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The diet of Saker Falcon *Falco cherrug* overwintering in the Mediterranean (Sicily)

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Abstract – The winter diet of Saker Falcon *Falco cherrug* in the Mediterranean basin is unknown. Thanks to satellite tracking of two individuals from Hungary to Sicily, during winters 2012-13 and 2013-14 we identified the roost and collected 40 pellets. Pellet analysis allowed identification of 124 prey belonging to 29 taxa. Saker Falcons during winter shift their alimentation to insects and birds, with respect to mammals in the breeding season, plundering from small beetles to rabbits. Insects, especially Orthoptera and Coleoptera, were the most frequent prey in both years, totalling the 66.9% of remains. Among vertebrates the Saker Falcons preyed upon birds (21.77%), mammals (5.65%) and reptiles (4.84%). The Rock Dove plus Feral Pigeons are the key-species of winter diet, representing the 45.78% of biomass ingested in the two years. Agricultural intensification and land abandonment is rapidly changing steppe-like habitats of Mediterranean, and negatively affecting most potential prey of Saker Falcons. Conservation of this globally threatened species should consider also anthropogenic pressures outside the breeding range, and implement agri-environment schemes in the more suitable wintering grounds.

Key-words:

INTRODUCTION

Conservation efforts addressed only to part of the life-cycle of migratory species may be inefficient, since pressures occurring in areas or stages different from the breeding ones may severely affect avian populations (Sutherland 1996, Martin *et al*. 2007). For instance, in the Lesser kestrel *Falco naumanni*, conservation of pre-migratory habitats has been argued as being vital as conservation of breeding areas (Sarà *et al*. 2014), because thousands of birds annually concentrate before migration, in small areas, whose condition and suitability may be critical for survival of entire local populations. For this reason, LIFE projects on Saker Falcon *Falco cherrug*, carried out between 2007-2014 in Hungary, Slovakia, Romania and Bulgaria, involved also the detection of migration routes and overwintering areas of this globally threatened species listed as Endangered for IUCN in Birdlife International (2012) and Spec1 for Tucker & Heath (1994), aiming at implementation of concrete actions for its conservation outside the breeding range. The European population of the Saker Falcon breeds in Central and Eastern Europe, especially in the Pannonian Plain (Hungary) and in southern Ukraine. The Asian population is almost totally migratory, while the European juveniles and adult Saker Falcons move to Africa in late summer and autumn after breeding (Bildstein *et al*. 2000, Prommer *et al*. 2012).

Advances in animal tracking technologies, such as geolocators and satellite tags, have recently allowed more detailed investigations of the migratory ecology of many raptor species, prompting the discovery of their wintering areas in Africa (Strandberg *et al*. 2010, Limiñana *et al*. 2012, Mellone 2013). Record of Saker Falcons overwintering in Italy was doubtful (Genero 1992). Nowadays, the species has been considered as a regular, although scarce, migrant with some probable overwintering in Southern Italy and Sardinia (Brichetti & Fracasso 2003a). Satellite tracking carried our within the Saker's LIFE projects, unquestionably proves the existence of a small contingent of individuals annually overwintering in Sicily. Preliminary analysis of habitat preferences showed that Saker Falcons choose steppe-like habitats of north-western and central Sicily to overwinter (Bondì *et al*. 2013). Diet of overwintering Saker Falcons is virtually unknown (Cramp & Simmons 1980; Ferguson-Lee & Christie 2001), therefore in this contribution we provide first-hand data on the prey taken during winter in Sicily, and discuss our findings in the frame of conservation of this species.

MATERIALS AND METHODS

The continuous satellite tracking of one adult individual during the 2012-13 winter, and of a second sub-adult during the following 2013-14 winter allowed the identification of the same roost, an *Eucalyptus* tree, and the collection of 40 pellets (20 per every year).

Pellets were collected at the base of the tree, during visits carried out every two weeks from late October to early February. They were put in separate plastic bags to avoid mixing the material, and then dried in laboratory to avoid organic decay. They were further dry-dissected under magnification using a Wild M5 Stereomicroscope. Diagnostic vertebrate and hexapod remains such as mandibles heads, fragment of legs, aedeagus and elytra were isolated. Legs, elytra, mandibles, etc. were paired with their partner, so that it was possible to count the minimum number of specimens in every pellet. Prey remains were identified, when possible at the species or genus level, by comparison with vertebrate and entomological collections hold in the Zoological Museum of Palermo University.

Feathers remains allowed detecting the presence of both wild Rock Doves *Columba livia* and Feral Pigeons *C. livia* f. domestica. Nonetheless, we considered together these two taxa that actually live in mixed colonies (AA. VV. 2008). We treated Black *Sturnus unicolor* and Common Starlings *S. vulgaris* in the same way, as they form mix flocks during winter.

We took special care to recognition of insect fragments, by comparing their small chitinous pieces with dissected sample collections (Rizzo & Massa 1995) of species commonly present in the study area (Massa 2011). Although identification was possible in many cases, some fragments remained unidentified and were assigned to the lowest possible taxonomic group. Body weight of prey species was obtained by Museum comparative collections and pertinent literature (e.g. Franco & Andrada 1977; Rizzo & Massa 1995; AA.VV. 2008). In addition, we standardized the body weight of some prey, using the minimum value reported for Wild Rabbit *Oryctolagus cuniculus* and the median value for Black Rat *Rattus rattus* (cf. Amori *et al*. 2008), likewise we cumulated the Rock Dove and Feral Pigeon weights and used their median value (cf. Brichetti & Fracasso 2003b).

In order to evaluate annual differences in the diet, we used STATISTICA 10.0 (Statsoft inc.) to run Wilcoxon Matched Pairs tests. The Wilconxon's T is a nonparametric statistic which was used to compare the average number of prey and the average meal consumed in one year with respect to the other year. To test for difference in biomass and numerical frequency, the invertebrate and vertebrate taxa were compared independently (e.g. PFI invertebrate 2012-13 *vs* PFI invertebrate 2013-14).

RESULTS

Over two years and in 40 pellets, we found 124 prey of at least 29 vertebrate and insect taxa, representing a total biomass of 9240.6 grams (Table 1). The average prey ± SE was 73.35 ± 35.87 grams and ranged from small beetles of 0.38 grams to Common Rabbits of 1000 grams. Insects were the most abundant prey in both years, totalling the 67.7% of remains (Table 1). Among insect, the most frequently groups preyed upon were Orthoptera (31.45%) and Coleoptera (19.35%), followed by Mantodea (13.71%) and Lepidoptera caterpillars (3.23%). *Mantis religiosa* and some orthopterans like *Calliptamus barbarus* and *Eyprepocnemis plorans* were frequently eaten (Table 1). Noticeably, the consumed insect biomass was negligible, and vertebrates were the dominant groups in preyed biomass, with birds representing almost 56% of total biomass preyed upon in the two years of study, followed by mammals (36.96%) and reptiles (6.18%). Among vertebrates the Saker Falcon preyed upon birds (21.77%), mammals (5.65%) and reptiles (4.84%). Rock Doves (including an unknown quota of feral Pigeons) were the most hunted prey among vertebrates representing the 45.78% of total biomass ingested in the two years. Other bird prey were *Sturnus vulgaris* and *S. unicolor*, *Passer hispaniolensis*, *Galerida cristata* and a *Tringa* sandpiper. Vertebrate prey other than birds were represented by reptiles (*Natrix natrix, Chalcides ocellatus*) and small mammals (*Crocidura sicula, O. cuniculus* and *R. rattus*). They were generally preyed in low numbers (range: 0.81-2.42% of total prey in Table 1), but some of them, like *O. cuniculus* or *N. natrix*, well contributed to total consumed biomass (32.46% and 5.19%, respectively). The diet of the two Saker Falcons in the two different winters was quite constant, because annual differences were statistically not significant across the two winters (Table 2). This holds true when comparing the numerical (PFI) and biomass (PBI) frequencies of the 16 insect taxa preyed upon during the two winters, as well as the PFI and PBI of the 13 vertebrate taxa; or even comparing the average number of prey per pellet and average meal in the total diet (Table 2). Therefore the numerical decrease of birds preyed upon in 2013-14 with respect to the former year (Table 1), which corresponded to a drop of the average meal (Fig. 1) proved not statistically significant (Table 2). The perceived difference comes up simply by chance, or due to the small sample studied so far, and not from real diet variation across the two years.

Table 1. Number, numerical percentage (PFI), biomass in grams and biomass percentage (PBI) of prey species found in 40 Saker Falcon pellets during the two winters of study (2012-13 and 2013-14) in Sicily.

	2012-13				2013-14				Total			
	n	**PFI**	**Biomass**	**PBI**	**n**	**PFI**	**Biomass**	**PBI**	**n**	**PFI**	**Biomass**	**PBI**
Blaps sp.	0	0.00	0.0	0.000	1	1.64	0.5	0.015	1	0.81	0.5	0.005
Carabidae indet.	0	0.00	0.0	0.000	2	3.28	1.0	0.030	2	1.61	1.0	0.011
Carabus morbillosus	3	4.76	1.5	0.026	1	1.64	0.5	0.015	4	3.23	2.0	0.022
Chrysomela sp.	1	1.59	0.7	0.012	0	0.00	0.0	0.000	1	0.81	0.7	0.008
Coleoptera indet.	0	0.00	0.0	0.000	1	1.64	0.7	0.021	1	0.81	0.7	0.008
Copris hispanus	0	0.00	0.0	0.000	2	3.28	1.4	0.041	2	1.61	1.4	0.015
Curculionidae indet.	0	0.00	0.0	0.000	1	1.64	0.7	0.021	1	0.81	0.7	0.008
Onthophagus sp.	0	0.00	0.0	0.000	1	1.64	0.7	0.021	1	0.81	0.7	0.008
Pentodon bidens	8	12.70	5.6	0.096	3	4.92	2.1	0.062	11	8.87	7.7	0.083
COLEOPTERA	**12**	**19.05**	**7.8**	**0.133**	**12**	**19.67**	**7.6**	**0.225**	**24**	**19.35**	**15.4**	**0.167**
Lepidoptera larvae	0	0.00	0.0	0.000	4	6.56	4.0	0.118	4	3.23	4.0	0.043
LEPIDOPTERA	**0**	**0.00**	**0.0**	**0.000**	**4**	**6.56**	**4.0**	**0.118**	**4**	**3.23**	**4.0**	**0.043**
Mantis religiosa	5	7.94	7.5	0.128	12	19.67	18.0	0.532	17	13.71	25.5	0.276
MANTOIDEA	**5**	**7.94**	**7.5**	**0.128**	**12**	**19.67**	**18.0**	**0.532**	**17**	**13.71**	**25.5**	**0.276**
Aiolopus strepens	3	4.76	1.1	0.019	0	0.00	0.0	0.000	3	2.42	1.1	0.012
Anacridium aegyptium	6	9.52	8.4	0.143	0	0.00	0.0	0.000	6	4.84	8.4	0.091
Calliptamus barbarus	8	12.70	4.6	0.079	5	8.20	2.9	0.086	13	10.48	7.5	0.082
Eyprepocnemis plorans	5	7.94	3.0	0.051	9	14.75	5.4	0.160	14	11.29	8.4	0.091
Platycleis intermedia	0	0.00	0.0	0.000	3	4.92	4.2	0.124	3	2.42	4.2	0.045
ORTHOPTERA	**22**	**34.92**	**17.2**	**0.293**	**17**	**27.87**	**12.5**	**0.369**	**39**	**31.45**	**29.7**	**0.321**
Aves indet.	4	6.35	400.0	6.831	1	1.64	100.0	2.955	5	4.03	500.0	5.411
Columba livia	9	14.29	2538.0	43.340	6	9.84	1692.0	49.991	15	12.10	4230.0	45.776
Galerida cristata	1	1.59	40.0	0.683	0	0.00	0.0	0.000	1	0.81	40.0	0.433
Passer hispaniolensis	1	1.59	30.0	0.512	0	0.00	0.0	0.000	1	0.81	30.0	0.325
Sturnus unicolor/vulgaris	3	4.76	225.0	3.842	1	1.64	75.0	2.216	4	3.23	300.0	3.247
Tringa sp.	1	1.59	80.0	1.366	0	0.00	0.0	0.000	1	0.81	80.0	0.866
AVES	**19**	**30.16**	**3313.0**	**56.575**	**8**	**13.11**	**1867.0**	**55.162**	**27**	**21.77**	**5180.0**	**56.057**
Crocidura sicula	0	0.00	0.0	0.000	1	1.64	9.0	0.266	1	0.81	9.0	0.097
Mammalia indet.	0	0.00	0.0	0.000	1	1.64	20.0	0.591	1	0.81	20.0	0.216
Oryctolagus cuniculus	2	3.17	2000.0	34.153	1	1.64	1000.0	29.546	3	2.42	3000.0	32.465
Rattus sp.	0	0.00	0.0	0.000	2	3.28	386.0	11.405	2	1.61	386.0	4.177
MAMMALIA	**2**	**3.17**	**2000.0**	**34.153**	**5**	**8.20**	**1415.0**	**41.807**	**7**	**5.65**	**3415.0**	**36.957**
Chalcides ocellatus	1	1.59	30.5	0.521	1	1.64	30.5	0.901	2	1.61	61.0	0.660
Natrix natrix	2	3.17	480.0	8.197	0	0.00	0.0	0.000	2	1.61	480.0	5.194
Podarcis sicula	0	0.00	0.0	0.000	2	3.28	30.0	0.886	2	1.61	30.0	0.325
REPTILIA	**3**	**4.76**	**510.5**	**8.718**	**3**	**4.92**	**60.5**	**1.788**	**6**	**4.84**	**571.0**	**6.179**
TOTAL PREY	**63**	**100.00**	**5856.0**	**100.000**	**61**	**100.00**	**3384.6**	**100.000**	**124**	**100.00**	**9240.6**	**100.000**

DISCUSSION

During the breeding season, the most common prey of Saker Falcons is Suslik *Spermophilus citellus*, a very abundant rodent of eastern European plains (Baumgart *et al*. 1991, Cramp & Simmons 1980, Puzovic 2008, Watson & Clarke 2000). Frequency of Suslik can be very high, ranging from 73% (Cramp & Simmons, 1980) to 93% of total food remains (Baumgart 1971). However, some Saker Falcon pairs can opportunistically prey upon much more birds (83%) than mammals (17%) outside the Suslik range (Bagyura *et al*. 2004). In all aforementioned works insects do not take part in Saker Falcon diet.

Data of winter diet of Saker Falcon are virtually absent

Table 2. Main parameters of Saker Falcon diet comparing by Wilcoxon's T statistic two overwintering seasons in Sicily.

	2012-2013	2013-2014	T	p
a) Insect prey taxa (n = 16)				
Numerical frequency (PFI)	3.87 ± 1.20 (0 - 12.3)	4.61 ± 1.38 (0 - 19.7)	55	0.50
Biomass frequency (PBI)	0.03 ± 0.01 (0 - 0.14)	0.08 ± 0.03 (0 - 0.53)	35	0.09
b) Vertebrate prey taxa (n = 13)				
Numerical frequency (PFI)	2.93 ± 1.09 (0 - 14.3)	2.02 ± 0.72 (0 - 9.8)	35	0.46
Biomass frequency (PBI)	7.65 ± 3.94 (0 - 43.3)	7.60 ± 4.21 (0 - 50.0	37	0.55
c) Total taxa (n = 29)				
Average n prey per pellet	3.15 ± 0.61 (1 - 10)	3.05 ± 0.60 (1 - 9)	59	0.93
Average biomass per pellet	292.84 ± 72.0 (0.7 - 1240)	169.22 ± 52.80 (0.5 - 1000)	44	0.12

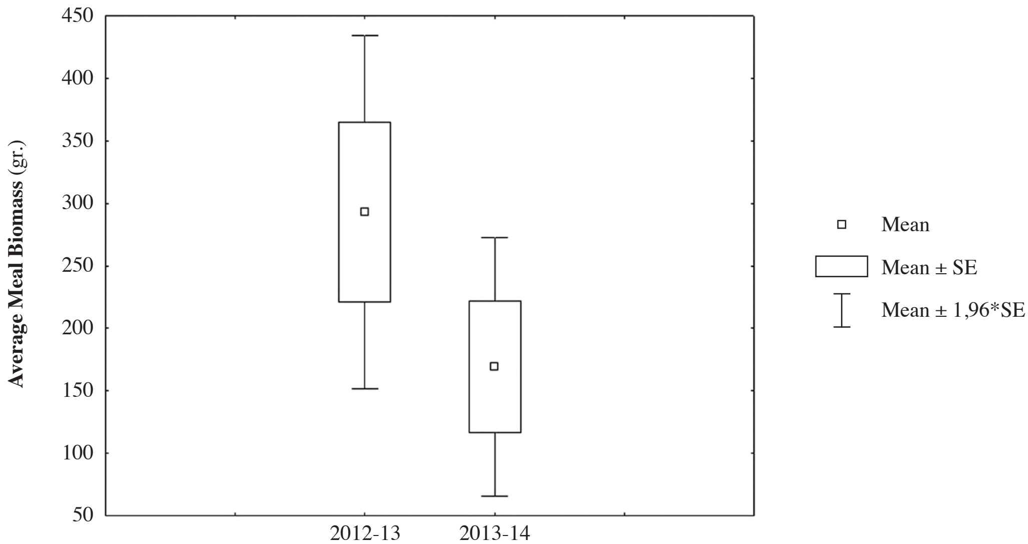

Figure 1. Box and whisker plot of average meal (biomass consumed per every pellet, as reported in Table 2) by Saker Falcons during the two winters of study (2012-13 and 2113-14) in Sicily.

in ornithological literature. Cramp & Simmons (1980) reported only a few spare data about winter quarters in India, where lizards and frogs formed most of diet. Issaka & Bouwer (2013) recorded only birds and beetles remains in just one pellet of a Saker Falcon overwintering in Niger.

Although from a limited sample, our findings show that during winter in Mediterranean areas, Saker Falcons change their alimentation feeding on birds and insects. It is not unusual that raptors shift their prey choice during wintering or migration times (Arroyo *et al*. 1995, Yanez *et al*. 2013), opportunistically taking advantage of the most abundant taxa available in the wintering grounds. Wild Rock Doves and Feral Pigeons are very common in Sicily (AA.VV. 2008), and represent the key-species of Saker Falcon during winter, as occurs for other Falcons (Dawson *et al*. 2011). Orthopterans and beetles active during winter form a significant complement of winter diet, due to their nutritional value recognized also for large animals (e.g. Redford & Dorea 1984, Deblauwe & Janseen, 2008). Other species of Sicilian steppe-like habitats, such as wintering passerines and waders, or reptiles and small mammals, although limited in frequency, may provide further important contributes to the diet due to their biomass. Interestingly Saker Falcons do not rely upon the Savi's Vole *Microtus savii*, a common semi-diurnal mammal in Sicily (AA.VV. 2008), which, although smaller (15-25 *vs* 250-300 g), is ecologically equivalent to the Suslik or to other voles consumed elsewhere in the range during the breeding season (cf. Watson & Clarke, 2000). We argue whether Saker Falcons rarely prey upon the Savi's Voles for ecological-behavioral reasons, or because they are becoming scarce years after year in some steppe-like habitats of Sicily, pursuing the destiny which is occurring to farmland bird species (Rete Rurale Nazionale & LIPU 2014).

Expansion of the European Union and its common market is currently driving agricultural intensification; and the Common Agricultural Policy is causing vast landscape-scale changes (Pe'er *et al.* 2014). According to Balmford *et al.* (2009), intensification of farming practices in flat and coastal areas and abandonment of less productive and marginal lands represent the main threats of agriculture on wildlife. These two opposite trends are rapidly changing friendly-to-wildlife farming systems (Brambilla *et al.* 2008). Land abandonment causes open habitat encroachment, which in turn alters bird community patterns (Sirami *et al.* 2008). This seems occurring not only in the European Union area; as for instance, across large areas of Kazakhstan, Watson & Clarke (2000) recorded that tall grasslands created by abandonment of grazing reduced the abundance of Susliks, which in turn affected the breeding success of Saker Falcons.

On the other hand, intensive farming in Mediterranean agro-ecosystems is affecting bird communities (Sirami *et al.* 2008) and insect diversity (e.g. Zamora *et al.* 2007), thereby producing a substantial reduction of biodiversity (Siebert 2004), through simplification of crop rotations or replacement by monocultures. In Sicily, vine monocultures are unfavourable habitats for bats (Di Salvo *et al.* 2009) and Lesser Kestrels (Sarà 2010), as well as in Spain for owls (Moreno-Mateos *et al.* 2011). Increased chemical inputs, a further aspect of intensification reduce invertebrate availability, and negatively affect populations of insectivorous raptors (Ortego *et al.* 2007).

Thus, agricultural intensification and land abandonment of steppe-like habitats posit a further threat for Saker Falcons and other raptors wintering in Southern Italy, potentially driving the population crash of some wild prey, like Rock Doves and overwintering insects in the next future. Conservation planning should therefore implement concrete actions, through for instance agri-environmental schemes deployed at landscape scale and among collaborative farmers (McKenzie *et al.* 2013, Pe'er *et al.* 2014) in the main overwintering areas of the Saker Falcons.

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REFERENCES

AA.VV 2008. Atlante della biodiversità della Sicilia: Vertebrati terrestri. Collana studi e ricerche ARPA-Sicilia, Palermo 535 p.

Amori G., Contoli L., Nappi A. 2008. Fauna d'Italia vol. XLIV. Mammalia II. Ed. Calderini, Bologna, 736 p.

Arroyo B.E., King J.R., Palomares L.E. 1995. Observations on the ecology of Montagu's and Marsh Harriers wintering in north-west Senegal. Ostrich 66: 37-40.

Baumgart W. 1971. Beitrag zur Kenntnis der Greifvogel Bulgariens. Beiträge zur Vögelkunde 17(1): 33-70.

Baumgart W. 1991. Der Sakerfalke. Die Neue Brehm-Bucherei. Wittenber Lutherstadt, A. Ziemsen Verlag, Band 514.

Bagyura J., Haraszthy L., Grof S., Demeter I. 2004. Comparison of Saker Falcon *Falco cherrug* predation during and after the breeding period. In: Chancellor R. D. & B.-U. Meyburg (eds.), Raptors Worldwide. WWGBP/MME.

Balmford A., Carey P., Kapos V., Manica A., Rodrigues A.S.L., Scharlemann J.P.W. 2009. Capturing the many dimensions of threat: Comment on Salafsky et al. Conservation Biology 23: 482-487.

Bildstein K.L., Zalles K., Ottinger J., McCarty K. 2000. Conservation Biology of the World's Migratory Raptors: status and strategies. In: Chancellor R. D. & B.-U. Meyburg (eds), Raptors at Risk. WWGBP I Hancock House.

BirdLife International 2012. Threatened birds of the world 2008. http://www.birdlife.org/datazone/species/factsheet/ 22696495.

Bondì S., Prommer M., Sarà M. 2013. Habitat preferences and diet of the Saker Falcon *Falco cherrug* overwintering in Sicily. XVII Italian Ornithological Congress, 142-143 (abstract).

Brambilla M., Guidali F., Negri I. 2008. The importance of an agricultural mosaic for Cirl Buntings *Emberiza cirlus* in Italy. Ibis 150: 628-632.

Brichetti P., Fracasso G. 2003a. Ornitologia italiana. Vol. 1 Gaviidae-Falconidae. A. Perdisa Ed., Bologna, 463 p.

Brichetti P., Fracasso G. 2003b. Ornitologia italiana. Vol. 3 Stercorariidae-Caprimulgidae. A. Perdisa Ed., Bologna, 437 p.

Cramp S., Simmons K.E.L. 1980. The Birds of the Western Palearctic Volume II. Oxford University Press, Oxford, New York, 695 pp.

Dawson R.D., Mossop D.H., Boukal B. 2011. Prey use and selection in relation to reproduction by Peregrine Falcons breeding along the Yukon River, Canada. Journal of Raptor Research 45(1): 27-37.

Deblauwe I., Janseens G.P.J. 2008. New insights in insect prey choice by chimpanzee and gorillas in Southeast Cameroon: the role of nutritional value. American Journal of Physical Anthropology 135:42-55.

Di Salvo I., Russo D., Sarà M. 2009. Habitat preferences of bats in a rural area of Sicily determined by acoustic surveys. Hystrix, Italian Journal of Mammalogy 20: 137-146.

Franco A., Andrada J. 1977. Alimentacion y seleccion de presa en *Falco naumanni*. Ardeola 23: 138-187.

Ferguson-Lee J., Christie D.A. 2001. Raptors: Birds of prey of the world. A & C Black Publishing, London 992 p.

Genero F. 1992. Sacro *Falco cherrug*, Gray 1834. In: Brichetti P., P. De Franceschi & N. Baccetti (eds.), Fauna d'Italia. Aves. I - Gaviidae-Phasianidae. XXIX: 678-681. Ed. Calderini, Bologna.

Issaka H., Brouwer J. 2012. Field observations of a Saker Falcon (*Falco cherrug*) holding a satellite transmitter on its wintering ground in Niger. Aquila 119: 79-90.

Limiñana R., Romero M., Mellone U., Urios V. 2012. Mapping the migratory routes and wintering areas of Lesser Kestrels *Falco naumanni*: new insights from satellite telemetry. Ibis 154: 389-399.

Martin T.G., Chadès I., Arcese P., Marra P.P., Possingham H.P., Norris D.R. 2007. Optimal conservation of migratory species. PLoS One, doi:10.13171/journal.pone0000751.

Massa B, 2011. Gli Ortotteri di Sicilia: check-list commentata. Biogeographia 30: 567-626.

McKenzie A.J., Emery S.B., Franks J.R., Whittingham M.J. 2013. Landscape-scale conservation: collaborative agri-environment schemes could benefit both biodiversity and ecosystem services, but will farmers be willing to participate? Journal of Applied Ecology 50: 1274-1280.

Mellone U. 2013. Movement ecology of long-distance migrants: insights from the Eleonora's Falcon and other raptors. PhD Thesis. University of Alicante (Spain).

Moreno-Mateos D., Rey Benayas J., Pérez-Camacho M., de la Montaña L., Rebollo E., Cayuela S.L. 2011. Effects of land use on nocturnal birds in a Mediterranean agricultural landscape. Acta Ornithologica 46: 173-182.

Ortego J., Aparicio J.M., Muñoz A., Bonal R. 2007. Malathion applied at standard rates reduces fledgling condition and adult male survival in a wild lesser kestrel population. Animal Conservation 10: 312-319.

Pe'er G., Dicks L.V., Visconti P., Arlettaz R., Báldi A., Benton T.G., Collins S., Dieterich M., Gregory R.D., Hartig F., Henle K., Hobson P.R., Kleijn D., Neumann R.K., Robijns T., Schmidt J., Shwartz A., Sutherland W.J., Turbé A., Wulf F. 2014. EU agricultural reform fails on biodiversity. Science 344: 1090-1092.

Prommer M., Bagyura J., Chavko J., Uhrin M. 2012. Migratory movements of the Central and Eastern European Saker Falcon (*Falco cherrug*) from juvenile dispersal to adulthood. Aquila 119: 111-134.

Puzovic S. 2008. Nest occupation and prey grabbing by Saker Falcon (*Falco cherrug*) on power lines in the province of Vojvodina (Serbia). Archives of Biological Science, Belgrade 60 (2): 271-277.

Redford R.H., Dorea J.G. 1984. The nutritional values of invertebrates with emphasis on ants and termites as food for mammals. Journal of Zoology 203: 385-395.

Rete Rurale Nazionale & Lipu 2014. Sicilia - Farmland Bird Index, Woodland Bird Index e andamenti di popolazione delle specie 2000-2013. http://www.reterurale.it/farmlandbirdindex

Rizzo M.C., Massa B. 1995. Morfologia mandibolare degli Ortotteri in relazione alla posizione trofica. Phytophaga 6: 205-222.

Sarà M. 2010. Climate and land-use changes as determinants of Lesser Kestrel *Falco naumanni* abundance in Mediterranean cereal steppes (Sicily). Ardeola 57: 3-22.

Sarà M., Campobello D., Zanca L., Massa B. 2014. Food for flight: pre-migratory dynamics of the Lesser Kestrel *Falco naumanni*. Bird Study 61 (1): 29-41.

Siebert S.F. 2004. Traditional agriculture and the conservation of biological diversity in Crete, Greece. International Journal of Agricultural Sustainability 2: 109-117.

Sirami C., Brotons L., Burfield I., Fonderflick J., Martin J.L. 2008. Is land abandonment having an impact on biodiversity? A meta-analytical approach to bird distribution changes in the north-western Mediterranean. Biological Conservation 141: 450-459.

Sokos C.K., Mamolos A.P., Kalburtji K.L., Birtsas P.K. 2013. Farming and wildlife in Mediterranean agroecosystems. Journal Nature Conservation 21: 81-92.

Strandberg R., Klaassen R.H.G., Hake M., Alerstam T. 2010. How hazardous is the Sahara Desert crossing for migratory birds? Indications from satellite tracking of raptors. Biological Letters 6: 297-300.

Sutherland W.J. 1996. Predicting the consequences of habitat loss for migratory populations. Proceedings of the Royal Society of London. B 263: 1325-1327.

Tucker G.M., Heath M.F. 1994. Birds in Europe: their conservation status. Conservation Series no. 3. BirdLife International, Cambridge, 600 pp.

Watson M., Clarke R. 2000. Saker Falcon diet: The implications of habitat change. British Birds 93: 136-143.

Yanez B., Muñoz A.R., Ferrer M. 2013. Invertebrates as prey of Short-toed Snake Eagles (*Circaetus gallicus*). Journal of Raptor Research 47 (3): 320-323.

Zamora J., Verdú J.R., Galante E. 2007. Species richness in Mediterranean agroecosystems: Spatial and temporal analysis for biodiversity conservation. Biological Conservation 134: 113-121.

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