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REMARKS ON THE IMPORTANCE OF SCATTERED VEGETATION IN DESERT AREAS OF LIBYA FOR MIGRATING AND BREEDING BIRDS

Abstract – Some authors suggested that there is no single optimal trans-Saharan migratory strategy, but possibly a variety of strategies, including: non-stop, stopover carrying minimal fat but with frequent refuelling, stopover without refuelling. Migrants, indeed, cannot refuel when crossing the Sahara, the only opportunities being the oases scattered in the desert. The presence of such large numbers of birds in oases or “islands” and “corridors” of vegetation in the middle of the desert implies the need to ensure a no risk stop. The authors carried out four visits in the desert areas of Libya, finding that areas covered by vegetation are more important for diurnal migrant birds in spring than in autumn. When, in autumn, birds reach the desert, they have not covered many kilometres and still store a good amount of subcutaneous fat, acquired during the Mediterranean crossing, whereas in spring they reach oases and other vegetated “islands” in the middle of the desert, after a long flight and may find themselves with scarce fat supplies; this is in line with the high availability of insects in desert areas with vegetation in spring and scarcity in autumn.

Assuming the high importance for migratory birds of the above mentioned areas of vegetation scattered throughout the Libyan desert and the presence of “oases” in the Sahara desert, the long term conservation of these areas should be ensured to protect birds breeding in Europe and wintering in Africa. This would obviously cross the borders of individual countries’ interests and authorities. Very few desert sites are listed as Important Bird Areas, and the authors therefore propose to include among them Germa lakes and Waw el Namus in the Libyan desert. Evidence for the degradation of staging sites on either side of the Sahara suggests that conservation plans are needed which take into account the needs of migrant birds; oases and new areas of irrigation may provide increasingly important feeding stations during bird migrations, resembling islands within a desert sea; countries involved should assume their international responsibilities in bird conservation; European countries, in turn, could invest in research projects and ecological restoration programs in African desert areas.

Key words – Desert areas, Libya, migrant and breeding birds, migratory strategies

Riassunto – *Considerazioni sull’importanza per gli uccelli migratori e nidificanti di aree coperte da vegetazione distribuite nel deserto della Libia.*

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Alcuni autori ritengono che non esista una sola strategia ottimale di migrazione trans-Sahariana, ma una varietà di strategie che comprendono l'attraversamento non stop del deserto, soste degli individui con scarso grasso sottocutaneo, in cui si riforniscono di cibo e soste senza rifornimento di energia. I migratori in effetti durante l'attraversamento del Sahara non possono sostare, tranne che nelle oasi sparse nel deserto. La presenza di grandi quantità di uccelli nelle oasi o nelle "isole" e nei "corridoi" con vegetazione, in mezzo al deserto sembra sia giustificata dal fatto che essi assicurano a questi uccelli una sosta senza rischi. Gli autori hanno effettuato quattro visite nelle zone desertiche della Libia, trovando che le aree con vegetazione sono molto più importanti per gli uccelli migratori diurni in primavera che in autunno; infatti, in autunno quando essi raggiungono le oasi del deserto, non hanno ancora coperto molti chilometri dall'ultimo luogo di sosta con rifornimento di energia e quindi hanno ancora un consistente strato di grasso sottocutaneo, acquisito durante l'attraversamento del Mediterraneo, mentre in primavera essi raggiungono le oasi e le altre aree del deserto con vegetazione, dopo un lungo volo e possono ritrovarsi con scarsa quantità di grasso sottocutaneo; ciò concorda anche con la grande disponibilità di insetti nelle aree desertiche con vegetazione in primavera ed una relativa scarsità o assenza in autunno.

Premessa la notevole importanza per gli uccelli migratori delle aree con vegetazione o di simili "oasi" presenti nel deserto del Sahara, dovrebbe esserne assicurata una conservazione a lungo termine per tutelare gli uccelli nidificanti in Europa e svernanti in Africa, che quindi superano le competenze e gli interessi di un singolo paese. Nel deserto del Sahara sono state proposte pochissime IBA, e sarebbe opportuno quanto meno includervi in futuro i laghi di Germa e Waw el Namus. Recenti indicazioni di un degrado in atto in alcuni siti ai due lati del Sahara suggeriscono che sono necessari dei progetti di conservazione su ampia scala che tengano nel dovuto conto le necessità degli uccelli migratori; oasi e nuove aree recentemente irrigate nel deserto possono diventare sempre di più importanti luoghi di sosta durante la migrazione degli uccelli, quasi come isole in mezzo al mare; i paesi coinvolti dovrebbero assumersi la loro responsabilità internazionale nella conservazione delle popolazioni di uccelli; l'Unione Europea, a sua volta, potrebbe investire in progetti di ricerca e programmi di restauro ambientale nelle aree desertiche e sub-desertiche dell'Africa.

Parole chiave – Deserto libico, uccelli migratori e nidificanti, strategie migratorie

Introduction

Trans-Saharan migration is an evolutionary adaptation by many bird species, which find their resources in two continents in different seasons. This behaviour certainly dates back to a remote period well before the environmental fluctuations that occurred more recently in the Sahara desert. Even if supposedly the Sahara is almost incapable of supporting any migrants because of its extreme barrenness (MOREAU, 1972), birds must have crossed the desert for hundreds of thousands of years, finding, as time went by, more or less unfavourable conditions and getting used to the fluctuating climate. Recent changes in the area currently covered by the Sahara desert (9.1 millions km²), possibly, influenced bird behaviour only moderately during migrations. According to WILLIAMS (1984), from about 12,000 to 6,000 years ago, the Sahara was a land of lakes, surely very favourable to migrant birds; after which, there was a return to aridity, that was accentuated towards

4,000 years ago. Historical, archaeological and geological records provide abundant evidence that, at least before 4,000 year B.P., the borders of the Sahara experienced more than one period when conditions were wetter than today (BUTZER, 1971), and, until no more than 5,000 years ago, at least the western Sahara was covered by a temperate-zone vegetation, sufficient to support a rich fauna (MOREAU, 1972). In agreement with pollen analysis, the desert cover should date back to about 4,000 years ago; in spite of this, along the Libyan coast, climate did not change in the last 4,000 years and it seems that the average rainfall of 400 mm at Tripoli and 600 mm on Djebel Akhdar (Cyrenaica) did not fluctuate during this time (HUFNAGL, 1972). The eastern margin of North Africa from Libya to Somalia is considered among the areas characterized by the highest intensity of aridity (OBERLANDER, 1979); rainfall in the extreme desert areas of Algeria and Libya is recorded only in late autumn to early winter and, more generally, northern Sahara exhibits strong winter rainfall seasonality, while southern Sahara and Sahelian regions have predominantly summer seasonal rainfall (WHITFORD, 2002). Presently, the long-term climatic prognosis is for a return to the hyper-arid conditions of 18,000-12,000 years ago, when intertropical aridity was world-wide (WILLIAMS, 1984; WHITFORD, 2002). The distribution of oases gives only a small idea of the availability of fossil water contained in the subsurface of some desert areas, such as Sarir, Kufra and Murzuq. They have a very important function in the conservation of non adapted fauna to barrenness conditions, that was once possibly much more widespread than today over the area currently covered by desert. These oases certainly had natural characteristics that were much different from today's. In fact, the Greek historian Herodotus (484-428 BC), who mentioned Augila oasis, wrote that the area was surrounded by thick bushes and described an abundance of water that does not exist today.

Nowadays, the Sahara is a region of extreme aridity, high temperatures and violent winds (CLOUDSLEY-THOMPSON, 1984; COSTA, 1995), comprising an area which has a mean annual precipitation of 100 mm or less, extending to about 5,150 km and expanding from the shores of the Atlantic Ocean to the Red Sea coast in Egypt. In some places, as in Libya, it reaches the southern shores of the Mediterranean sea, extending from N to S between 970 to 1290 km (SMITH, 1984); in addition, for many migrant birds making diagonal crossings, the desert passage will be considerably longer than the 1500 km for a direct route between the 100 mm isohyets (PETTET, 1984).

MOREAU (1961, 1972) suggested that passerines fly continuously day and night to cover the distance of 1600-2200 km in a long non-stop flight of at least 40-60 hours; his hypothesis was supported by observations that migrants accumulate considerable amounts of fat before their thans-

Saharan flight. WOOD (1982, 1989, 1992) supported this hypothesis, pointing out that evidence currently available suggests that migrating birds use non-stop flight to cross the Sahara. However, detailed studies carried out in stopover sites inside Saharan oases indicate that a proportion of trans-Saharan migrants regularly stopover in desert oases, mainly for a daytime rest, but sometimes also for refuelling (e.g.: HOGG, 1974; MISONNE, 1974; COWAN, 1982, 1983, 1985; BAIRLEIN, 1985, 1992; BIEBACH *et alii*, 1986, 1991, 2000; HERREMANS, 1991; LAVEE *et alii*, 1991; BIEBACH, 1992; LIECHTI *et alii*, 2003), suggesting an alternative short-stop strategy, or intermittent migration, with flight only during the night and rest during the day (BAIRLEIN, 1985; BIEBACH *et alii*, 1986, 2000; LIECHTI *et alii*, 2003). According to this hypothesis, migrants with significant fat reserves for further migration may stop only to rest, whereas those with insufficient fat deposits stop to forage and replenish their reserves. In general birds with insufficient fat reserves prefer larger and more vegetated sites where they can forage. However, due to their foraging activity, the proportion of land birds at a particular stop-over site can be overestimated (BAIRLEIN, 1992). Actually, foraging opportunities in the eastern Sahara are marginal, except in a few oases, since the rest of the desert is virtually bare, stony or sandy, without vegetation (BIEBACH, 1992).

We visited Libya four times on the whole, carrying out interesting observations on the behaviour of migrant birds in some oases and along roads crossing different areas of the desert. Additionally, we recorded some breeding evidences of wetland species in natural lakes in the middle of the desert. We report here some remarks on the importance of residual vegetated areas and introduced plants for birds.

Areas visited¹

Between 4 and 16 April 1998 BM visited the country from the Tunisia-Libya to the Libya-Egypt frontier and back (MASSA, 1998); between 19 and 28 September 2004 MV crossed Tripolitania and Fezzan, following mainly an archeological itinerary in Cyrenaica and Tripolitania, including brief stops inside the Akakus region and Germa lakes too; between 17 and 29 April 2005 BM and MV visited Fezzan (Sebha-Murzuk, Mathendusc², Germa lakes, Waw el Namus), Tripolitania coast (Leptis Magna) and Cyrenaica (Djebel Akhdar); finally, between 30 October and 8 November 2005 MV returned again to

¹ For convenience the regions as mentioned by BUNDY (1976) are used in this paper.

² Mathendusc, a rupestrian archaeological site (25°42.85'N-12°08.65'E) lying on the South-East slopes of Messak Settafet plateau, is an open-air site, where there are 10,000-year-old engravings of elephants, giraffes, crocodiles and other African animals that presumably once roamed here.

Libya passing through the area from Tripoli to Ghadames and then south along the Algerian border to Ghat, Akakus region, Erg Uan Caza and coming back to Tripolitania, Sabratha.

Selected species

On the whole, we observed approximately 80 species of birds in the desert areas, a small sample of those regularly breeding and migrating through the Sahara (cf. MOREAU, 1972; HOGG, 1974; MISONNE, 1974; COWAN, 1982, 1983, 1985). We list here only some selected taxa (16 in all) observed during our trips, basing the discussion on their numbers and behaviour.

Little Grebe *Tachybaptus ruficollis*

Many pairs at Waw el Namus on 20 April 2005, one individual with chicks. BROWN *et alii* (1982) report that it occurs sporadically on seasonal ponds and oases in N Sahara (Kufra); Fezzan population was previously unknown.

Water Rail *Rallus aquaticus*

Two individuals performing courtship display, very probably breeding at Waw el Namus on 20 April 2005. COWAN (1982, 1985) and URBAN *et alii* (1986) report from Libyan Sahara only localities of Brak and Sebha; more recently, GASKELL (2005) lists it as sedentary at Benghazi. The record at Waw el Namus is very far from the previously mentioned one.

Moorhen *Gallinula chloropus*

A breeding population of tens of pairs at Waw el Namus on 20 April 2005; some pairs nesting among the reeds of Mahfu, Gabron and Um el Ma lakes (Germa) on 23 April 2005. We consider that the whole population detected by us in Fezzan could amount to more than 100 pairs; only 50 pairs are estimated from Sebha area (ERARD, 1970; COWAN, 1983, 1985; URBAN *et alii*, 1986), but considering the total number of lakes surrounded by reed vegetation in the Germa area, overall population should be considerably larger than previously known.

Marsh Harrier *Circus aeruginosus*

At least 8-10 individuals at Waw el Namus on 20 April 2005; one individual observed hunting a small passerine among reeds.

Pallid Harrier *Circus macrourus*

One individual female at Germa, Um al Ma lake on 23 April 2005, actively trying to prey on wagtails.

Common Ringed Plover *Charadrius hiaticula*

Five ind. at Germa, on 23 April 2005, on the sandy borders of Gabron lake, preying on small fly larvae.

Common Sandpiper *Actitis hypoleucos*

Four individuals at Germa, on 23 April 2005, on the sandy borders of Gabron lake, preying on small fly larvae.

European Bee-Eater *Merops apiaster*

Some ind. between Tocra and Tolmeta on 7 April 1998; some individuals migrating near At Tamimi on 10 April 1998; flocks migrating at Tobruk on 11 April 1998; flocks at Sabrata on 15 April 1998. Tens preying on insects at Waw el Namus on 20 April 2005. It is a diurnal migrant, very frequent in spring through the Sahara.

Eurasian Roller *Coracias garrulus*

Two individuals at Waw el Namus on 20 April 2005, resting on lake reeds.

Bank Swallow *Riparia riparia*

Flocks migrating W-E between Sirt and Ben Jawwad on 6 April 1998; flocks in migration at Waw el Namus on 20 April 2005; some individuals mixed with other swallows at Germa, Mahfu, Gabron and Um el Ma lakes on 23 April 2005 (all resting and preying on insects).

Common House Martin *Delichon urbicum*

Some individuals migrating eastwards at Benghazi on 6 April 1998; flocks at Apollonia on 9 April 1998, at Tobruk on 11 April 1998, at Ajadabia on 13 April 1998; some individuals at Messa on 21 April 2005; some at Germa, Mahfu, Gabron and Um el Ma lakes on 23 April 2005 (all resting or preying on insects).

Barn Swallow *Hirundo rustica*

Many individuals at Homs, and W of Sirt on 5 April 1998, many ind. between Sirt and Ben Jawwad, 100 Km E of Sirt, between Ben Jawwad and Ajadabia, and at Benghazi on 6 April 1998, many individuals at Derna on 10 April 1998, many individuals at Tobruk on 11 April 1998, some flocks W of At Tamimi on 12 April 1998, many individuals between Tobruk and Ajadabia, some at Ajadabia, some at Ras Lanuf on 13 April 1998, many individuals between Sirt and Tripoli, and at Tripoli on 14 April 1998 (many were migrating W-E, others were preying on insects flying on tamarisk flowers); many individuals 150 Km SE of Sebha on 19 April 2005 (feeding on insects flying on tamarisk flowers); many at Zweila on 19 April 2005 (preying on insects); many individuals flying

over oases scattered in the desert between Waw el Kebir and Waw el Namus on 20 April 2005 (some migrating, others catching insects); hundreds at Waw el Namus on 20 April 2005 (some evidently migrating, others feeding on insects over the water); many individuals at Messa on 21 April 2005 (apparently resting and catching insects over tamarisks); very abundant at Murzuk on 22 April 2005 (many migrating, some resting); many at Mathendusc on 22 April 2005 (some of them resting); hundreds at Germa, Mahfu, Gabron and Um el Ma lakes on 23 April 2005 (all flying over the water, feeding on the huge numbers of flies present there).

Red-Rumped Swallow *Hirundo daurica*

One individual at Zweila on 19 April 2005, mixed with Barn Swallows (catching insects); some at Messa on 21 April 2005 (preying on insects). All the species of swallows are diurnal migrants.

Yellow Wagtail *Motacilla flava*

Some individuals of subsp. *feldegg* and *cinereocapilla* at Ajadabia and many at Ras Lanuf on 13 April 1998 (resting on narrow strip of vegetation); some individuals of different subspecies (among them one “*superciliaris*”, with black head and white supercilium) at Zweila on 19 April 2005 (resting in the oasis); high numbers between Waw el Kebir and Waw el Namus on 20 April 2005 (some migrating, others resting on narrow strip of vegetation); very many around the lake of Waw el Namus on 20 April 2005 (resting and catching insects); some individuals at Mathendusc on 22 April 2005 (resting); roughly ten at Germa, Mahfu, Gabron and Um el Ma lakes on 23 April 2005 (resting on reeds or preying on flies on the reed borders); many individuals at Germa, Mandara lake on 23 April 2005 (catching insects on the mud at the borders of residual puddles). The Yellow Wagtail is a typical diurnal migrant.

European Reed-Warbler *Acrocephalus scirpaceus*

Many ind. resting and singing at Waw el Namus on 20 April 2005. In the light of the recent findings of small wintering numbers at Benghazi (GASKELL, 2005), the individuals observed by us could belong to a local population. However, its presence on early April at Waw el Namus has been previously recorded by Jany (1960 in BUNDY, 1976).

Eurasian Golden Oriole *Oriolus oriolus*

Flocks of about ten resting on acacias of oases between Waw el Kebir and Waw el Namus on 20 April 2005.

Discussion

*“Se alcune vite si salvano lo devono alla tálha; forse alcune rondini che saettano nel nostro cielo, devono l’esistenza ad un’acacia spinosa nel deserto”*³ (SCORTECCI, 1945). Oases represent a very important faunistic refuge; they are scattered in the desert up to the coast and include irrigated land for agriculture, small villages and isolated habitats associated to water presence. In recent times, new oases have been established for agriculture exploitation, even if with scarce success (as Sarir, S of Cyrenaica: POPOV *et alii*, 1984). With conditions generally hostile to the survival of unadapted birds, for lack of shade or shelter, migrants may easily die of heat-stress and dehydration if they remain grounded for long (PETTET, 1984) (Fig. 1); the oases scattered across the desert host a good number of migrants, but their total area is so small compared with the vastness of the Sahara that their importance to trans-Saharan migrants could seem negligible.

Nevertheless, birds cross the desert two times a year, and very probably so far it was not the reason of the decline of any species. HOGG (1974) has already discussed on the possible favourable function of the chain of oil production centres for birds, running roughly at distances up to 6-700 km from the Mediterranean coast, as a series of rest posts during trans-Saharan migration; he recorded on the whole 127 bird



Fig. 1- A Barn Swallow exhausted, photographed on 19 April 2005 while it rested on the back door of the car in the Libyan desert, not far from Waw el Kebir irrigated area (Photo: B. Massa).

³ If some life is safe this is due to tálha (arabic name of acacia); some swallows which fly speedily through our sky, perhaps owe their existence to one thorny acacia in the middle of the desert.

species from these areas. Along the route between Akakus and Sebha there are other rest posts, such as small oases, villages and many trees planted by man, as date palms and tamarisks, as well as narrow strips of vegetation, which, indeed, provide for a seemingly more hospitable area in south-western Fezzan. Small reliefs in the middle of the desert play a highly climatic and ecological role; at their base, modest rainfalls produces little amounts of humidity consenting the growth of small areas of vegetation, mainly constituted by tamarisks. Many reliefs are narrow and long, often diagonally placed, thus outlining at their base vegetated corridors, following the same direction. Msak Mustafit, NW of Murzuq, is an example of a relief producing a long diagonal corridor of vegetation towards Sabha, regularly crossed by migrant birds (Fig. 2). There, in April we observed that flowering tamarisks attracted huge numbers of pollinator insects, which in turn attracted a large number of typically diurnal migrants swallows, sometimes hundreds, which preyed on them over the foliage. Tamarisks grow in small groups and proliferate so that they form thickets; leaflets continuously falling to the soil constitute a very thick layer of organic matter, nourishing the plants. Roots become enormous, raised isolated sand banks, on which plants grow (SCORTECCI, 1945). In this small space, organic matter attracts insects and other organisms, among which migratory birds (Fig. 3).

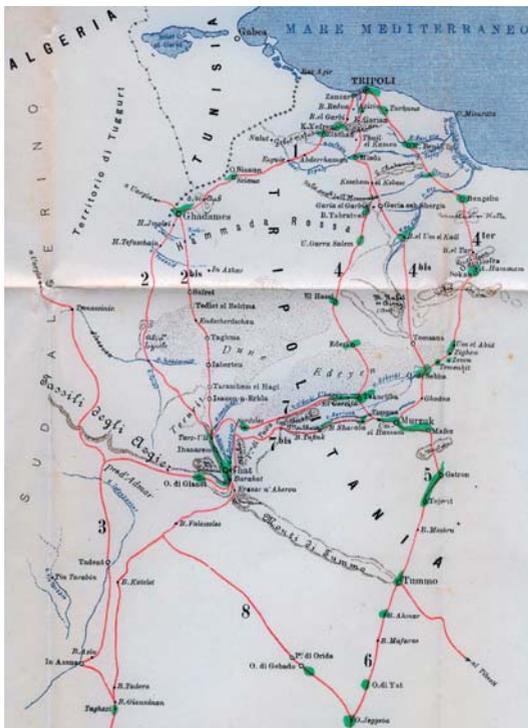


Fig. 2 - Map published on 1912 showing scattered desert areas of Fezzan covered by modest vegetation (source: BOURBON DEL MONTE, 1912).



Fig. 3 - Wind movements favours the setting up of small sand banks around single tamarisk plants in the middle of desert, which attract insects and insectivorous birds; they also offer shelter to migrating birds (Photo: B. Massa).



Fig. 4 - Scattered acacias offer shelter and shade to migrants through Sahara desert (Photo: P. Ceruleo).

Apart from tamarisks, acacias scattered along camel tracks also provide shade, other than for camels, to many bird species, such as Turtle Doves, Golden Orioles and many small passerines, which rest on them for several minutes or sometimes hours (Fig. 4). Villages and oases are characterized by the presence of water, drawn from wells, which is often used to irrigate modest surfaces of cultivated land. In fact where water was present, in the middle of the desert, we observed hundreds of wag-tails and swallows, attracted by a wide number of insects (Figs 5, 6); they are known to migrate by day, rather than by night as preferred by most other passerines (DORKA, 1966; BIEBACH *et alii*, 1991, 2000).

Undoubtedly, the most important biological richness of the desert consists of perennial lakes, numbering much more than may be imagined (Fig. 7); Ubari Sand Sea, lying within the Germa area, has been a feature of the landscape for at least the last 2.5 millions of years; while parts of the sand sea would have been submerged during lacustrine phases, much of this area would have been above the level of the lake surface. Small lakes still exist in the eastern part of the sand sea where the land surface intercepts the local water table to form the perennial oases of Gabron, Um el Ma and Mahfu. In other places the water table is close to the surface, forming sebkhas such as Sebkhah Beni Ateyi and the ephemeral Lake Mandara, both of which are characterised by abundant vegetation and support a relatively diverse and still unexplored ecology (WHITE *et alii*, 2000). In the area of Germa 21 lakes of variable size were censused (15 permanently full, four filled only in winter and two drained, but covered by palm groves: GANDINI, 2000). A very wide humid zone lies within Waw el Namus (Figs 8, 9, 10), hosting in spring huge numbers of birds probably coming from Tibesti (Chad), as well as some breeding birds. It is a humid area widely surrounded by reeds,



Fig. 5 - Water flowing from a well at Zweila oasis on 19 April 2005, when hundreds of Yellow Wagtails were resting and preying on soil insects (Photo: B. Massa).



Fig. 6 - Yellow Wagtails feeding on small insects over the water surface at Zweila oasis on 19 April 2005 (Photo: P. Ceruleo).



Fig. 7 - Mafu lake, near Germa, hosts many migrant birds in spring, when their waters are very rich in insects (Photo: B. Massa).



Fig. 8 - In spring Waw el Namus is one of the most important resting areas for birds migrating through the Sahara desert, possibly coming from Tibesti area (Photo: U. Pessolano).

lying within a volcano caldera about 4 km in diameter, bordered by a 5-10 km wide dark black deposit of ash that stands out starkly against the yellowish desert. The Arabic word “Namus” means “mosquito”, a very abundant insect in the area, which attracts many migrant birds. All these humid habitats are characterized by a high productivity and by the presence of a thick shore vegetation, which provides shelter to many species of migratory birds, that possibly have unfavourable fat conditions. On April 2005, on the water surface of lakes visited around Germa we observed a very abundant population of thousands and thousands of flies [the eurihalyne *Ephydra glauca* Meigen (Diptera Ephydridae)], both larvae and adults (Fig. 11); hundreds of swallows and wagtails stopped for a time over those lakes to supply an easy food resource before continuing their journey northeastwards. When MV visited Germa lakes on September 2004 and October 2005, insects over the water were absent and consequently this food resource for insectivorous birds in autumn was unavailable; this could easily explain the scarce presence of diurnal migrants in this season. According to BIEBACH *et alii* (2000), during autumn migration passerines are unable to accumulate enough energy stores to cover the distance between breeding and wintering sites without refuelling; therefore flight periods, preferably at night, are followed by stopover periods with intense feeding and energy

storage for the next flight period. Birds should cross the Mediterranean and the Sahara in three nights of flight and two daylight periods with stops, one at the Mediterranean coast and one somewhere in the desert (BIEBACH *et alii*, 2000), where food resources are available.

In spring, birds whose populations winter south of the Equator most likely do not arrive in southern Europe directly from their winter quarters, but make a stopover south of the Sahara, as close as possible to the southern boundary of an ecological barrier extending for more than 2000 km; this barrier is much larger for species linked to forest habitats than it is for species of open habitats, which can find areas suitable for building up fat reserves both at the northern and southern edges of the desert (PILASTRO & SPINA, 1997). HERREMANS (1991) and BIEBACH *et alii* (1991, 2000) wisely suggested that there is no single optimal trans-Saharan migratory strategy, but possibly a variety of strategies, including non-stop, stopover carrying minimal fat but with frequent refuelling, stopover without refuelling. However, the presence of large numbers of birds of open habitats in oases or vegetated “islands” and “corridors” in the middle of the desert implies the need to ensure a no risk stop. Possibly, for migrant birds linked to open habitats these vegetated areas are more important in spring than in autumn; when in autumn



Fig. 9 - Reeds surround the wide humid zone of Waw el Namus, offering shelter and food resource to migrant birds; some of them, indeed, take large amounts of insects to replenish fat reserves (Photo: B. Massa).



Fig. 10 - Aerial view of Waw el Namus, as it probably appears to birds flying overhead (after BIANI, 1934).

migrants reach them, indeed, they have not covered many kilometres and still store good amount of subcutaneous fat, acquired during the Mediterranean crossing, whereas in spring they meet oases and other vegetated “islands” in the middle of the desert, after a long flight and may find themselves with scarce fat supply. Furthermore, the Sahara is characterized by a high rainfall seasonality, generally recorded in winter; thus, while in spring desert oases and vegetated zones offer some food resources, in autumn after the long dryness seasons resources are very poor or absent. This is in line with the high availability of insects in desert vegetated areas in spring and scarcity of insects in autumn.

Assuming that the above mentioned areas of scattered vegetation in the Libyan desert and the presence of suchlike “oases” in all the Sahara desert (BAIRLEIN, 1992) are highly important for some migratory birds, long term conservation plans should be ensured to protect birds breeding in Europe and wintering in Africa. This would cross several individual countries’ interests and authorities. ROBERTSON & ESSGHAIER (2001) list only two desert areas among the Important Bird Areas (IBA) of Libya, namely Zallaf (Sabha, Ash Shati, Awbari) and Ghat Oases (Awbari), while many desert sites have been recorded from other North African countries. Germa lakes and Waw el Namus certainly lie within the IBA criterion A3 (Biome-restricted assemblages = sites known to



Fig. 11 - Huge numbers of *Ephydra glauca* (Diptera Ephydriidae) and their larvae were present on the Mafu lake, near Germa, on 23 April 2005; hundreds of swallows and wagtails were resting and preying on them (Photo: B. Massa).

hold a significant component of the group of species whose distributions are largely or wholly confined to one biome; the following species confined to one biome breed there: *Streptopelia senegalensis*, *Ammomanes deserti*, *Oenanthe leucopyga*, *Corvus ruficollis* and *Passer simplex*) and deserve to be included among IBA. Already WOOD (1992) pointed out the need for protection of a wide range of sites for use by migrant birds in Africa, since individual birds use many different places in the course of the winter. Also PILASTRO & SPINA (1997), considering that North Africa is unlikely to offer suitable habitats to species adapted to winter in tropical forests, have emphasized the evidence that the ongoing deforestation and desertification processes in the sub-Saharan might threaten not only palearctic birds wintering there, but also migrants which, despite the fact that they winter further south, use that area as a main stopover site during migration. Additionally, BREHME *et alii* (2002), highlighting the importance of the wetlands within the Sahara as resting and wintering places for birds, also point out the need of permanent conservation of these areas. Evidence for the degradation of staging sites on either side of the Sahara suggests that conservation plans are needed

which take into account the needs of migrant birds (BAIRLEIN, 1992). For example, Mandara lake is nearly drained, possibly due to excessive extraction from the water table, and generally it is supposed that a further deterioration of other lakes will take place within a few years, due to the tourism impact and exploitation. Oases and new areas of irrigation may provide increasingly important feeding stations during bird migrations, resembling islands within a desert sea; countries involved should assume their international responsibilities in the conservation; Europe, in turn, could invest in research projects and ecological restoration programs on African desert and sub-Saharan areas.

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