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BIOLOGY OF THE BLACKCAP, *SYLVIA ATRICAPILLA*, IN A MEDITERRANEAN HABITAT

Riassunto. — *Biologia della Capinera,* Sylvia atricapilla, *in un habitat mediterraneo.*

Sono state studiate numerose coppie di Capinera in due agrumeti della Sicilia nell'arco di quasi vent'anni, ottenendo numerose informazioni originali, messe a confronto con i dati disponibili su questa specie in Europa e Nord Africa. La deposizione del primo uovo ha generalmente luogo tra il 10 aprile ed il 20 maggio ($\bar{x}$ = 2 maggio), ed avviene quasi regolarmente una seconda nidificazione. L'intervallo tra l'involo dei pulcini e la deposizione delle uova della seconda covata è risultato in media di 17 giorni; mentre la prima covata è risultata in media costituita di 3.9 ± 0.6 uova, la seconda è risultata più piccola, cioè pari a 3.5 ± 0.5 uova. Covate più piccole sembrano comunque tipiche dei paesi mediterranei, incluso il Nord Africa, mentre nell'Europa centrale esse sono caratterizzate da un numero statisticamente più alto di uova. Il numero medio di pulcini nati è risultato pari a 3.0 ± 1.1 ed il numero di pulcini involati 2.2 ± 1.4; questo successo riproduttivo scarso rispetto all'Europa centrale è tuttavia bilanciato dal fatto che nel Mediterraneo sembra regolare una seconda covata, mentre nel centro Europa è un evento raro. La registrazione con una telecamera delle attività riproduttive di tre coppie presso il nido ha consentito di raccogliere parecchie informazioni sulla dieta alimentare e nuovi ed interessanti dati sulle cure parentali, in cui il maschio è risultato più coinvolto della femmina.

Abstract. — This research was carried out in two *Citrus* plantations of Sicily between 1978 and 1997. Breeding of Blackcap begins in April-May, with laying date of the first egg between 10 April and 20 May ($\bar{x}$ = 2 May); second brood occurs regularly. The interval between fledging of the first brood and laying of the first egg of second clutch averages 17 days. The first clutch consists of 3.9 ± 0.6 eggs, the second one of 3.5 ± 0.5; it seems that smaller clutches are typical of North Africa, Corsica, Sicily and probably other mediterranean countries, while larger clutches occur in central Europe. The average number of chicks hatched is 3.0 ± 1.1, mean number of fledglings 2.2 ± 1.4. The lower breeding success is balanced by the more or less regular double brooding in respect to central Europe, where it is rather

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unfrequent. Video recording of three nests in 1997 has confirmed more frequent care by male (65%) in respect to female (35%). Lastly, the author provides many data on summer and winter diet.

Introduction

Although Blackcap biology is rather well known in its north-central breeding area (cf. CRAMP, 1992; MASON, 1995), available data from the southernmost distribution are few and scattered.

Some authors have pointed out that Blackcap lays fewer eggs in an insular condition, such as Corsica (PIACENTINI & THIBAULT, 1991) and Sicily (MASSA, 1981; LO VALVO, 1993), than on the European mainland (MASON, 1995), others have observed a possible minor productivity in North Africa (HEIM DE BALSAC & MAYAUD, 1962). Some southern populations such as those living at Gibraltar, Sicily, Sardinia and Corsica, show shorter and more rounded wings (LO VALVO et alii, 1988); this has been related to their habitat preferences, mainly consisting in tall maquis, sclerophyll and scrub woodland (e.g. CODY & WALTER, 1976; MASSA, 1981; LO VALVO et alii, 1988; IAPICHINO & MASSA, 1989; PIACENTINI & THIBAULT, 1991; LO VALVO *et alii*, 1993). While north-central populations are migrant breeders, mainly wintering in the mediterranean basin, southern ones are sedentary and mix in winter with migrants, which possibly exploit their same resources from October to March.

The present research aims to summarize all the available data on the Blackcap biology in the mediterranean area in order to compare them with information collected in other parts of its distribution.

Material and methods

Field work was carried out between 1978 and 1997, mainly in two orchards (loc. Pagliarelli and Borgo Molara, c. 200 m a.s.l., province of Palermo, Sicily), c. 1 ha wide on the whole, consisting of *Citrus* spp. (dominant species), mixed with scattered *Eryobotria japonica*, *Pyrus communis*, *Prunus persica*, *P. domestica*, *Ficus carica*, *Morus alba*, *M. nigra*; at the edge of them a row of ornamental trees (*Cupressus arizonica*, *Thuja* sp., *Ficus macrocarpa*, *Pinus halepensis*, *Melia azedarach*) and some shrubs (*Pistacia lentiscus*, *Myrtus communis*, *Rubus ulmifolius*, *Vitis labrusca*, *Jasminum* sp., *Duranta ellisi*, *Bignonia* sp. and *Hedera helix*) have been planted. Both orchards are surrounded by other orchards with similar characteristics. Each year Blackcap nests were

checked, collecting all the possible parameters (date of laying, number of eggs, adult brooding, chicks hatched and fledged); in 1997 three nests were monitored by a videotape, and data on relationships between adults and chicks have been provided directly or by recording images (10 hours of useful recordings). Other observations were carried out in different areas and natural habitats of Sicily; many of them have been reported by MASSA (1981), IAPICHINO & MASSA (1989) and LO VALVO *et alii* (1993). Some data concern only one of reproductive parameters, thus sample size may be different.

Winter observations have been performed in the same orchards, in others with similar characteristics, or in natural woody habitats; some data on feeding habits were obtained from the stomach contents of 33 individuals found dead on roadsides next to Palermo between November 1978 and March 1994, the skins of which are preserved at the Museo di Zoologia dell'Università of Palermo and the Museo Regionale of Terrasini (Palermo).

Results and discussion

Breeding and winter habitats

Since Sicilian populations of Blackcaps mix in winter with migrants coming from continental Europe, shifting of frequency of occurrence in the two seasons from one habitat to others may be easily detected through census of individuals (Fig. 1). Analysis of frequency of occurence in six habitats (LO VALVO *et alii*, 1993) has shown higher values in winter in respect to breeding season in orchards, conifers, maquis and

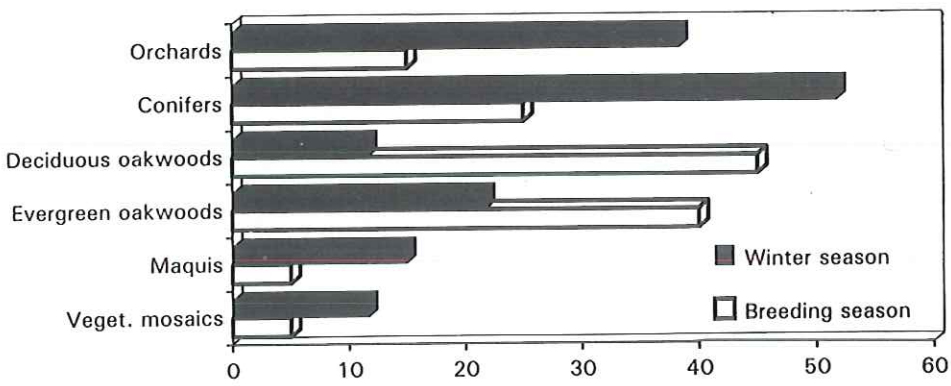

Fig. 1. — Summer and winter frequency of occurrence of the Blackcap in six Sicilian habitats (redrawn from LO VALVO *et alii*, 1993).

vegetational mosaics, and lower values in winter than in the breeding season in deciduous and evergreen oakwoods. Possible reasons of this seasonal trend may be the different habitat selection of wintering Blackcaps in respect to sedentary individuals, as well as the different availability of resources in the habitats considered, respectively during winter and spring-summer months, which in turn could result in a seasonally different habitat selection by Blackcaps, both wintering and sedentary.

Breeding period

It starts in April-May, with laying date of the first egg between 10 April and 20 May ($\bar{x}$ = 2 May; n = 80), a bit before the laying date in central Europe, but well overlapping with that in North Africa and Corsica (Table I). Anticipation of insect availability and sedentariness are possible reasons of earlier laying in these southern populations in respect to north-central ones.

TABLE I — Breeding parameters of the Blackcap, *Sylvia atricapilla*, in Europe and North Africa according to different sources. 1 = BAIRLEIN et alii, 1980; 2 = MASON, 1976; 3 = PIACENTINI & THIBAULT, 1991; 4 = HEIM DE BALSAC & MAYAUD, 1962; 5 = present study.

	mean number of eggs laid	laying date
Lituania [1]	4.61 ± 0.65 (n = 67)***	-
Finland [1]	4.59 ± 0.69 (n = 27)***	14.VI (25.V-14.VII)
Germany [1]	4.76 ± 0.58 (n =662)***	15.V (17.IV-29.VII)
Great Britain[2]	4.65 ± 0.78 (n = 699)***	15.V (6.IV-19.VII)
Switzerland [1]	4.57 ± 0.69 (n = 265)***	-
Corsica [3]	3.56 ± 0.77 (n = 25)*NS	15-21.V (8-15.IV-1-7.VII)
North Africa [4]	4.08 ± 0.64 (n = 12)NS	17.IV-27.V
Sicily [5]	3.9 ± 0.6 (n = 58)(1st)	2.V (10.IV-20.V)
	3.5 ± 0.5 (n = 32)(2nd)	4.VI (20.V-5.VII)

t of Student test between the 1st Sicilian clutch and clutches of other countries: *** $P < 0.0001$; * $P = 0.03$; NS = Not Significant; Corsican clutch was compared both with the 1st and the 2nd Sicilian clutch, resulting significantly different from the 1st but not from the 2nd one.

Second brood probably occurs regularly; it is generally difficult to establish whether a not-ringed pair is performing a second or a repeat brood, but I found many cases (32 out of 60 checked) of a further brood on a nest built next to the first one after fledging (max. 8-10 m away) or a second brood on the same nest; in these cases laying of the first egg occurs between 20 May and 5 July ($\bar{x}$ = 4 June; n = 44). There were exceptional cases of laying at the end of July-beginning of August and fledging in August-September (MASSA, 1981; IAPICHINO & MASSA, 1989; LO VALVO *et alii,* 1993).

The interval between fledging of the first brood and laying of the first egg of second clutch averaged 17 days (min-max: 13-22; n = 26). According to BAIRLEIN (1978) the percentage of second clutch in Germany was 5% in one year and 13% in the next, with a mean period of 21.4 days between fledging of the first brood and laying of the second clutch. These differences may be related to differences observed in the brood size (see below).

Number of nests

Blackcaps build more than one nest per breeding season; six pairs breeding on an area of 1 ha regularly produced each year between 10 and 15 nests, that is between 1.7 and 2.5 nests per pair, but they used only between 8 and 12. One pair in 1994 built four nests in three months. Nests are generally placed on trees or shrubs, between 1.5 and 3 m above the ground; preferred plants were *Citrus* spp., *Thuja* spp., *Cupressus arizonica*, *Duranta ellisi*, *Jasminum* sp., *Bignonia* sp.

Number of eggs laid

The first clutch ranged between 3 and 5 eggs ($\bar{x}$ = 3.9 ± 0.6; n = 58), the second one between 2 and 5 ($\bar{x}$ = 3.5 ± 0.5; n = 32); differences between them were significant (test t of Student = 3.37; P = 0.001). A smaller Sicilian sample, including first and second clutches (LO VALVO, 1993), gave 3.6 ± 0.5 (min-max: 3-4; n = 35). Double broods also occur commonly in Corsica, as the double peak of Fig. 5 in PIACENTINI & THIBAULT (1991) suggests.

A seasonal reduction of clutch-size has been generally observed in central Europe (BAIRLEIN *et alii*, 1980; MASON, 1995). Smaller clutches seem typical of North Africa, Corsica, Sicily and probably other mediterranean countries (Table I). Differences between clutch-size of Sicilian Blackcaps and that of continental Europe resulted statistically significant, while those between North african and Sicilian ones did not; Corsican clutch was compared with the 1st as well as the 2nd Sicilian clutch, resulting significantly different from the 1st but not from the 2nd one (see Table I).

Incubation

Incubation period ranged between 11 and 14 days (n = 28); according to MASON (1976) and BAIRLEIN (1978) in continental Europe it takes on average 11-11.7 days (range: 10-16), decreasing with increasing of clutch-size. Blackcaps laid one egg per day early in the morning; as generally reported by authors (cf. MASON, 1995) incubation starts after

laying of the penultimate egg (n = 21), thus Blackcaps know the final number of eggs before last egg laying. Both sexes incubate the eggs, with some minor difference of frequency of occurrence; out of 180 cases of adults brooding eggs (in different years, nests, days after laying and day times) 97 (54%) were females and 83 (46%) males. Only female was observed incubating at night (n = 12), as already recorded by MASON (1995).

Number of chicks hatched and fledged

The average number of chicks hatched was 3.0 ± 1.1 (min-max: 1-4; n = 44; nests preyed upon during egg incubation were not considered); previous Sicilian data from a smaller sample, recorded by LO VALVO (1993), gave 2.58 ± 1.16 (min-max: 0-4; n = 12). Nestling period ranged between 11 and 13 days, matching those recorded in Germany respectively by BAIRLEIN (1978) (11.5 days) and by BAIRLEIN *et alii* (1980) (12 ± 0.94; min-max: 10-15), and in Great Britain by MASON (1995) (11-12 days). According to BAIRLEIN *et alii* (1980) nestling period decreases with increasing number of nestlings.

Mean number of fledglings was 2.2 ± 1.4 (min-max: 0-4; n = 39); previous data on fledging success in Sicily (some of them are here included), reported by LO VALVO (1993), indicate a smaller value (1.88 ± 1.41; min-max: 0-4; n = 16), confirming the low breeding success of this warbler in Sicily in respect to continental Europe (cf. MASON, 1995). This lower breeding success is balanced by the more or less regular double brooding in respect to continental Europe, where it is rather unfrequent.

Fledging occurred always after 12:00 a.m., mainly between 12:00 and 16:00 (74%), less between 16:00 and 18:00 (26%) (n = 42 chicks from 18 nests). All the chicks fledged in the same day, even if in different times.

I found many cases of nesting failure, some of them due to predators; among them I was able to identify *Pica pica* (on chicks), *Rattus rattus* (on eggs) and feral cats (on eggs and chicks).

Parental care

Adults regularly brood their chicks on the nest for the first 5-6 days, with an evident difference between the sexes; out of 120 cases of adults brooding chicks (in different years, nests, days after hatching and day times), 84 (70%) were males and 36 (30%) females, but only the female seems to brood them at night (n = 7 in two nests) until the eighth day after hatching.

Video recording of three nests in 1997 confirmed a more frequent

care by male (65%) in respect to female (35%); the male also showed to be particularly involved in the nest protection, sanitation and cleaning of nest cup, eliminating eventual parasites and ants at the nest edges and on the close branches, while the female seemed more involved in the food searching; out of 280 cases of adults feeding chicks, 140 (50%) have been followed by the male (for a time ranging from 20 seconds to 8 minutes), 42 (15%) by the female care (between 20 seconds and 2 minutes), and 98 (35%) by none.

Faecal sacs were removed by both parents; faeces were produced by chicks after feeding, adults were waiting for excretion. Due to possible incomplete digestion of ingested food, both male and female at once swallowed chick faecal sacs, always for the first 8-9 days, and in the majority of cases (85%) between 8th and 12nd day after hatching; in the other cases (15%) they removed them from the nest.

Chicks were fed by both parents, 4-5 times/hour in the first day after hatching, 7-10/h in the third day, 8-13/h in the fourth, 12-18/h in the sixth, and 20-25/h from the eighth to the day before fledging; the last nesting day was characterized by much adult activity around the nest, but little food carried to chicks. On the whole adults were feeding their chicks between 1500 and 2000 times in 12 days.

According to video recording, chick feeding varied in the different day times and through the hatching period; in the first days chicks were fed less between 12:00 and 16:00, but in the following days feeding rate was more or less regular in the different day times. Both parents spent the same time feeding chicks (male: 51%; female: 49% of total times in which chicks were fed), but the female carried more animal (70%), and the male more vegetal food (60%). The male spent 2.4-4.6 and the female 3.0-7.5 minutes between two following nest visits for chick feeding; the difference was statistically significant (t test for paired data = 2320; $P = 0.02$; d.f. = 260). Since the male spent more time on the nest than the female, brooding chicks or expending other forms of parental care, the obvious consequence is that less time than that spent by female remained for food searching; this was eventually the reason for which it fed chicks mainly with fruits collected from a next source, namely a tree close to the nest.

Insectivorous and frugivorous diet

Table II lists prey items carried by adults to chicks, according to video recordings; the most frequent prey were aphids, very probably *Myzus persicae*, collected on a *Prunus persica*, only 7 m away from the nest, where in 1997 they were very much abundant during breeding of

Blackcaps. Aphids, feeding on the plant lymph, are very rich in carbohydrates, thus representing a highly nutritious prey; they were taken mainly by the female, which each time carried at least between 10 and 20 individuals to chicks; I desume that, during nestling period, adults fed chicks with about 5,000 aphids.

TABLE II — Prey items of Blackcaps and their frequency according to video recordings.

Prey	Frequency* (%)
Figs of *Ficus macrocarpa*	9
Fruits of *Morus alba*	10.5
Other fruits or berries	7.8
Aphids	20
Caterpillars and larvae	13.2
Adults of Coleoptera Cantharoidea	11.9
Spiders and Opilionids	6.4
Insects not identified	21.2

* Times in which prey item has been carried to chicks, indipendently from the number of individuals

The second most important prey were caterpillars of Lepidoptera and larvae of Coleoptera, some of which were surely collected on the ground or under organic detritus (e.g.: two larvae of *Pentodon bidens* (Coleoptera Scarabaeoidea), ca. 2 cm long, carried by the male); I indeed observed sometimes Blackcaps searching for prey on the ground, at the base of trees. Other animal prey, mainly captured by the female, were *Cantharis livida* (Coleoptera Cantharidae), much abundant on the branches of the above mentioned *Prunus persica* where were preying upon aphids. Other invertebrates not identified, mainly small beetles, ranged from few mm to 2-3 cm; spiders (Araneae) and harvestmen (Opilionida) resulted rather unfrequent.

As regards the vegetal diet, the most frequent fruits came respectively from one tree 9 m away from the nest (*Morus alba*, very rich in fruits during Blackcap breeding), and another one c. 20 m away from the nest (*Ficus macrocarpa*, the figs of which started to ripen). Only in three cases other fruits were collected on a tree of *Melia azedarach*, c. 40 m away from the nest.

The analysis of 33 stomach contents collected in winter revealed that, between November and February, although Blackcaps feed mainly on fruits and berries (85% of their diet), a small portion of prey (15%) consists of invertebrates, which become prevailing from March onwards (55%), when winter fruits are less available. More frequent fruits were those of *Laurus nobilis* (autumn), *Hedera helix* (winter), *Vitis labrusca* (autumn), *Rubus ulmifolius* (autumn).

According to CUADRADO GUTIERREZ (1988) in shrubby habitats of Spain

Blackcaps use in winter the feeding gleaning technique, which allows animal as well as vegetal diet. Because of their climatic conditions, Mediterranean ecosystems inhabiting Blackcaps can supply good resources both to sedentary and wintering individuals; they are chiefly frugivorous and can take advantage of the shrub fruit abundance, which at these latitudes occurs two months later than in North-central Europe (HERRERA, 1982; JORDANO, 1985; SNOW & SNOW, 1988; TELLERIA *et alii*, 1988).

There is an evident difference between the nutritive value of fruits and berries and that of insects or other invertebrates, and consequently between frugivorous and insectivorous diet. According to KARASOV (1990) c. 75% of Arthropod and only 50% of whole fruit energy are metabolized. Some fruits have a great fat content (e.g.: 42% in *Olea europaea*), but the majority are rich in carbohydrates, which are converted to fat by birds; thus they represent a good food source for wintering individuals. On the contrary while insects and other invertebrates are very low in carbohydrates (with the exception of aphids and some other lymph feeding insects), they are rich in proteins (BELL, 1990), excellent food source for young and for making new feathers during moult (MASON, 1995); according to HUDSON & RANDS (1988) chick growth largely depends on the presence in the diet of cystine and methionine, sulphur-based amino acids whose levels are much higher in insects than in plants.

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