

Arthropod abundance and breeding performance of Tits in deciduous, evergreen oakwoods and pine reforestation of Sicily (Italy)

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Abstract - The aims of this research, carried out in 1993-96, were: 1) to ascertain the existence of differences in resource abundance between deciduous and evergreen oakwoods; 2) to verify the overlap degree of the peak resource and the peak-demand of young Tits in the two oakwoods; 3) to study the breeding performance of Tits (*Parus major* and *P. caeruleus*) in relation to resource parameters in woodlots dominated by trees of different species which are part of the same woodland, namely evergreen *Quercus ilex*, deciduous *Quercus pubescens* and *Pinus halepensis* reforestation. In the four years of this research clutch size, number of fledglings and arthropod abundance were higher in the oakwoods than in the pine reforestation; the arthropod abundance coincided with the peak of demand by young, particularly in deciduous oakwood. Blue and Great Tits breeding in oakwoods appeared to be significantly more successful than in reforestation sites; clutches generally were larger and started earlier in the oakwoods than in reforestation. Even if differences in the arthropod abundance between deciduous and evergreen oakwoods were detected, no important differences in the breeding performance were noticed in the four years, while they were observed in the pine reforestation in respect to oakwoods, both for Great and Blue Tit.

Introduction

According to Blondel *et al.* (1993) large clutch size and earlier laying date characterize populations of Blue Tits in continental deciduous oakwood, small clutch size and late laying date those living in insular evergreen oakwood of Corsica, while intermediate values for these traits are noticed in continental evergreen oakwoods. Cramm (1982), Isenmann *et al.* (1987), Blondel and Pradel (1990), Clamens (1990) and Blondel (1991) have pointed out that the development of vegetation and its arthropods occurs later in the Mediterranean sclerophyll than in deciduous woods; the food availability for insectivorous birds in mediterranean sclerophyll is considered scarcer than in deciduous woodland (e.g. in Corsica: Zandt *et al.* 1990), and corsican Tits, due to lower availability of caterpillars, prey upon other insects and spiders, poorer in water (Blondel and Pradel 1990). This is considered as a possible reason for scarcer production of young in corsican than in continental woods (Blondel and Pradel 1990; Martin and Bellot 1990). Dhondt *et al.* (1984) also suggest that variation in laying date between habitats reflects differences in food availability and microclimate. The aims of our research were to ascertain in the insular woodland of Sicily: 1) if differences actually exist in resource abundance (we prefer this term

instead of availability, for the reasons reported by Holmes 1990) between deciduous and evergreen oakwoods; 2) the overlap degree of the peak resource and the peak-demand of young Tits in the two types of oakwoods; 3) the breeding performance of Tits in relation to resource parameters in woodlots dominated by trees of different species which are part of the same woodland.

Methods

In December 1992 we placed 102 nestboxes in the central part of a wooded area, 1600 Ha wide, in the inland Sicily (next to Santo Stefano di Quisquina, about 600 m a.s.l., province of Agrigento), subdivided in three homogeneous areas, one dominated by the deciduous Downy oak *Quercus pubescens* (thereafter DO), another by the evergreen Holm oak *Quercus ilex* (EO), and the third constituted by a reforestation of *Pinus halepensis* about 35 years old (PR). We placed 36 nestboxes in DO and 33 in EO and PR; they were located in such a way that territories of nesting Tits did not overlap between two different types of wood. From April to July 1993, 1994, 1995 and 1996 all the nestboxes were visited weekly and the following information was recorded: 1) date of the first egg, calculated assuming that females lay one egg each day; 2) clutch-size; 3) hatching date; 4) brood size; 5)

fledging success. Overall breeding season was calculated from the earliest lay-date to the latest one plus 28 days of egg incubation and nest attendance. In the same area and the same months, every 2-3 weeks we sampled foliage arthropods (between 1.5 and 4 m from the ground) of the tree species characterizing the woodlots, extracting them by an Univac portable suction sampler (Arnold *et al.* 1973) within branch layers of 15-20 plants for 15 minutes, to obtain absolute quantitative values of arthropods, comparable among them and relevant as food resource of typical insectivorous birds as Tits. In the four years we carried out a census of breeding Great and Blue Tits in the three habitats by the E.F.P. method (Blondel 1975), which gives the frequency of occurrence of breeding species.

Local meteorological data for the period 1980-1996 were provided by Genio Civile della Regione Siciliana (Palermo) and refer to the station Lago del Leone. Statistics were performed by the two way ANOVA.

Results

Frequency of occurrence and nestbox occupation

Two species of Tits, the Great Tit *Parus major* and the Blue Tit *P. caeruleus*, bred in the nestboxes in the four years; 104 pairs of Blue and 95 of Great Tit bred in the three habitats in the four years (Table 1). According to censuses carried out by the E.F.P. method, the frequency of occurrence of Great Tit was stable in DO (60%), EO (50%) and PR (70%), that of Blue Tit passed in DO and EO from 60% in 1993 to 70% in 1994, 1995 and 1996, while in PR decreased from 50 in 1993 to 30% in 1994 and then increased again to 50% in 1995 and 1996. Nestbox occupation (with egg laying) by Great Tit changed little in the four years in the three habitats, nestboxes occupied by Blue Tit instead increased in DO from 1993 to 1996, in EO passed from 12 in 1993 to 14 in 1994 and then

decreased to 9 in 1995 and 6 in 1996, while in PR were more or less stable in the four years. The number of nestboxes occupied by Blue Tit resulted always higher than that used by Great Tit in DO and EO, while was lower in PR (with the exception of 1994: Table 1).

Laying date

Tits showed a quite synchronous start of laying in the oakwoods in the four years, but reproduction of Blue Tit in DO lasted more. Since we did not find, both for Blue and Great Tit, any significant difference in the breeding parameters among the four years, we pooled the four breeding seasons when testing differences among the three habitats. As regards to the laying date, it was simultaneous in the four years in the two oakwoods; both Tit species bred significantly earlier in DO and EO than in PR (Table 3). Only one pair of Great Tit bred twice in the DO in 1993.

Clutch size

Clutch size of Blue Tit ranged between 7.8 and 9.5 in DO, 8.5 and 9.3 in EO and between 5.2 and 7.3 in PR, that of Great Tit between 6.4 and 9 in DO, 8 and 9 in EO, 5.5 and 7.5 in PR (Table 2). Clutches of both species were significantly smaller in PR than in DO and EO, those of Great Tit breeding in DO and EO resulted significantly different (Table 3).

Number fledged and fledging success

In the four years number of young Blue Tit fledged varied from 6.9 to 8.6 in DO, from 7.2 to 9 in EO and from 3 to 5.7 in PR, fledgling Great Tits ranged between 6 and 8.5 in DO, 5.7 and 8.7 in EO, 4.8 and 6 in PR (Table 2). Number of fledglings of both species was significantly higher in DO and EO than in PR (Table 3). Fledging success (number fledged/clutch size x 100) of Blue Tit varied between 83 and 95% in DO, 84 and 100% in EO and 41 and 96% in PR, that of Great Tit between 94 and 98% in DO, 69 and 97% in EO, 78 and 87% in PR (Figures 1-3).

Table 1 - Frequency of occurrence (%) and number of nestboxes occupied (with egg laying) by Blue Tit and Great Tit in the four years in the deciduous oakwood, evergreen oakwood and pine reafforestation of Demanio Forestale of S. Stefano di Quisquina (Sicily).

Woodlot/Year	1993		1994		1995		1996		Total	
	Blue	Great	Blue	Great	Blue	Great	Blue	Great	Blue	Great
<i>Quercus pubescens</i>	60	60	70	60	70	60	70	60		
<i>Quercus ilex</i>	10	8	18	8	17	13	26	10	71	39
<i>Pinus halepensis</i>	60	50	70	50	70	50	70	50		
	12	4	14	3	9	6	6	5	41	18
	50	70	30	70	50	70	50	70		
	9	11	3	12	6	6	4	9	22	38

Table 2 - Reproductive performance of Blue (*Parus caeruleus*) and Great Tit (*Parus major*) in three different wood habitats of Sicily in 1993, 1994, 1995 and 1996. Table shows mean value, standard deviation and sample size (in parenthesis), and variation range. Lay date = number of days from the 1st January (92 = 1st April).

Laying date	1993		1994		1995		1996	
	P. caeruleus	P. major	P. caeruleus	P. major	P. caeruleus	P. major	P. caeruleus	P. major
<i>Q. pubescens</i>	117.7 (11.2; 10)	119.6 (4.8; 8)	104 (8.7; 18)	102.1 (2.6; 8)	114.9 (11.5; 17)	114.2 (7.6; 13)	122.9 (11.2; 26)	118.4 (7.7; 10)
	110-122	112-129	96-124	98-105	103-150	105-135	103-149	108-132
<i>Q. ilex</i>	117.3 (3.1; 12)	118.5 (4.5; 4)	104.9 (8.3; 14)	107 (4.2; 3)	110.1 (8; 9)	111.7 (7; 6)	122.5 (12.4; 6)	120 (16.4; 5)
	112-123	115-126	96-121	101-110	93-123	101-120	111-142	106-146
<i>P. halepensis</i>	134.8 (6.9; 9)	124.7 (7.9; 11)	117.7 (7.6; 3)	128.2 (6.4; 12)	124.3 (4.8; 6)	126.5 (11.2; 6)	133.5 (11.9; 4)	132.4 (9.3; 9)
	127-147	110-137	107-124	121-140	118-129	118-148	125-154	116-143

Clutch-size	1993		1994		1995		1996	
	P. caeruleus	P. major	P. caeruleus	P. major	P. caeruleus	P. major	P. caeruleus	P. major
<i>Q. pubescens</i>	9.5 (1.6; 10)	8.4 (1.1; 8)	9.2 (1.2; 15)	9 (0.8; 7)	7.8 (1.9; 17)	8.1 (0.9; 12)	7.8 (2.4; 26)	6.4 (2.1; 9)
	6-12	7-10	6-11	8-10	5-11	7-10	1-12	2-9
<i>Q. ilex</i>	8.5 (2; 12)	9 (2.2; 4)	8.6 (1.7; 14)	8.3 (0.9; 3)	9.3 (1.6; 9)	8.8 (1.5; 6)	9 (4.1; 4)	8 (1.2; 5)
	3-12	6-12	7-12	7-9	6-11	7-11	8-10	8-10
<i>P. halepensis</i>	6.4 (1.3; 9)	6.7 (1; 11)	7.3 (0.5; 3)	7.5 (0.9; 8)	6 (0.8; 4)	5.5 (1.5; 6)	5.2 (2; 4)	6.4 (0.8; 7)
	4-9	5-9	7-8	6-9	5-7	3-7	2-7	5-7

Eggs hatched	1993		1994		1995		1996	
	P. caeruleus	P. major	P. caeruleus	P. major	P. caeruleus	P. major	P. caeruleus	P. major
<i>Q. pubescens</i>	7.9 (2; 10)	8.2 (1; 8)	8.8 (1.4; 13)	8.5 (0.5; 6)	6.9 (2.1; 17)	7.9 (0.9; 12)	7.4 (2.8; 26)	6.25 (2.1; 8)
	3-10	7-10	0-11	8-9	3-11	7-10	1-12	2-9
<i>Q. ilex</i>	8.4 (1.2; 11)	8.7 (2.2; 4)	7.5 (2.7; 14)	5.7 (1.2; 3)	8.5 (2.3; 9)	8.3 (1; 6)	9 (4.1; 4)	7.2 (0.8; 5)
	0-11	6-12	0-12	4-7	4-11	7-10	8-10	6-8
<i>P. halepensis</i>	5.8 (0.8; 9)	5.9 (0.8; 11)	3 (0; 1)	7.3 (1; 7)	6 (0.8; 4)	5.5 (1.5; 6)	5.2 (2; 4)	5 (1.1; 5)
	0-7	4-7	0-3	0-9	5-7	3-7	2-7	4-7

Young fledged	1993		1994		1995		1996	
	P. caeruleus	P. major	P. caeruleus	P. major	P. caeruleus	P. major	P. caeruleus	P. major
<i>Q. pubescens</i>	7.9 (2; 10)	8.2 (1; 8)	8.6 (1.2; 13)	8.5 (0.5; 6)	6.9 (2.1; 17)	7.9 (0.9; 12)	7.4 (2.8; 23)	6 (2.3; 8)
	3-10	7-10	6-11	8-9	3-11	7-10	1-12	1-9
<i>Q. ilex</i>	8.4 (1.2; 11)	8.7 (2.2; 4)	7.2 (2.9; 13)	5.7 (1.2; 3)	8.5 (2.3; 9)	8.3 (1; 6)	9 (4.1; 4)	7.2 (0.8; 5)
	6-11	6-12	3-12	4-7	4-11	7-10	8-10	6-8
<i>P. halepensis</i>	5 (1.4; 8)	5.8 (0.9; 11)	3 (0; 1)	6 (1.7; 8)	5.7 (0.9; 4)	4.8 (1.7; 6)	5 (2.1; 4)	5 (1.1; 5)
	2-7	4-7	-	3-9	5-7	2-7	2-7	4-7

Table 3 - Statistics (two way ANOVA) on breeding parameters of Blue and Great Tit living in the three woodlots dominated by three different tree species; since any significant difference in the breeding parameters among the four years has been found, they were treated as a single sample.

	Great Tit <i>Parus major</i>		Blue Tit <i>Parus caeruleus</i>	
	<i>Q. pubescens</i>	<i>Q. ilex</i>	<i>Q. pubescens</i>	<i>Q. ilex</i>
Laying date				
<i>Q. ilex</i>	F = 0.042		0.926	
	P < 0.961		0.400	
<i>P. halepensis</i>	F = 23.122	11.729	10.646	20.017
	P < 0.001	0.001	0.001	0.001
Clutch size				
<i>Q. ilex</i>	F = 1.188		0.397	
	P < 0.311		0.001	
<i>P. halepensis</i>	F = 4.046	11.218	13.887	17.733
	P < 0.025	0.001	0.001	0.001
Number hatched				
<i>Q. ilex</i>	F = 0.003		0.635	
	P < 1.00		0.671	
<i>P. halepensis</i>	F = 9.903	6.175	6.429	10.804
	P < 0.001	0.005	0.03	0.001
Number fledged				
<i>Q. ilex</i>	F = 0.001		0.487	
	P < 1.00		0.610	
<i>P. halepensis</i>	F = 10.125	7.200	9.012	12.193
	P < 0.001	0.02	0.004	0.001

Abundance of arthropods

The trend was different in 1993, 1994, 1995 and 1996 (Figures 1, 2 and 3). Due to huge numbers of caterpillars of *Tortrix viridana* L. (Lepidoptera Tortricidae), richness resulted much higher in 1993 than in 1994, 1995 and 1996, when the moth was almost absent; this caused a reduction to half of arthropod values in DO between 1993 and 1994. In EO in 1993 figures of arthropods extracted in 15 min of sampling were much lower than in DO (due to the absence of caterpillars in EO), and in 1994, 1995 and 1996 they still decreased by about 70%. Finally in PR samples of arthropods resulted very scarce in all the four breeding seasons.

Climate trend

Local mean meteorological data for the period 1980-92 show a dry season between May and September and a rainy and humid one between October and April (Figures 4). Data from January 1993 to June 1996 are to some extent different from those above mentioned; in fact the months January, April and December 93, March and May 94 were drier than in the previous 13 years. The 1994-95 winter-spring seasons were characterized by an exceptional dryness all the months

around; on the contrary the 1995-96 winter-spring months were highly rainy and humid in respect to previous 15 years. In the rainy years laying was delayed in respect to wetter ones, and a positive correlation between the rain value in March and the day of the first egg laid has been detected (both species together: $r = 0.524$; $P = 0.009$; $fd = 22$).

Discussion

The first aim of our research was to ascertain whether differences actually exist in resource abundance between EO and DO. Even if differences in the arthropod richness between the two oak species were detected, breeding performance of the two Tit species did not show significant differences between oakwoods dominated by deciduous and evergreen trees. Arthropods were qualitatively and especially quantitatively more abundant in DO than in EO, particularly in 1993 and 1994, and to a lesser extent in 1995 and 1996. In DO arthropods were more abundant in 1993 (due to the outbreak of *Tortrix viridana*) and decreasing in the three following years; in EO we observed a similar decrease, but it was less evident for the absence of caterpillars. We may conclude that

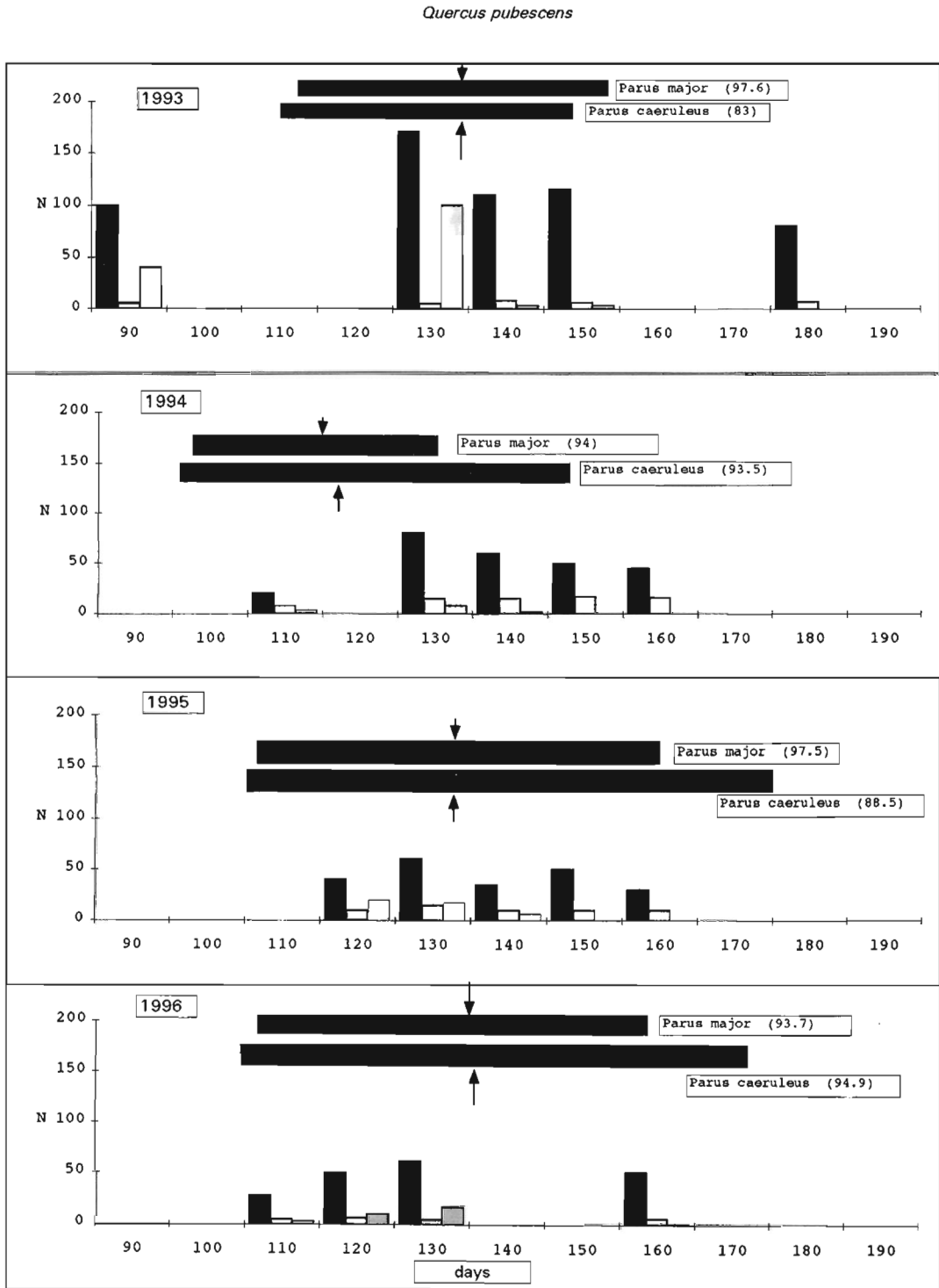


Figure 1 - Overall number of arthropods (black), caterpillars of *Tortrix viridana* (grey) and arthropod orders (white) extracted by the Univac portable suction sampler within branch layers of 15-20 plants of *Quercus pubescens* for 15 minutes. Horizontal bars indicate the breeding season of Great and Blue Tits in the *Q. pubescens* woodlot (that is from the earliest lay-date to the latest fledging-date); fledging success (number fledged/clutch size x 100) follows the scientific name of Tits. In the abscissa is reported the number of days from the 1st January (92 = 1st April). The arrow shows the peak of breeding, that is the mean laying-date + 15 days to hatch.

Quercus ilex

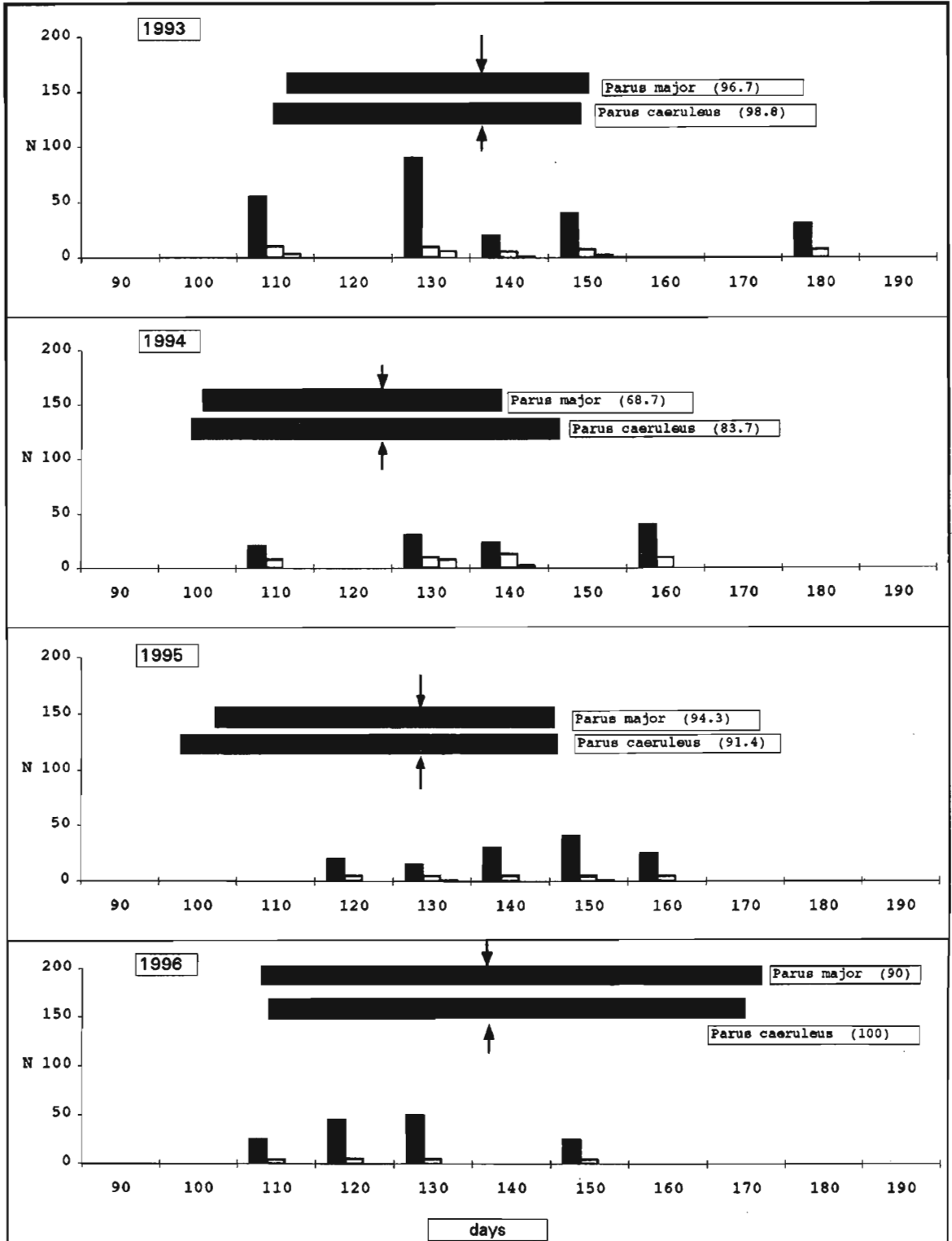


Figure 2 - As Figure 1, wood of *Quercus ilex*.

Pinus halepensis

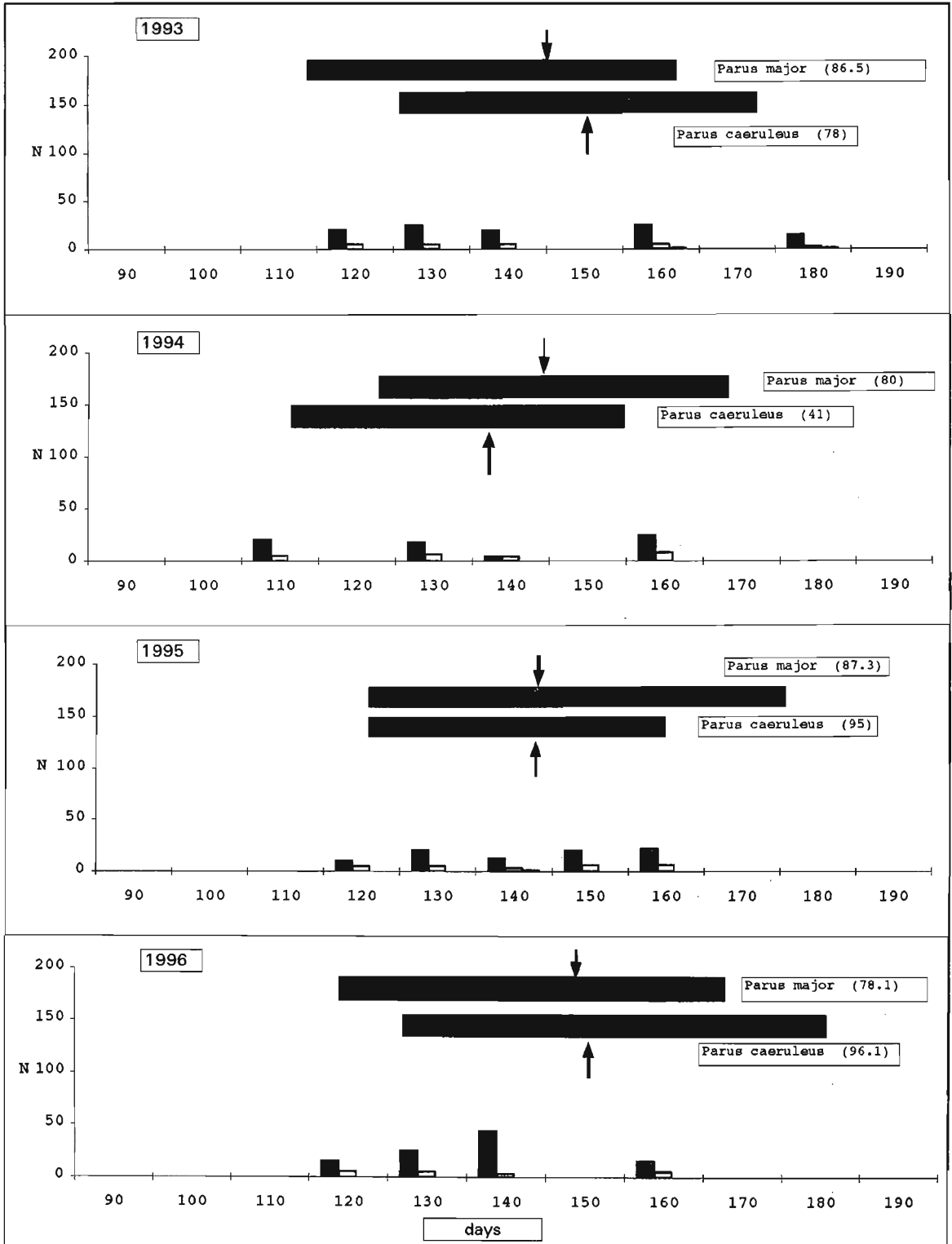


Figure 3 - As Figure 1, reafforestation of *Pinus halepensis*.

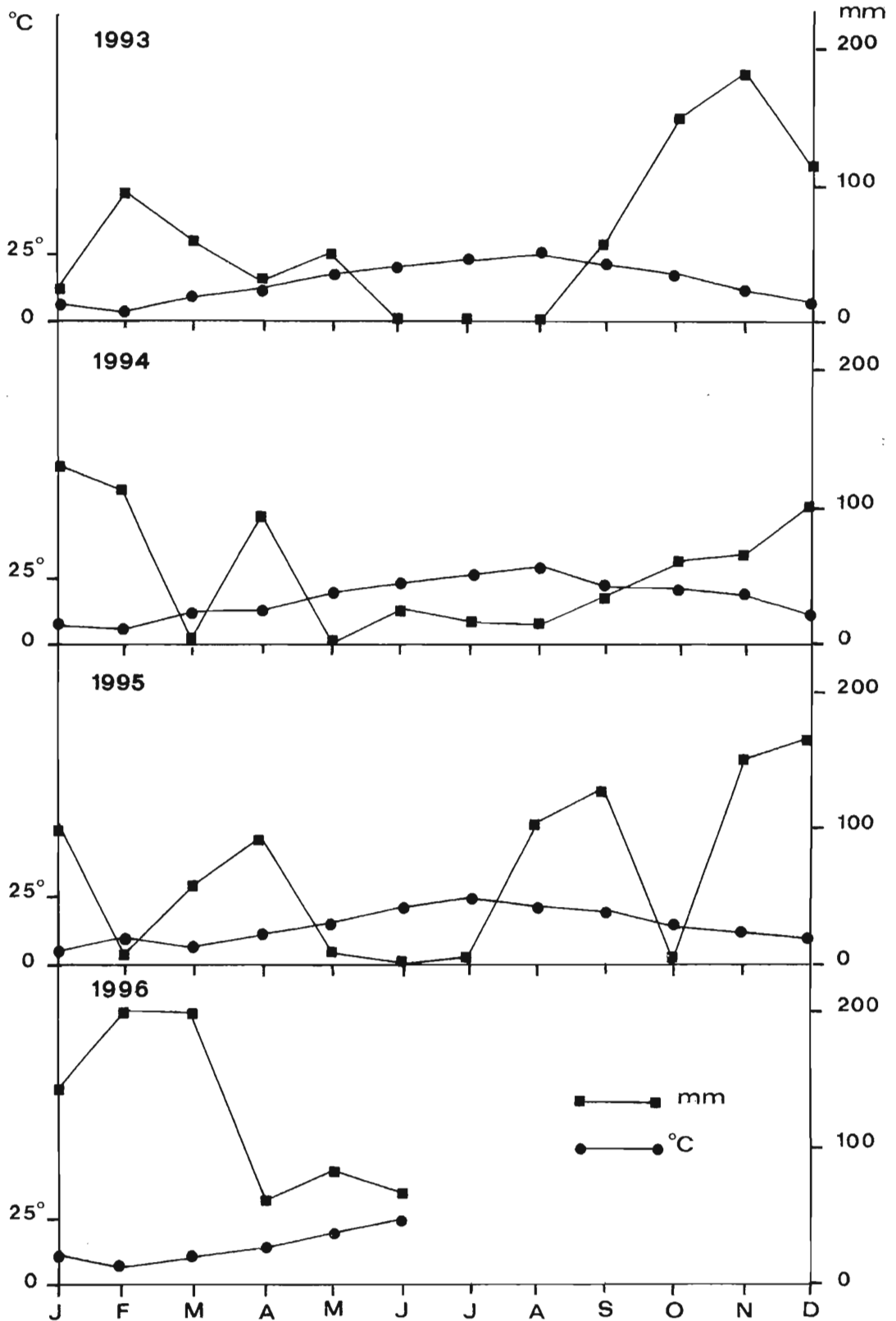


Figure 4 - Climatic trend from January to December 1993, 1994, 1995 and from January to June 1996.

evergreen oakwoods are less productive and rich in arthropods than deciduous ones. Our results seem do not agree with what was observed by some authors (e.g. Perrins and Mc Cleery 1989), who found a correlation between clutch size and annual caterpillar density. In 1993, even if resource (= caterpillars) abundance in DO was much higher than in EO, the fledging success did not differ in the two woods both for Great and Blue Tit. Captures of arthropods in DO in 1994 match well those of EO in 1993, as well as reproduction of the two species of Tits in DO in 1994 (fledging success of the two species: 93.5 and 94%) and in EO in 1993 (fledging success: 97 and 99%). Caterpillars, nevertheless, are not always important prey for Tits (e.g. Blue Tit in evergreen Iberian oakwoods: Gil Delgado *et al.* 1992). Thus the sole differences in the abundance of caterpillars of *Tortrix viridana* in 1993 in respect to other years in DO cannot account for the possible differences in the breeding trend in DO. Parallel differences also occurred in the other woodlots; as a matter of fact only in 1994, year of scarcity of caterpillars of *Tortrix viridana*, both Great and Blue Tits started earlier the reproduction both in DO (where in 1993 caterpillars were abundant) and in EO (where caterpillars were almost absent), and in 1994, 1995 and 1996, all years of caterpillar scarcity, Blue Tits increased their frequency of occurrence and nestbox occupation. The changement of food resource before, during laying and chick growth might be the reason of earlier laying in 1994 in respect to other years (cf. Martin and Bellot 1990); this changement possibly accounts for the lower fledging success of both Great (69%) and Blue Tit (84%) in EO in 1994 in respect to the other years (see Table 2). Earlier laying date recorded in 1994 cannot be related to the mere absence of caterpillars, but probably to other factors, as the anticipation of the overall abundance of insects, the microclimate, etc. The second aim of our research was to ascertain the overlap degree of the peak resource and the peak-demand of young in the two types of oakwoods. As suggested by Haywood (1993), climate may influence the resource peak, which in turn may influence the breeding success. Temperature and rain values should act through the spring development of the leaves and the associated arthropod fauna the Tits prey upon (Perrins and Mc Cleery 1989; also see Clamens (1990) who noticed a significant correlation between laying date and bud burst in deciduous oakwood). A rainy winter and an earlier summer may influence the demography of insect populations and could account for the breeding performance of Tits, and, according to the theory, earlier clutches tend to be larger than later ones (cf. Perrins 1970; Gosler 1993). As we found a correlation between the rain value in March

and the day of the first egg laid, but did not find any significant correlation between the day of the first egg laid and the clutch size or the number of young fledged, we suppose that winter-spring climate may have influenced the laying date of sicilian Tits, while their laying date possibly did not influence the clutch size and fledging success.

In the four years pairs of Blue and Great Tits breeding in oakwoods appeared to be significantly more successful than in reafforestation sites: clutches generally were larger and started earlier in the oakwoods than in reafforestation. No important differences were noticed in the breeding performance between DO and EO in the four years both for Great and Blue Tit, while they were observed in PR. In DO breeding of Tits occurred in such a way that the two peaks (abundance of arthropods and demand by young) resulted properly adjusted in the four years. In EO, where arthropods resulted less abundant than in DO but showed a gaussian curve of abundance, the demand by young Tits overlapped less with the peak of resource availability; nevertheless this did not affect the fledging success. In PR, where arthropods were monotonously scarce, the demand of young could not be adjusted to any kind of curve, and clutch size and number of young fledged was lower respect to the oakwoods. Thus it seems that both the overall abundance and the presence of a peak of arthropods during the breeding season of Tits may influence the fledging success.

Generally dry mediterranean habitats do not favour the occurrence of second clutches of Tits (but see Bellavita and Sorace (1991) who report high percentages of double clutches in central Italy); the possible reason of the double clutch of one pair of Great Tit in DO in 1993 was the high availability of caterpillars.

Our third aim was to check the breeding performance of Tits in relation to resource parameters, in woodlots dominated by trees of different species which are part of the same woodland. Previous work on the breeding biology of the Great Tit has shown that timing has a strong influence on other reproductive parameters and is critical for their success; for example, earlier fledged young tend to be heavier and have a higher probability of surviving to breed, while later-laid eggs tend to be heavier, but later clutches and broods tend to be smaller (cf. Perrins 1970, 1979, Gosler 1993). According to Blondel *et al.* (1993) in continental deciduous oakwoods of France and in insular evergreen oakwoods of Corsica Blue Tits time their laying date so that their young are in the nest around the peak of food abundance. Their results support the theory that selection favours earlier breeding and larger clutches in rich deciduous mainland habitats,

and smaller clutches and later laying dates in poor evergreen island habitats. Possibly due to gene flow between Blue Tits living in deciduous and evergreen oakwoods, birds living in continental evergreen oakwoods start laying before the optimal date (Clamens and Martin 1991). The apparent maladaptation of Blue Tits in the evergreen continental oakwood has been interpreted by Blondel *et al.* (1993) as the result of an asymmetric gene flow between rich deciduous habitats (source), where well adapted birds produce many fledglings, and poor evergreen habitats (sink) where the density is maintained through the immigration from rich habitats. Our results are not in accord with the hypothesis of genetic differences in the mean laying date in insular Blue Tit (Perret *et al.* 1989; Blondel *et al.* 1990, 1993; Lambrechts and Dias 1993). In Sicily, Downy and Holm oak respectively cover 18,677 and 9,993 Ha, pine reforestations 56,831 Ha (Asciuto 1992); we assume that most of the sicilian broadleaved woodland populations of Great and Blue Tits are not isolated from their surroundings (e.g. pine reforestations) and an exchange of birds between the different habitats occurs more or less regularly (cf. McCleery and Clobert 1990), particularly in our sample area where wood sites are lots of the same woodland. Values of clutch size of Blue Tit in oakwoods (7.8-9.5) lie among those known for other mediterranean continental areas (cf. Blondel *et al.* 1993; Isenmann 1987), whereas clutches in pine reforestation (5.2-7.3) lie among those known for Corsica, Canary Is., Pantelleria Is. and North Africa (cf. Blondel *et al.* 1993; Isenmann 1987; Lo Valvo and Massa 1995). The mean laying date of Blue Tit in sicilian oakwoods (12 April-2 May; cf. Table 4) is typical of mediterranean continental areas (20 April according to Blondel *et al.* 1993 and Isenmann 1987), whereas the laying date in pine reforestation (27 April-13 May) is among the latest of the Mediterranean (the island of Corsica: Blondel *et al.* 1993; some Iberian continental populations: Gil Delgado *et al.* 1992; see Table 4). The gene flow between deciduous and evergreen oakwood individuals could account for the insignificant differences of the breeding performance in the two oakwoods, but the low clutch size and fledging success observed in PR, habitat qualitatively and quantitatively poor in resources, disagrees with the above theory, being very unlikely the lack of gene flow between individuals living in PR and those breeding in EO and DO.

Van Balen (1973) found marked differences in the density of Great Tit pairs between mature oak *Quercus* spp. woodland (1-2.3 pairs/ha) and Pine *Pinus* spp. woods (0.1-0.4 pairs/ha). At such densities, clutch-size was similar in both habitats;

however, when population densities were similar, clutch size was much greater in oakwoods, and nestling survival rates were much lower in pine woods. Lemel (1989) however found little evidence for a difference in reproductive success of Great Tits breeding in deciduous and coniferous forest in Sweden. In general the variation we observed in many measured parameters was greater in PR oakwoods (particularly for Blue Tit), and this in itself may indicate the poorer quality and more variable environment of this semi-natural habitat. Most of western Europe is now characterized by fragmented habitats of variable, but often low, quality; small pockets of ancient natural woodland are the remnants of once extensive forest cover (Riddington and Gosler 1995); pine reforestation revealed to be an entomologically poor habitat, much poorer than the remnants of the natural woodland. As a possible consequence of the inadequacy of the resources, Tits nesting there lay less eggs and produce less young than in natural woods immediately close to it. Lastly, we might hypothesize that some of the differences observed between oakwoods and pine reforestation could be caused by age effects of Tits; reforestation should be a secondary habitat, chosen by young individuals, which breed later and produce less young. Nevertheless, the low fledging success in sicilian reforestations seems a generalized model. As a matter of fact we found a low number of fledged young of Great Tit in another sicilian pine reforestation (Mt. Pellegrino, Palermo, 4.0 fledglings in 1993, 5.4 in 1994 and 5.0 in 1995).

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Riassunto - Abbondanza di insetti ed andamento della riproduzione delle Cince in querceti sempreverdi e decidui e rimboscamenti di pini in Sicilia.

Questa ricerca, condotta negli anni 1993-96, ha avuto come scopi: 1) valutare l'abbondanza e le eventuali differenze di risorse (artropodi) esistenti negli alberi che caratterizzano i querceti sempreverdi e quelli decidui; 2) controllare se il picco delle risorse coincide con il picco della domanda da parte dei giovani di due specie di Cince (*Parus major* e *P. caeruleus*); 3) verificare l'andamento della riproduzione ed i principali parametri riproduttivi delle due specie di Cince in tre habitat carat-

Table 4 - Breeding data of Great and Blue Tits in the Mediterranean area; numbers are referred to minima and maxima or to mean and standard deviation (in brackets) according to various sources. Laying dates are referred to the number of days from the 1st January (92 = 1st April).

	Laying-date		Clutch-size	
	Great	Blue	Great	Blue
Evergreen				
France	100-124 ^[5]	108.2(5.09) ^[4,6]	8.3-10.1 ^[5]	8.1(1.5) ^[4,6]
Spain		76-88 ^[8]		7.5-8.5 ^[8]
Spain		127(7.25) ^[5]		9.5(1.4) ^[5]
Italy	104.4(1.5) ^[2]	114.4(3.9) ^[2]	8.3(0.5) ^[2]	8.3(0.9) ^[2]
Algeria		130 ^[10]		6.6(1.4) ^[10]
Morocco		93-112 ^[1]		6.8(1.1) ^[1]
Sicily	107-120 ^[13]	105-122 ^[13]	8-9 ^[13]	8.5-9.3 ^[13]
Corsica	127-148 ^[6]	123.3-150 ^[3,6,7,9]	6-7 ^[6]	5.2-7.2 ^[3,6,7,9]
Mallorca				6.9(1.2) ^[8]
Is. Vivara			3.9-6.1 ^[11]	
Deciduous				
France		100.9(4.2) ^[4,7]		10.9(1.8) ^[4,7]
Italy	111(11) ^[2]	101.7(8.7) ^[2]	7.8(1.2) ^[2]	8.2(1.3) ^[2]
Sicily	102-120 ^[13]	104-123 ^[13]	6.4-9 ^[13]	7.8-9.5 ^[13]
Corsica		117.7(6.2) ^[7]		
Coniferous				
France	110-140 ^[6]		7.5-7.8 ^[6]	8.8(1.3) ^[7]
Italy	100.2(8.3) ^[2]	114.9(10.5) ^[2]	7.8(1.4) ^[2]	8.2(1.3) ^[2]
Morocco		135-147 ^[7]		6.7(1.3) ^[7]
Sicily	125-132 ^[13]	118-135 ^[13]	5.5-7.5 ^[13]	5.2-7.3 ^[13]
Corsica	143-158 ^[6]		7.8-8 ^[6]	6.3(0.5) ^[7]
Canary Is.				3.5(1) ^[7]
Mixed				
I. Pantelleria		104-150 ^[12]		4.5-5.5 ^[12]

References:

- 1 = Baouab et al. 1986;
- 2 = Bellavita and Sorace 1991;
- 3 = Blondel and Isenmann 1979;
- 4 = Dervieux et al. 1990;
- 5 = Gil Delgado et al. 1992;
- 6 = Isenmann 1982;
- 7 = Isenmann 1987;
- 8 = Isenmann et al. 1990;
- 9 = Lambrechts and Dias 1993;
- 10 = Moali and Isenmann 1990;
- 11 = Fusco et al. 1991;
- 12 = Lo Valvo and Massa 1995;
- 1996 unpublished data;
- 13 = present study.

terizzati da alberi diversi (querceto deciduo, querceto sempreverde e rimboscimento di pini), ma facenti parte di un'unica ampia area boschiva. Nei quattro anni la dimensione della covata, il numero dei giovani involati e l'abbondanza degli artropodi sono risultati maggiori nei querceti che nel rimboscimento di pini. L'abbondanza degli artropodi è più o meno coincisa sempre con il picco della domanda da parte delle giovani Cince, in modo particolare nel querceto deciduo. La riproduzione è iniziata sempre prima (anche di 20 giorni) nei querceti rispetto al rimboscimento. Non sono emerse importanti differenze nell'andamento della riproduzione tra i due querceti, mentre sono state osservate tra i querceti ed il rimboscimento; in entrambi i querceti, nei quattro anni, dimensione della covata e numero di involati sono stati significativamente maggiori dei corrispondenti valori osservati nel rimboscimento.

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