult to lay transect on steep slopes we used pre-existing footpath of 1 km length in each sampling site for monitoring the Himalayan Monals abundance. We walked thrice a month on each transect with an average speed of 1 km/h. We walked transects in the mornings before 10.00 *a.m.*, when Himalayan Monals forage on the ground around their roosting sites (Ramesh 2003). This timing allowed us to sample abundance in habitat that is critical for pheasant survival. Sampling in the morning additionally lowered the chances that villagers and tourists would flush birds, as these people occasionally traversed the trails. For each encounter of a Himalayan Monal, we recorded data on sex, sighting angle, sighting distance, time and location. Walking pace was standardized to reduce irregularities in sampling effort and abundance estimates.

The samples collected were small in number because it was difficult to identify and establish calling stations on rugged and steep slopes of the Jiwa Valley. So we have used pre-existing huts of GHNP as calling station in the present study. Moreover, pheasants breed in spring season, which last only for two months so this restricted us to April and May only.

Since November 2009, adit construction was ceased in Manjhan Adit due to contract related dispute. This resulted into a reduction in anthropogenic disturbance in the adit site. We used this as an opportunity to investigate if the disturbance in the Jiwa Valley was because of the hydro-electric project. So we monitored pheasants abundance in both Manjhan and Manjhan Adit in spring 2010.

Data analysis

We calculated the mean encounter rate by dividing the number of birds observed by the total number of call count stations or transect walks.

We have classified the sites based on the land use type. Apgian and Manjhan was classified as "forest sites" using detailed topographic map (1 : 50 000), while Manjhan Adit was identified as a "disturbed site" due to the PHEP activity.

The data set was entered into PAST v. 2.05 and analysis was carried out using this statistical software.

RESULTS

Presence/absence survey

In presence/absence survey we recorded five species of pheasants: Himalayan Monal, Koklass Pheasant, Cheer Pheasant, Western Tragopan and Kalij Pheasant (*Lophura leucomelanos*). The Western Tragopan and Cheer Pheasant, which are threatened and endemic species of the Western Himalayas, were recorded in Apgian and Manjhan.

Pheasants abundances in the Jiwa Valley

In 2010, the Himalayan Monals mean abundance in Apgian was 2.7 ± 0.21 (*SE*) indiv./count, which was slightly less than in Manjhan – 2.8 ± 0.40. The mean abundance of calling male Koklass Pheasants in Apgian was recorded as 3.5 ± 0.22, while 4.3 ± 0.33 in Manjhan. The Western Tragopan was recorded only in Apgian with the mean abundance of 2.5 ± 0.42. The mean abundance of Cheer Pheasants in Apgian was 0.3 ± 0.21, while in Manjhan it was as high as 3.0 ± 0.36 (Table 1).

Table 1
Breeding season abundance of pheasants in the Jiwa valley, Himachal Pradesh, India (2009-2011)

Himalayan Monal (*Lophophorus impejanus*)							
	Apgian		Manjhan		Manjhan Adit		
No. of replicates	2010	2011	2010	2011	2009	2010	2011
1	3	3	2	1	0	2	0
2	3	3	2	1	0	2	0
3	2	2	3	3	1	2	0
4	3	2	4	1	0	3	0
5	3	3	2	1	0	4	1
6	2	3	4	3	0	4	1
Mean	2.7	2.7	2.8	1.7	0.2	2.8	0.3
SE	0.21	0.21	0.40	0.42	0.16	0.40	0.21
Koklass Pheasant (*Pucrasia macrolopha*) – calling males							
	Apgian		Manjhan		Manjhan Adit		
No. of replicates	2010	2011	2010	2011	2009	2010	2011
1	4	4	6	4	0	4	3
2	3	4	4	4	0	3	3
3	4	3	4	6	0	3	2
4	4	3	4	5	0	4	2
5	3	4	4	5	0	3	3
6	3	4	4	6	0	3	3
Mean	3.5	3.7	4.3	5.0	0	3.3	2.7
SE	0.22	0.21	0.33	0.36	0	0.21	0.21

Western Tragopan (*Tragopan melanocephalus*) – calling males							
	Apgian		Manjhan		Manjhan Adit		
No. of replicates	2010	2011	2010	2011	2009	2010	2011
1	4	3	0	2	0	0	0
2	2	3	0	2	0	0	0
3	3	2	0	1	0	0	0
4	2	3	0	1	0	0	0
5	3	3	0	1	0	0	0
6	1	3	0	1	0	0	0
Mean	2.5	2.8	0	1.3	0	0	0
SE	0.42	0.16	0	0.21	0	0	0
Cheer Pheasant (*Catreus wallichii*) – calling males							
	Apgian		Manjhan		Manjhan Adit		
No. of replicates	2010	2011	2010	2011	2009	2010	2011
1	1	0	2	4	0	0	0
2	0	0	2	4	0	0	0
3	0	0	3	0	0	1	0
4	1	0	4	0	0	1	0
5	0	0	4	0	0	1	0
6	0	0	3	0	0	0	0
Mean	0.3	0	3.0	1.3	0	0.5	0
SE	0.21	0	0.36	0.84	0	0.22	0

In 2011, in Apgian the Himalayan Monals abundance remained unchanged. In Manjhan, we recorded the lower number of Himalayan Monals (as compared to the previous year) with the mean abundance of 1.7 ± 0.42. The Koklass Pheasants mean abundance in Apgian was 3.7 ± 0.21, while 5.0 ± 0.36 in Manjhan. The Western Tragopans mean abundance in Apgian was 2.8 ± 0.16, which was slightly higher than in 2010. In Manjhan, we recorded calls of Western Tragopans with the mean abundance of 1.3 ± 0.21. We did not record Cheer Pheasants in Apgian while in Manjhan their mean abundance was 1.3 ± 0.84, which was less than in the previous year (Table 1).

Abundance of pheasants in the disturbed site

The pheasants were not recorded at Manjhan Adit site during 2009 (except for one individual of the Himalayan Monal), but the number of pheasants increased in 2010-2011 (Table 1). The cessation of hydro-electric development activities since 2009 made the conditions favourable for the birds. The mean abundance of Koklass Pheasants increased from 0 to 3.3 ± 0.21 (*SE*) in 2010 and 2.7 ± 0.21 in 2011. For the Himalayan Monal we also recorded a sharp rise in abundance from 0.2 ± 0.16 to 2.8 ± 0.40, which further declined to 0.3 ± 0.21.

We did not record the Western Tragopan and Cheer Pheasant in Manjhan Adit, except for 2010, when we did record the calls of Cheer Pheasants with the mean abundance of 0.5 ± 0.22 (Table 1).

DISCUSSION

Monitoring of Himalayan pheasants in the Jiwa Valley has revealed that this valley supports sizeable population of *Phasianidae*. The Western Tragopan, a flagship species, was confined to undisturbed forest sites (Apgian and Manjhan). The presence of this species in the interior of forest suggests that this species is sensitive to human presence. Discussion with local shepherds and local people revealed that in the past they had heard calls of Western Tragopans and other pheasants also from disturbed sites. Thus, other locations are also suitable for the Western Tragopan but anthropogenic activities make them unfavourable for survival. The species descends down below 1500 m a.s.l. during winter season (Kazmierczak 2009), but the human presence in lower altitudes makes it restricted to a higher range, which may result in higher mortality during winter. During 2011, Western Tragopans were heard from Manjhan calling station, which implied that the decrease in disturbance in the areas adjoining Manjhan Adit had made this site suitable for this species. The Cheer Pheasant is another endemic and threatened species recorded in the Jiwa valley. Manjhan supports relatively higher number of Cheer Pheasants as compared to other sites. The presence of secondary vegetation, *i.e.* grassy mountain slopes along with the moderate level of human disturbance, such as farming and grazing in upland rural areas are the preferred habitats for the Cheer Pheasant. Koklass Pheasants and Himalayan Monals were abundant both in Manjhan and Apgian. These species remain confined to the tree line and were not reported below the altitude of 2500 m a.s.l. They had responded negatively to hydro-electric project activity and were not recorded in 2009 (except for one individual of the Himalayan Monal), but their abundance increased in 2010-2011. During our study the PHEP construction activity was halted due to some contract related disputes since November 2009, which caused reduction in human disturbance and thus attracted some of the pheasants around Manjhan Adit. This implies that pheasants are sensitive to intense human activity. Moreover, the susceptibility to noise exposure is relatively higher in *Phasianidae* compared to *Passeriformes* (Ryals *et al.* 1999), thus they avoid places where noise levels are high. Blasting, labour colonies and project vehicles keep this site disturbed.

The territorial behaviour of the Koklass Pheasant and Western Tragopan is very predominant during breeding season. It is known that the size of territory is directly related to the size of birds (Schoener 1968). As pheasants are comparatively large, they need more space to defend. The congregation of pheasants in adjacent region would increase competition among males for food, sex and space, which can reduce the fitness of males.

Blasting probably disturbs the territorial behaviour of pheasants to a great extent. Blasting sounds were heard during their crowing time in both seasons and both the Koklass and Cheer Pheasants calls were not reported after blasting. The males call loudly during spring season to demarcate their territories, warn rivals and attract females. Thus, blasting should be banned at least during early morning of breeding period (CISMHE 2000).

There is a need of comprehensive long term monitoring of *Phasianidae* in the GHNP and eco-development zone by the GHNP staff. More emphasis should be put on protecting habitats of the Cheer Pheasant and Western Tragopan, as these are very important species from a conservation point of view. Their habitats are fragmented in the Western Himalayas and need special protection. The recovery of pheasants during 2010-2011 springs in Manjhan Adit showed that the PHEP activity had displaced the pheasants during 2009. So due to our finding, we suggest that large scale development activity poses a serious threat to the existence of pheasants in the Western Himalayas.

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BIOMETRICS OF NON-BREEDING IMMATURE MALLARDS (*Anas platyrhynchos*) IN NORTH-EASTERN POLAND

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ABSTRACT

Jankowiak Ł., Polakowski M. 2011. *Biometrics of non-breeding immature Mallards (Anas platyrhynchos) in north-eastern Poland.* Ring 33, 1-2: 47-53.

Non-breeding immature Mallards from north-eastern Poland (Północnopodlaska Lowland) were captured and measured (altogether 182 individuals in their 1st year of life). Immature males were significantly larger than females according to all analysed parameters. The length of bill and wing were the most sexually dimorphic traits and the least dimorphic were the total length of bill with head and tarsus length. The results of the present analysis and other studies in different regions of Europe suggest that wing size of Mallards follows Bergmann's rule, while a bill size – Allen's rule. Mallards from north-eastern Poland are larger than those from western Europe. We hypothesize that the reason for this is the fact that main population of non-breeding Mallards originates from the larger eastern European population, which is confirmed by some ringing data.

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Key words: Mallard, *Anas platyrhynchos*, non-breeding, biometrics, Bergmann's rule, Allen's rule.

INTRODUCTION

The Mallard is a common breeding species in Europe (Hagemeijer and Blair 1997, BirdLife International 2009) and one of the most common wintering bird in the Western Palearctic (Pihl *et al*. 1995, Avilova 2008) as well as in Poland (Tomiałojć and Stawarczyk 2003, Piotrowska 2003, Meissner and Rydzkowski 2007, Ławicki *et al*. 2008). The Mallard is a numerous wintering and regular breeding species in Białystok (NE Poland). A great proportion of individuals observed there are non-breeding birds from Północnopodlaska Lowland (Mazurek and Polakowski 2002, Świętochowski 2007, Polakowski *et al*. 2010). The species shows sexual dimorphism, *i.e.* males are bigger and more coloured than females (Cramp and Simmons 1977, Owen and Cook 1977). The feathers stop growing once the immature individuals are fully grown (Panek and Majewski 1990).

The variation of morphological parameters can indicate intra-species variability and therefore the analysis of these parameters can be useful for describing different populations. According to the fact that the morphometric variability is lower within a population than within a species, after statistical analysis, it is possible to show the population differentiation of a species (Busse 1974, Busse and Maksalon 1986). Such biometric studies on the Mallard based on the analysis of basic morphological parameters have not been carried out in Poland, opposite to those in western Europe (Schiøler 1925, Cramp and Simmons 1977, Owen and Montgomery 1978).

The aim of this paper is to: (1) analyse the morphological variability of immature Mallards in relation to their sex, (2) determine the origin of non-breeding Mallards in north-eastern Poland.

MATERIAL AND METHODS

The study was carried out in the town of Białystok (NE Poland: 53°08’N, 23°10’E), which is situated in the coldest region in Poland. The data were collected in 2003-2009, particularly during September-March. The measurements were taken mainly from wintering individuals. Studies were conducted at 27 wintering sites of Mallards, particularly on the small rivers Biała and Dolistówka (Polakowski *et al*. 2010) in the administrative limits of the town.

We measured a total of 182 immature individuals (*i.e.* in their 1st year of life). Ducks were baited into the loop-trap (Polakowski *et al*. 2010) with a few trapped in hands. Captured Mallards were ringed and measured according to standard methods (Cramp and Simmons 1977, Baker 1993). The measurements taken were: length of bill, total length of head with bill, lengths of tarsus and wing. The bill was measured from its tip to the distal corner of the nostril, the total length of head with bill was measured from the tip of the bill to the back of the head (occiput), according to Green (1980), and the tarsus was measured from the notch at the back of the intertarsal joint to the distal edge of the last large complete scale at the front of the foot (before the toes diverge). The wing was measured as a maximum chord according to Cramp and Simmons (1977). In some birds it was impossible to take all parameters described above. The results we compared with measurements from literature, which were taken by the same methods and based on immature and adult individuals together. According to Cramp and Simmons (1977) there are no significant differences between those age classes.

The Storer's index (Storer 1966) was used to calculate the sexual dimorphism according to the formula:

$$DI = 100 \times (f - m) / 0.5 \times (f + m)$$

where:

f – the mean value of female parameter,
m – the mean value of male parameter.

Not all data met the assumption of normality and homogeneity of variance, therefore to test the differences between the parameters, a nonparametric Mann-Whitney *U*-test was used. The coefficient of Pearson's linear correlation was calculated to analyse relationships in different measurements. All tests were two-tailed and $p < 0.05$ was considered as significant. STATISTICA 8.0 (StatSoft Inc. 2007) program was used for statistical analyses.

RESULTS

The biometrics of the studied Mallard females and males are given in Table 1. According to the data immature males are significantly larger in all analysed parameters (Table 2). According to the Storer's index, the most sexually dimorphic traits were wing and bill ($DI_{wing} = 7.54$, $DI_{bill} = 7.20$) and the least ones – head with bill and tarsus ($DI_{head\ with\ bill} = 5.68$, $DI_{tarsus} = 6.53$). A significant correlation was found between the length of bill and total length of head with bill in females ($N = 40$, $r = 0.51$, $p < 0.001$) and in males ($N = 45$, $r = 0.37$, $p < 0.001$).

Table 1
Biometrics of the studied females and males of the Mallard.
All values are given in millimetres.

Measurements	N	Mean	Minimum	Maximum	*SD*	*SE*
Females						
Bill	40	51.8	48.2	57.7	1.97	0.31
Head with bill	66	108.7	102.7	117.3	3.19	0.39
Tarsus	40	42.7	40.0	47.7	1.70	0.27
Wing	77	269.6	250.0	286.0	7.72	0.88
Males						
Bill	45	55.2	50.1	59.6	2.05	0.31
Head with bill	79	115.8	107.0	124.7	3.11	0.35
Tarsus	46	45.3	40.9	48.5	1.48	0.22
Wing	98	286.3	267.0	306.0	8.42	0.85

Table 2
Differences in biometric parameters between immature female and male Mallards
(the Mann-Whitney *U*-test)

Measurement	*N* females	*N* males	*Z*	*p*
Bill	40	45	-6.08	<0.0001
Head with bill	66	79	-8.90	<0.0001
Tarsus	40	46	-6.25	<0.0001
Wing	77	98	-9.65	<0.0001

DISCUSSION

There are no data regarding biometric characteristics of the Mallard in Poland and in eastern Europe except those reported by Dementiev and Gladkov (1951). Those authors presented only maximum and minimum length of wing, bill and tarsus, while missed the mean values of these parameters. They also did not describe the origin of those data (countries from the former Soviet Union) and did not give the sample size. Other published data regarding Mallards' biometry come from studies in northern and western Europe: Greenland and Iceland (Schiøler 1925), the Netherlands (Cramp and Simmons 1977) and England (Owen and Montgomery 1978). However, a part of these data was obtained from museum skins, with only small sample sizes being taken. Moreover, such parameters as the total length of head with bill were not included. These data showed a difference between males and females, with regard to the lengths of wing, bill and tarsus, *i.e.* the males tended to be larger. Our study shows that males are significantly larger according to all these parameters (Table 1). The most dimorphic traits are the wing and bill, while the least dimorphic – the head with bill and tarsus lengths. There are two possible hypotheses explaining the size differences of sexes: the intersexual competition and social mating system in which social polygamy provides large size differences (Owens and Hartley 1998). The observed difference in the length of bill could be explained by the first hypothesis. The study on sexual size dimorphism in bill morphology of *Anas spp*. from North America shows that intersexual competition for food favours the size difference of the bill (Nudds and Kaminski 1984). The differences in the wing and tarsus lengths could be associated with a social mating system. We think that the higher dimorphism of wing (as compared to tarsus and head with bill) results from intersexual differences in growth pattern as a consequence of allometry (Teather and Weatherhead 1994). The high correlation between the bill and head with bill lengths can be easily explained by the fact that bill is included in the measurement of "head with bill". In conclusion, this parameter relates to the two hypotheses: bill – to the intersexual competition and wing with tarsus – to social polygamy. The lack of correlation between other parameters most probably results from different selection pressure on each feature.

The studies in other parts of Europe (Schiøler 1925, Cramp and Simmons 1977, Owen and Montgomery 1978) demonstrated that wing length could be arranged in descending order from cooler to warmer regions, with the coolest being Greenland and the warmest being western Europe. This correlation is related to Bergmann's rule, which states that mammals and birds residing in cooler regions are larger (Ashton 2002). Wing lengths of Mallards studied in this paper are larger than those in western Europe, with both males' and females' patterns being rather consistent with Bergmann's rule (Table 3). The bill length shows the reverse arrangement, consistent with Allen's rule, which states that the body apendages of endothermic species are smaller in cooler regions, in order to prevent heat loss (Symond and Tattersall 2010). Mallards in warmer parts of Europe have larger bills than Mallards in cooler regions, such as Iceland and Greenland. The larger bill allows them to lose heat easily (Midtgard 1984). However, a survey from North America has shown a trend in bill morphology, consistent with Bergmann's rule (DuBowy 2000). It is unclear why Mallards from Iceland are consistent with Allen's and not Bergmann's rule. The consistency of surveyed group in north-eastern Poland with Bergmann's and Allen's rule could be explained also by heterogeneity of this group. We hypothesized that a part of wintering population could be of local, while another one of more north-eastern European origin, so being originated from cooler areas than Poland.

Table 3
Comparison of the wing and bill lengths of Mallards in Europe*.
All values are given in millimetres

Wing					
Females	Greenland	**NE Poland**	Netherlands	Iceland	England
	272	269.6	265/257	263	258.6
Males	Greenland	**NE Poland**	Iceland	Netherlands	England
	292	286.3	282	279/272	274.8
Bill					
Females	Netherlands	**NE Poland**	England	Iceland	Greenland
	51.8	51.8	51.3	50.8	48.1
Males	Netherlands	**NE Poland**	England	Iceland	Greenland
	55.4	55.2	54.6	53.4	46.6

* Note, however, that samples contain only adults – Greenland, Iceland (Schiøler 1925); only immatures – this study; adults and immatures together – England (Owen and Montgomery 1978); or for the Netherlands: wing – adults/immatures, bill – adults and immatures together (Cramp and Simmons 1977).

During winter, breeding Mallards migrate from eastern Europe to south-western Europe, particularly to the Mediterranean Sea (Euring 2009). Some authors (Veen *et al.* 2005) have shown that some Mallards migrate from north Europe to winter in central Europe. In Sweden Mallards move south-west to wintering grounds in western Europe, with some also travelling to northern Poland (Fransson and Pettersson 2001). Population from Białystok is, however, somewhat different to that of Scandinavia. The results of the present study show that average wing lengths of the analysed Mallards are larger compared to the data reported from other parts of Europe. Therefore, we suggest that the population of Mallards from Białystok comprises a proportion of birds migrating here from eastern Europe during winter. This can be also confirmed by recoveries of two immature females ringed in Białystok and reported heading east during the spring season, at sites that were probably close to their breeding grounds. The first bird, which was ringed in Białystok on 24 January 2007, was shot on 20 May 2008 in Russia (Proletariy, Novogorod, 58°25'N, 31°42'E). Another Mallard, which was ringed on 9 February 2007, was found freshly dead on 26 March 2010 in Belorussia (Gorki, Mogilev, 54°16'N, 30°58'E), but it was earlier reported from Białystok until 24 December 2009.

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AN OVERVIEW OF BIRD MIGRATION STUDIES IN EGYPT

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ABSTRACT

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This is an overview of ornithological studies carried out in Egypt since the beginning of XXth century till the present time made on the basis of several more or less general publications. Geographical location and climate descriptions give the background information about the area. The literature overview stresses especially problems connected with the migration of passerines, but wider avifaunistic background is discussed as well. Special attention is paid to the passerines' strategy of migration through the Mediterranean Sea and Sahara Desert, its direction and timing, as well as to the factors affecting passerines migration and bird ringing in Egypt. In conclusion, it is stressed that the studies on bird migration were done sporadically, from time to time and from one place to another, and there is a dramatic lack of permanent ringing / bird migration study field stations, despite the fact that some suitable and promising localities have been found, in which the studies have been carried out since 2001 by the SE European Bird Migration Network in cooperation with some protected areas managements.

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Key words: bird migration, Egypt, studies, overview

INTRODUCTION

The Afro-tropical region receives migrant birds from the northern hemisphere. The number of Palearctic birds arriving in African sub-Sahara is estimated at 3750 million individuals, about one million of which are waterbirds (Moreau 1972). The area of only 20 million km^2 is capable of receiving the migrants, out of 29 million km^2 of African territory. The rest is occupied by the inhospitable Sahara (BirdLife 2005).

One of the main flyways for migration from Palearctic to Africa is the River Jordan to the Nile Valley, which is considered as the most significant corridor for bird migration in the world, and is the main eastern corridor between Europe/Asia and Africa used by millions of birds to pass through a series of migratory bottleneck sites