

Passerine migrants in Bahariya oasis, Western desert, Egypt: surveys and habitat associations

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We report records of 83 species of birds in Bahariya oasis, the Western desert, Egypt, August–September 2010, including over 30 passerine migrant species and 36 species of water birds. Fifty-four species were recorded at Abu Yasser lake (El Heiz) and 74 at El Marun lake (Bawiti). Spanish Sparrow *Passer hispaniolensis* (>210 birds) was the most abundant species recorded, followed by Yellow Wagtail *Motacilla flava* (>130) and Western Cattle Egret *Bubulcus ibis* (>112). 144 birds of 18 species were trapped in total. Willow Warbler *Phylloscopus trochilus* was the most numerous trapped species (20.1%), followed by Spanish Sparrow (18%), Yellow Wagtail (14.5%) and Rufous-tailed Scrub Robin *Cercotrichas galactotes* (13.8%). 52.8% of the birds were trapped in tamarisk habitat, 39% in Alfalfa *Medicago sativa* crops, 4.8% in fruit trees and 3.2% in reeds/rushes. 100% (21) of the Yellow Wagtails were trapped in a mosaic of alfalfa crops as well as 75% (18) of the Willow Warblers at El Marun lake. This study confirms Bahariya oasis is a stopover area for passerine migrants, which are probably using an intermittent migration strategy on passage through the Western desert. A large number of passerine migrants with reasonably high fat scores were recorded actively foraging in a variety of habitats. The birds and wildlife of Bahariya oasis are threatened by development, overuse of water resources for agriculture, and illegal hunting. Protection is required through nature conservation designation and conservation management to protect, restore and maintain habitats for resident and migratory birds.

INTRODUCTION

The Egyptian Western desert or 'Libyan' desert (681 000 km²) is about two-thirds of Egypt's total land area. From east to west the Western desert stretches from the Nile valley (31°E) to the Libyan border (25°E) and south to north from the Sudanese border (25°N) nearly to the coast of the Mediterranean (34°N). Bahariya oasis is located 180 km west of the Nile valley and has a maximum length of 95 km, width of 40 km and a total area of 1800 km². The oasis was formed by abundant rainfall widening ground floor fractures, which were weathered down to Nubian sandstone strata. It is located in a depression that rises up to 150 m asl and is partly surrounded by steep desert escarpments (Goodman *et al* 1986).

Agriculture dominates the Bahariya oasis landscape, which is supported by fertile soils and several shallow and deep-cased wells. Extensive date palm plantations, alfalfa crops and cash crops are all dependent on irrigation. Most crops are located around saline lake depressions, primarily formed by run-off irrigation water, that have small amounts of water through the year, such as El Marun lake, north of Bawiti, and Abu Yasser lake in El Heiz (Figure 1). Bawiti is the largest town, accessed by a good 370 km tarmac road from central Cairo. Bawiti has various shops, markets, museums and tourist hotels, which have been developed to cater for desert trips. El Heiz is a small bedouin town in southern Bahariya oasis, surrounded by the 'Black' desert.

Ornithological records from Bahariya oasis were obtained in 1925 when RE Moreau visited the area to collect specimens. Al Hussani also recorded birds in 1938 and 1958 (Goodman *et al* 1986). Several studies were conducted at Sadat farm, 15 km north of Bahariya oasis, in the 1980s by German ornithologists (Biebach *et al* 1986).

More than half a billion birds from Europe and Asia migrate through the Middle East (Shirihai 1996). Egypt is located in an extremely important strategic position along these migratory flyways, connecting the European and African continents (Baha El Din 1999). Biannually, passerines migrate and stopover at suitable sites throughout the country from locations as far as northern Europe (Fransson *et al* 2005, Hasseb *et al* 2006). However, many migrant species *eg* Spotted Flycatcher *Muscicapa striata* and Red-backed Shrike

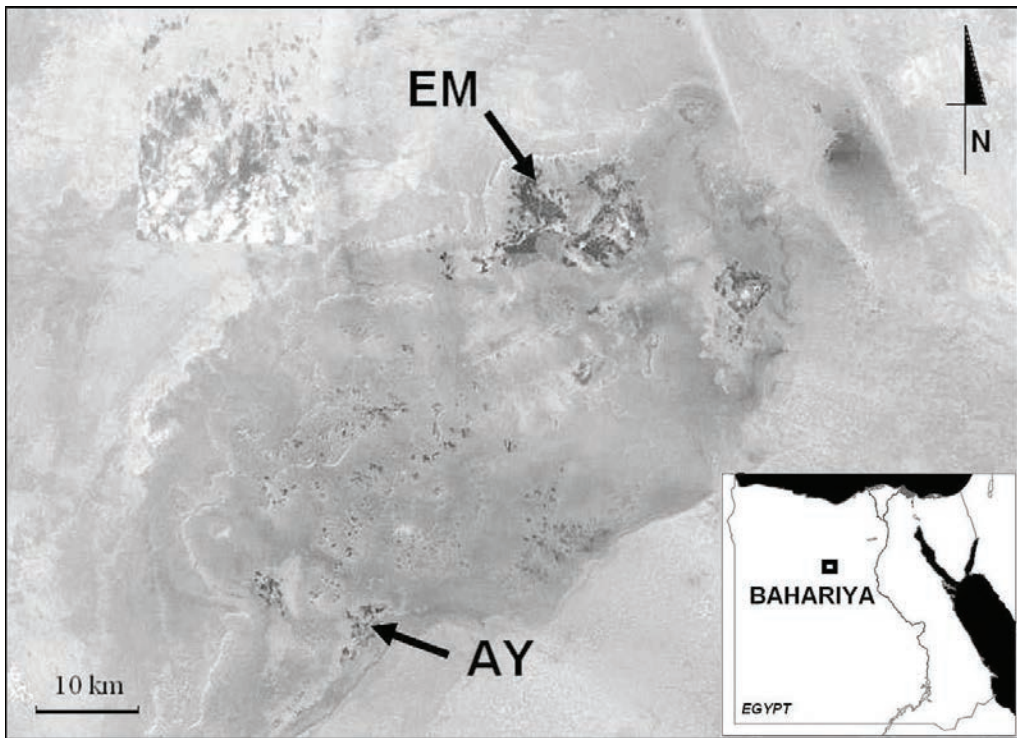


Figure 1. Bahariya oasis study sites, Western desert, Egypt. The main area of the oasis with El Marun lake is shown in the upper half of the photo, Abu Yasser lake in El Heiz in the lower. AY = Abu Yasser lake, EM = El Marun lake. Source of photograph: GoogleEarth.

Lanius collurio are experiencing declines in their breeding populations throughout Europe (BirdLife International 2004). One of the reasons is thought to be decreased survival on migration. Recently, it has been accepted that some migrant birds use an intermittent migration strategy, stopping over en route to rest and refuel (Schmaljohann *et al* 2007, Salewski *et al* 2010). Bahariya oasis could be an important stopover area for a variety of migrant birds.

An assessment of its avifauna was therefore commissioned and conducted by the Nature and Science Foundation, Egypt, in collaboration with the SE European Bird Migration Network (SEEN) based at University of Gdańsk, Poland, to provide baseline data on resident and migratory species, with a view to setting up a permanent ringing station in future years.

STUDY SITES AND METHODS

The Abu Yasser lake study site/ringing station was in operation 26–31 August and the El Marun lake study site/ringing station 1–15 September, 2010.

Abu Yasser lake (El Heiz)

Abu Yasser (28.01282° N, 28.71953° E) is a small saline lake, part of El Heiz, 3 km southeast of the Bahariya–Farafra oasis road. In August 2010 only a small area of the lake had standing water (Plate 1). The lake landscape is a mosaic of different habitats including mudflats, rushes, reeds, date palm plantations, cultivated land, tamarisk trees and scrub. Low-level agriculture has changed the desert landscape with date palm plantations as well as small patches of cash crops such as grass pasture and alfalfa feed for cattle.



Plate 1. Abu Yasser lake habitats, foreground grass and date palms, lake in background, August 2010, Bahariya oasis, Egypt. © Matthew White

Hunting is practised and several local bedouin people were observed shooting at ducks on the lake. At Abu Yasser 7 x 12 m and 3 x 7m (105 m) of mist-nets with 4 pockets were erected in a variety of different habitats near the lake: grass pasture, alfalfa, rushes, reeds and tamarisk/scrub.

El Marun lake (Bawiti)

El Marun (28.41862° N, 28.88110° E) is a saline lake 6 km north of Bawiti town. El Marun is one of the largest lakes (over 10 km²) in Bahariya oasis and has an area of standing water, supplemented by runoff from irrigation channels. The lake (Plate 2) merges into a mosaic of different habitats such as mudflats, rushes, reeds, date palm plantations, cultivated land, tamarisk trees, scrub vegetation and fruit trees. Agriculture has changed the desert landscape in the form of large date palm plantations. There are also over 10 ha of irrigated alfalfa crops on the northeast side of the lake, where the ringing station was based, attracting considerable insect diversity and passerine birds. To the north and northeast the cultivated areas merge into desert habitats over steep sandstone escarpments. There are several small bedouin settlements dotted around the lake with livestock (cattle, goats, camels, horses and donkeys) and one small disused hotel complex on the northeast side of the lake. From south Bawiti several motorable tracks circle the lake. Bird hunting was observed in the date plantations and on the lake. At El Marun 11 x 12 m and 3 x 7 m (153 m) mist-nets were set up in habitats next to the lake: grass pasture, alfalfa, rushes, reeds, tamarisk/scrub and fruit trees.

After initially surveying each lake area nets were placed in a variety of habitats where birds were present in higher numbers. Nets were left open 05.30–10.00 h and 16.30–19.00 h each day. Temperatures were high throughout the midday period and nets were closed due to the potential risk of trapped birds being exposed to heat of over 40°C. Nets were closed in the evening to reduce the risk of birds being left, caught overnight. Each bird was processed using SEEN methods. A Polish or Egyptian coded metal ring was attached to the bird's tarsus—sex and age were assessed, fat deposition was estimated according



Plate 2. El Marun lake, alfalfa in foreground with mist-nets, lake and a more mature date palm, September 2010, Bahariya oasis, Egypt. © Matthew White

to a scale from 0 to 8 (Busse 2000), wing formula and wing and tail measurements were recorded, and weight. Selected birds were tested for directional preferences in a Busse orientation cage (Busse 1995; for results see Stępniewski *et al* 2011). Vantage point counts and casual bird observations were conducted each day for 30 minutes at strategic points around each lake, mainly to record water birds.

RESULTS

Eighty-three species of birds were recorded in the Bahariya oasis area: 54 species at Abu Yasser lake and 74 at El Marun lake (Table 1). Pallid Harrier *Circus macrourus* and Sooty Falcon *Falco concolor*, classified as near threatened by IUCN (2008), were recorded. Spanish Sparrow *Passer hispaniolensis* was the most abundant species (>210 birds), followed by Yellow Wagtail *Motacilla flava* (>130) and Western Cattle Egret *Bubulcus ibis* (>112). At Abu Yasser Yellow Wagtail and Dunlin *Calidris alpina* were the most abundant species recorded (30), followed by Blue-cheeked Bee-eater *Merops persicus* (20). The most abundant species at El Marun was Spanish Sparrow (>200) followed jointly by Yellow Wagtail (>100) and Western Cattle Egret (>100).

Over 30 species of passerine migrants were recorded including 50 Willow Warblers *Phylloscopus trochilus*. Thirty-six species of water birds were noted including Dunlin (50), Little Egret *Egretta garzetta* (40) and Kentish Plover *Charadrius alexandrinus* (40).

Overall, 144 birds (18 species) were trapped. Willow Warbler was the most frequently trapped species (20.1%), followed by Spanish Sparrow (18.0%), Yellow Wagtail (14.5%) and Rufous-tailed Scrub Robin (13.8%) (Table 2).

Trapping results Abu Yasser lake

During 6 days at Abu Yasser, 21 birds (7 species) were trapped though none were re-trapped within this period. The most frequently-trapped species was Red-backed Shrike 33.3% (7 birds, Plate 3) followed by Willow Warbler 23.8% (5), Sedge Warbler *Acrocephalus schoenobaenus* and Spanish Sparrow 14.2% (3). The capture rate was very low,

reaching 0.04 birds/m of net/day. Most birds carried a substantial amount of fat (fat score >3, Table 2).

Trapping results El Marun lake

During 14 days of trapping at El Marun 123 individuals (17 species) were trapped (Table 2). The most frequently trapped species were: Willow Warbler 19.5% (24 birds, Plate 4), Spanish Sparrow 18.6% (23), Yellow Wagtail 17% (21, Plate 5) and Rufous-tailed Scrub Robin 15.4% (19). These four species constituted almost 75% of all the birds caught and were also the most numerous passerines observed in the area. The Rufous-tailed Scrub Robins were of subspecies *galactotes*. Yellow Wagtail subspecies were difficult to determine, as most birds caught were immature; the single adult male and two adult females caught were probably *feldegg* hybrids. Other ringed birds included one Common Kingfisher *Alcedo atthis* and three Pied Kingfishers *Ceryle rudis*, caught in nets used for trapping bats by a small pond c600 m from the ringing site. The only re-traps were two Rufous-tailed Scrub Robins, the first ringed 5 September and caught again 7 Sept, the second ringed 7 Sept and re-caught 8 Sept, weight did not change significantly between trappings (22.6/21.1 g and 25.2/26.2 g respectively). Capture rate was higher at El Marun, but still low, reaching 0.06 bird/m of net/day, in spite of quite high numbers of birds observed daily in the ringing area.

Fat scores

The majority of migratory passerines had quite large amounts of fat (fat scores >3, Table 2). These included Willow Warblers (mean 3.6, 29 birds) from both ringing sites and Yellow Wagtails (3.7, 21) at El Marun.

Birds with lower fat scores included, all at El Marun: Eurasian Reed Warblers *Acrocephalus scirpaceus* (1.7, 6), Rufous-tailed Scrub Robins (1.6, 19) and Spanish Sparrows (1.2, 23).

Habitat associations of birds at El Marun lake

Out of 123 birds trapped at El Marun, 52.8% were trapped in tamarisk habitat, 39% in alfalfa crops, 4.8% in fruit trees and 3.2% in reeds/rushes (Table 3). All (21) Yellow Wagtails were trapped in a mosaic of alfalfa crops as well as 75% (18) of Willow Warblers. The large majority of Yellow Wagtails and Willow Warblers were observed openly foraging



Plate 3. Red-backed Shrike *Lanius collurio* trapped beside tamarisk bushes at Abu Yasser lake, August 2010, Bahariya oasis, Egypt. © Katherine Stewart



Plate 4. Willow Warbler *Phylloscopus trochilus* trapped at El Marun lake, September 2010, Bahariya oasis, Egypt. © Matthew White



Plate 5. Yellow Wagtail *Motacilla flava* juvenile trapped in alfalfa crops at El Marun lake, September 2010, Bahariya oasis, Egypt. © Matthew White

in insect-rich alfalfa crops which were very patchy in distribution (average height 35.8 mm). All (100%) Eurasian Reed Warblers (6) and Lesser Whitethroats (6, Plate 6) were recorded in tamarisk habitats including 78.9% (15) of the Rufous-tailed Scrub Robins. Several other species were trapped alongside apricot fruit trees including a single Garden Warbler *Sylvia borin*, Thrush Nightingale *Luscinia luscinia*, Whinchat *Saxicola rubetra* and Spotted Flycatcher and two Collared Flycatchers *Ficedula albicollis*.

DISCUSSION

This study confirms that Bahariya oasis is a stopover area for migratory birds. Passerine migrants were recorded actively foraging in a variety of habitats such as tamarisk bushes, alfalfa crops, reeds, fruit trees; with body mass and fat loads well above breeding levels. Willow Warbler and Yellow Wagtail were the two species trapped most frequently, mirroring a study conducted in autumn 1982/1983 (Biebach *et al* 1986), at the



Plate 6. Lesser Whitethroat *Sylvia curruca* trapped beside tamarisk bushes at El Marun lake, September 2010, Bahariya oasis, Egypt. © Matthew White

Table 1. Bird species and numbers recorded at lakes Abu Yasser and El Marun, Bahariya oasis, August and September 2010. Status: MB = migrant breeder, RB = resident breeder, PV = passage visitor, WV = winter visitor (following Goodman *et al* 1986).

		Status	Abu Yasser	El Marun	Bahariya Total
Common Quail	<i>Coturnix coturnix</i>	PV	1	1	2
Northern Shoveler	<i>Anas clypeata</i>	PV, WV	7		7
Garganey	<i>Anas querquedula</i>	PV	1	10	11
Glossy Ibis	<i>Plegadis falcinellus</i>	PV	4	10	14
Black-crowned Night Heron	<i>Nycticorax nycticorax</i>	PV		2	2
Squacco Heron	<i>Ardeola ralloides</i>	PV, WV	1	1	2
Western Cattle Egret	<i>Bubulcus ibis</i>	RB?, PV, WV	12	100	112
Little Egret	<i>Egretta garzetta</i>	PV, WV	10	30	40
Grey Heron	<i>Ardea cinerea</i>	PV, WV	2	15	17
Purple Heron	<i>Ardea purpurea</i>	PV		1	1
Western Marsh Harrier	<i>Circus aeruginosus</i>	PV, WV, RB?		1	1
Pallid Harrier	<i>Circus macrourus</i>	PV, WV		2	2
Long-legged Buzzard	<i>Buteo rufinus</i>	PV, WV	1	1	2
Common Kestrel	<i>Falco tinnunculus</i>	RB?, PV, WV	1		1
Sooty Falcon	<i>Falco concolor</i>	MB	4		4
Water Rail	<i>Rallus aquaticus</i>	RB, PV, WV	2	2	4
Eurasian Coot	<i>Fulica atra</i>	RB, PV, WV		1	1
Black-winged Stilt	<i>Himantopus himantopus</i>	RB? WV	20	2	22
Northern Lapwing	<i>Vanellus vanellus</i>	PV, WV	2		2
Spur-winged Lapwing	<i>Vanellus spinosus</i>	RB, PV	2	12	14
Common Ringed Plover	<i>Charadrius hiaticula</i>	PV, WV	1	2	3
Little Ringed Plover	<i>Charadrius dubius</i>	(MB?), PV, WV	2	1	3
Kentish Plover	<i>Charadrius alexandrinus</i>	RB?, PV, WV	20	20	40
Common Snipe	<i>Gallinago gallinago</i>	PV, WV	2	1	3
Black-tailed Godwit	<i>Limosa limosa</i>	PV, WV		1	1
Spotted Redshank	<i>Tringa erythropus</i>	PV, WV	1		1
Common Redshank	<i>Tringa totanus</i>	PV, WV	1	1	2
Marsh Sandpiper	<i>Tringa stagnatilis</i>	PV, WV	1	2	3
Common Greenshank	<i>Tringa nebularia</i>	PV, WV	6	10	16
Green Sandpiper	<i>Tringa ochropus</i>	PV, WV	2	3	5
Wood Sandpiper	<i>Tringa glareola</i>	PV, WV	2	5	7
Common Sandpiper	<i>Actitis hypoleucos</i>	PV, WV	2	1	3
Little Stint	<i>Calidris minuta</i>	PV, WV	11	20	31
Curlew Sandpiper	<i>Calidris ferruginea</i>	PV	2	1	3
Dunlin	<i>Calidris alpina</i>	PV, WV	30	20	50
Ruff	<i>Philomachus pugnax</i>	PV, WV	8	10	18
Collared Pratincole	<i>Glareola pratincola</i>	MB?, PV		1	1
Gull-billed Tern	<i>Gelochelidon nilotica</i>	PV		4	4

Whiskered Tern	<i>Chlidonias hybrida</i>	PV, (WV)	2	3	5
White-winged Black Tern	<i>Chlidonias leucopterus</i>	PV	2	2	4
Feral Pigeon	<i>Columba livia domestica</i>	RB	10	10	20
European Turtle Dove	<i>Streptopelia turtur</i>	MV, PV, WV		2	2
Eurasian Collared Dove	<i>Streptopelia decaocto</i>	RB	2	5	7
Laughing Dove	<i>Spilopelia senegalensis</i>	RB	10	10	20
Pharaoh Eagle Owl	<i>Bubo ascalaphus</i>	RB		1	1
European Nightjar	<i>Caprimulgus europaeus</i>	PV		1	1
Egyptian Nightjar	<i>Caprimulgus aegyptius</i>	MB	2	2	4
Common Swift	<i>Apus apus</i>	PV		1	1
Common Kingfisher	<i>Alcedo atthis</i>	PV, WV		3	3
Pied Kingfisher	<i>Ceryle rudis</i>	RB?, WV, PV		3	3
Blue-cheeked Bee-eater	<i>Merops persicus</i>	MB?, PV	20	5	25
European Bee-eater	<i>Merops apiaster</i>	PV	1		1
Eurasian Hoopoe	<i>Upupa epops</i>	RB, PV	1		1
Red-backed Shrike	<i>Lanius collurio</i>	PV (WV?)	10	3	13
Eurasian Golden Oriole	<i>Oriolus oriolus</i>	PV		1	1
Hooded Crow	<i>Corvus cornix sardonius</i>	RB	1	1	2
Brown-necked Raven	<i>Corvus ruficollis</i>	RB	2	13	15
Greater Hoopoe-Lark	<i>Alaemon alaudipes</i>	RB		2	2
Sand Martin	<i>Riparia riparia</i>	PV	1	5	6
Barn Swallow	<i>Hirundo rustica</i>	PV		10	10
Common House Martin	<i>Delichon urbicum</i>	PV		1	1
Willow Warbler	<i>Phylloscopus trochilus</i>	PV, (WV?)	10	40	50
Eastern Bonelli's Warbler	<i>Phylloscopus orientalis</i>	PV	1		1
Sedge Warbler	<i>Acrocephalus schoenobaenus</i>	PV	3	6	9
Eurasian Reed Warbler	<i>Acrocephalus scirpaceus</i>	PV		6	6
Eastern Olivaceous Warbler	<i>Iduna pallida</i>	MB, PV	2	2	4
Icterine Warbler	<i>Hippolais icterina</i>	PV	1		1
Garden Warbler	<i>Sylvia borin</i>	PV		1	1
Lesser Whitethroat	<i>Sylvia curruca</i>	PV, WV		6	6
Eastern Orphean Warbler	<i>Sylvia crassirostris</i>	PV, WV		1	1
Common Whitethroat	<i>Sylvia communis</i>	PV		1	1
Eurasian Blackbird	<i>Turdus merula</i>	WV		3	3
Thrush Nightingale	<i>Luscinia luscinia</i>	PV		1	1
Rufous-tailed Scrub Robin	<i>Cercotrichas galactotes</i>	MB, PV, (WV)	5	20	25
Whinchat	<i>Saxicola rubetra</i>	PV	1	2	3
Isabelline Wheatear	<i>Oenanthe isabellina</i>	PV, WV		1	1
Northern Wheatear	<i>Oenanthe oenanthe</i>	PV		1	1
White-crowned Wheatear	<i>Oenanthe leucopyga</i>	RB	2	2	4
Spotted Flycatcher	<i>Muscicapa striata</i>	PV	1	10	11
Collared Flycatcher	<i>Ficedula albicollis</i>	PV		2	2
Spanish Sparrow	<i>Passer hispaniolensis</i>	PV, WV	10	200	210
Yellow Wagtail	<i>Motacilla flava</i>	RB?, PV	30	100	130
White Wagtail	<i>Motacilla alba</i>	PV, WV		1	1

Table 2. Number, weight and fat deposition (\pm SD) of all birds at first capture in mist nets at lakes Abu Yasser and El Marun, Bahariya oasis, August and September 2010. If less than 4 birds were caught, the individual weights and fat scores are given (following Hilgerloh & Raddatz 2009).

		N	Weight (g)	Fat score
Abu Yasser				
Red-backed Shrike	<i>Lanius collurio</i>	7	29.20 \pm 2.06	4.0 \pm 0.0
Willow Warbler	<i>Phylloscopus trochilus</i>	5	8.24 \pm 0.61	3.6 \pm 0.6
Eastern Bonelli's Warbler	<i>Phylloscopus orientalis</i>	1	8.2	4
Sedge Warbler	<i>Acrocephalus schoenobaenus</i>	3	12.9, 12.5, 12.0	6, 4, 4
Eastern Olivaceous Warbler	<i>Iduna pallida</i>	1	8.4	1
Rufous-tailed Scrub Robin	<i>Cercotrichas galactotes</i>	1	24.1	2
Spanish Sparrow	<i>Passer hispaniolensis</i>	3	23.3, 23.8, 25.0	3, 2, 0
TOTAL		21		
El Marun				
Laughing Dove	<i>Spilopelia senegalensis</i>	1	99.9	-
Common Kingfisher	<i>Alcedo atthis</i>	3	31.9, 31.3, 28.0	-
Pied Kingfisher	<i>Ceryle rudis</i>	3	81.4, 86.1, 82.4	-
Red-backed Shrike	<i>Lanius collurio</i>	3	28.6, 24.1, 27.4	4, 4, 4
Willow Warbler	<i>Phylloscopus trochilus</i>	24	8.61 \pm 0.81	3.6 \pm 0.6
Sedge Warbler	<i>Acrocephalus schoenobaenus</i>	6	11.72 \pm 1.44	4.5 \pm 1.2
Eurasian Reed Warbler	<i>Acrocephalus scirpaceus</i>	6	10.30 \pm 0.70	1.7 \pm 0.8
Eastern Olivaceous Warbler	<i>Iduna pallida</i>	2	9.2, 10.6	2, 3
Garden Warbler	<i>Sylvia borin</i>	1	15.3	3
Lesser Whitethroat	<i>Sylvia curruca</i>	6	11.50 \pm 0.92	3.7 \pm 1.5
Thrush Nightingale	<i>Luscinia luscinia</i>	1	22.3	3
Rufous-tailed Scrub Robin	<i>Cercotrichas galactotes</i>	19	23.13 \pm 2.21	1.6 \pm 1.6
Whinchat	<i>Saxicola rubetra</i>	1	18.9	5
Spotted Flycatcher	<i>Muscicapa striata</i>	1	15.3	4
Collared Flycatcher	<i>Ficedula albicollis</i>	2	11.9, 12.9	3, 3
Spanish Sparrow	<i>Passer hispaniolensis</i>	23	24.83 \pm 1.62	1.2 \pm 1.3
Yellow Wagtail	<i>Motacilla flava</i>	21	17.76 \pm 1.77	3.7 \pm 0.7
TOTAL		123		

now disused Sadat farm 15 km north of Bahariya. Willow Warblers (24 birds) trapped at El Marun had a mean weight of 8.61 \pm 0.81 g and mean fat scores of 3.6 \pm 0.6. Mean weight was similar in Willow Warblers at Sadat farm in autumn 1982/1983, 8.78 \pm 1.18 g (733) with median fat score in class 3. In comparison, Willow Warblers (73) trapped September/October 2006 at a sewage plant in the Eastern desert had a lower mean weight, 7.87 \pm 2.12 g and fat score 2 \pm 0.7 (Hilgerloh & Raddatz 2009). Mean body mass of Yellow Wagtails (21) at El Marun was 17.76 \pm 1.77 g and they had a mean fat score of 3.7 \pm 0.7, very similar to Sadat farm Yellow Wagtails (1212 birds) 17.5 \pm 1.2 g, with median fat score in class 4, well above lean body mass values of 14 g (Biebach *et al* 1986). Only 6 Lesser Whitethroats were trapped, the first on 5 September, and then 12–14 September—if the trapping period had been prolonged into late September more birds may have been ringed. Lesser Whitethroat (629 birds) was the third most abundant species caught at Sadat farm (Biebach *et al* 1986).

Birds of most species caught in Bahariya carried substantial amounts of fat, crucial for successful crossing of the desert (Biebach *et al* 1986). The exceptions require closer

Table 3. Habitat preferences of birds caught at El Marun lake, Bahariya oasis, September 2010.

		Habitat			
		Apricot Trees	Tamarisk	Lucerne crop	Reeds/ rushes
Laughing Dove	<i>Spilopelia senegalensis</i>		1		1
Common Kingfisher	<i>Alcedo atthis</i>		3		3
Pied Kingfisher	<i>Ceryle rudis</i>		3		3
Red-backed Shrike	<i>Lanius collurio</i>		3		3
Willow Warbler	<i>Phylloscopus trochilus</i>		5	18	1
Sedge Warbler	<i>Acrocephalus schoenobaenus</i>		1	5	6
Eurasian Reed Warbler	<i>Acrocephalus scirpaceus</i>		6		6
Eastern Olivaceous Warbler	<i>Iduna pallida</i>		2		2
Garden Warbler	<i>Sylvia borin</i>	1			1
Lesser Whitethroat	<i>Sylvia curruca</i>		6		6
Thrush Nightingale	<i>Luscinia luscinia</i>	1			1
Rufous-tailed Scrub Robin	<i>Cercotrichas galactotes</i>		15	4	19
Whinchat	<i>Saxicola rubetra</i>	1			1
Spotted Flycatcher	<i>Muscicapa striata</i>	1			1
Collared Flycatcher	<i>Ficedula albicollis</i>	2			2
Spanish Sparrow	<i>Passer hispaniolensis</i>		20		3
Yellow Wagtail	<i>Motacilla flava</i>			21	21
TOTAL		6	65	48	4
				23	123

consideration. The Rufous-tailed Scrub Robin breeds in Bahariya (Goodman *et al* 1986), so our sample may have included local birds, not prepared for migration, with probably lower fat scores. Spanish Sparrow is an abundant migrant and wintering species in Egypt (Goodman & Meininger 1989). The birds caught in Bahariya were in active moult of remiges and rectrices. As both moult and deposition of fat are energy consuming (Schaub & Jenni 2000), the birds probably stayed during the moult period in the oasis or overwintered and did not accumulate fat for migration. Eurasian Reed Warbler is a regular migrant wintering in the sub-Saharan zone (Dowsett-Lemaire & Dowsett 1987). Its relatively low fat scores, in comparison to other trans-Saharan migrants in Bahariya, might be a little surprising. This species is not restricted to a particular source of food and can gain weight in many places en route (Bibby & Green 1981). Reed Warblers caught in autumn in the Nile delta, after flying over the Mediterranean, had mostly moderate fat scores (mean 2.6)—moving south along the Nile valley, the amount of fat increased as the birds refueled up to a mean of 3.9 in Aswan (Ożarowska *et al* 2011) before crossing the Sahara. It is therefore possible that Reed Warblers caught in Bahariya use the oasis as a stopover site to rest and refuel before continuing the journey (towards lake Chad perhaps, Stepniowski *et al* 2011); however, since we caught no retraps of this species, there is no evidence so far for this hypothesis. By contrast, Sedge Warblers had very high fat scores (as high as 6 in the 0–8 scale). This species is more specialized, foraging mostly on reed aphids that have patchy and unpredictable inter-annual density. Sedge Warblers need to accumulate fuel in habitats with abundance of aphids, they then migrate long distances with few opportunities to deposit fat (Bibby & Green 1981). Consequently, the birds caught



Plate 7. Nets next to tamarisk (mid distance) at El Marun lake, northern desert escarpment in background, September 2010, Bahariya oasis, Egypt. © Matthew White

in Bahariya may have accumulated fat loads in the Nile delta or maybe even in Europe and probably used the oasis mainly as a place to rest without refueling. The reedbeds in Bahariya are poorly developed and maybe cannot supply the birds with the amounts of aphids needed for restoring the fat load.

Habitat associations of Palearctic migrants trapped in the Bahariya oases indicate species-specific habitat preferences. All Yellow Wagtails and the majority of Willow Warblers were caught in an irrigated patchy mosaic of alfalfa crops teeming with insects. Yellow Wagtails were observed running through bare areas of open alfalfa crops and catching insects. Willow Warblers were observed using low perches and foraging in alfalfa crops on the ground taking small insects and caterpillars. Reed Warblers and Lesser Whitethroats (foliage-gleaning species) were all caught alongside tamarisk bushes providing food and cover. The rough structural mosaic of crops and habitats at El Marun lake clearly provide several factors intrinsic to migrant stopover habitat suitability including foraging opportunities and shelter against predators and heat (Moore & Woodrey 1993).

An intermittent migration strategy is now assumed in trans-Saharan passerine migrants (Biebach *et al* 2000, Schmaljohann *et al* 2007, Salewski *et al* 2010). Most trans-Saharan migrants fly nocturnally over the desert and rest in shade during the day, implying the birds have enough fat to continue without refueling (Biebach *et al* 2000, Schmaljohann *et al* 2007). Only a few birds were re-trapped in this study, Yellow Wagtails and Willow Warblers possibly only stopped for one day with reasonable fat loads, foraging intensively to increase fat load, then continuing passage the following evening. Over 100 Yellow Wagtails were regularly observed running and foraging in alfalfa crops but they probably could see the nets against the sky, especially when the wind was blowing. If walk-in traps are used in the future there may be a higher number of Yellow Wagtails trapped and re-trapped.

The birds and wildlife of Bahariya oasis are threatened by development, overuse of water resources for agriculture, and hunting. Protection is required through nature

conservation designation and conservation management to protect, restore and maintain habitats for resident and migratory birds. Further research is required involving a permanent ringing station near El Marun lake and using a variety of trapping methods for passerines and water birds. Long-term ringing of passerine migrants, together with analyses of fat score and retrap rate, would enable study of the strategies of bird migration across the desert and further determine the importance of Bahariya oasis as a stopover place. Monitoring and trapping should also take place in spring migration periods and water bird counts on the lakes could take place in winter when water levels are higher.

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