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BREEDING BIOLOGY OF THE PALLID SWIFT (*APUS PALLIDUS*) IN NORTH-WESTERN ITALY

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INTRODUCTION

The northern boundary of the breeding range of the Pallid Swift (*Apus pallidus*) passes through southern France and northern Italy (Cramp, 1985), reaching its northernmost point in the neighbourhood of Lake Maggiore (Pulcher and Boano, 1984; Lardelli, 1987). North of the Alps, the bird is known as a vagrant in Great Britain and the Netherlands (two sightings in 1979, Harwey, 1981).

According to some authors (Mayaud, 1951; Di Carlo, 1969), the species is spreading northward, but the difficulties in field identification may have concealed its real trend, delaying the discovery of nesting colonies (Lack and Lack, 1951a); even some museum specimens collected at the beginning of this century have been only recently identified as belonging to this species (Boano, 1974; Lardelli, 1986).

Moreover, the breeding biology of the Pallid Swift shows intriguing aspects because of its extended presence at colonies and late breeding (Boano, 1979; Pulcher, 1985), its double clutches at breeding sites on buildings (Finlayson, 1979 *in* Cramp, 1985) but not in Corsican islets (Thibault *et al.*, 1987) and for the problems posed by its sympatry with the Common Swift (*Apus apus*).

Updated results of our long-term study on two colonies in northern Italy are here dealt with, mainly concerning breeding season, reproductive success and double broods.

STUDY AREA AND METHODS

Fig. 1 shows known breeding localities in Piedmont, referring to the results of the recently completed regional Atlas Project (Mingozzi, Boano and Pulcher,

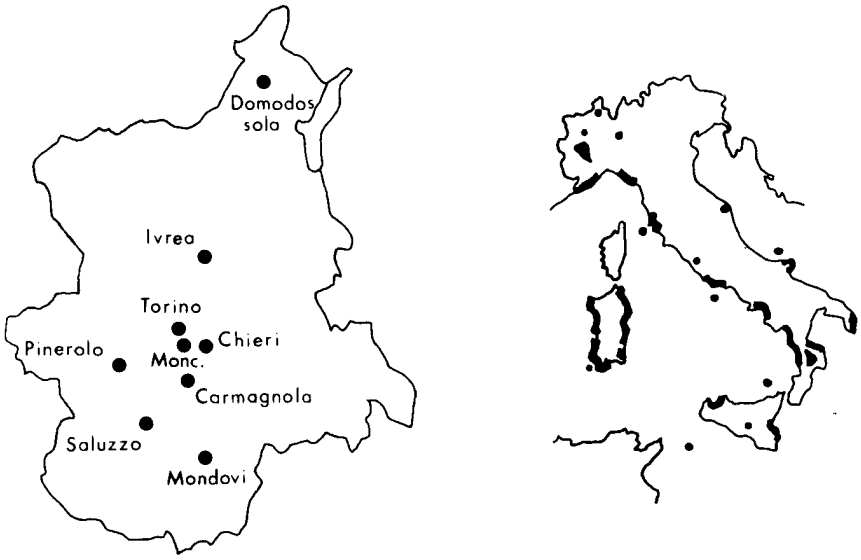

Fig. 1. Distribution of the Pallid Swift in Piedmont (left) and Italy (right).

1988), and in the rest of Italy; the spot in the center of northern Italy refers to the recent discovery of its breeding in Milan (Gimpel *et al.* 1986). Our research was carried out in Carmagnola (Turin) and Saluzzo (Cuneo), where about 40 and 110 pairs, respectively, of Pallid Swift breed among many more Common Swifts.

In both cases the birds breed in holes in old buildings or churches, as usual in this region.

Observations started in Carmagnola in 1974, and, since 1976, nests have been numbered and checked almost fortnightly (with the exception of 1977, 1981 and 1982) (G. Boano and collaborators); in Saluzzo checks were conducted only in 1984, but once every 2-3 days (M. Cucco).

In Carmagnola, nests were easily reached from inside the buildings, while in Saluzzo, where holes are larger, they were inspected from the outside by means of a long ladder.

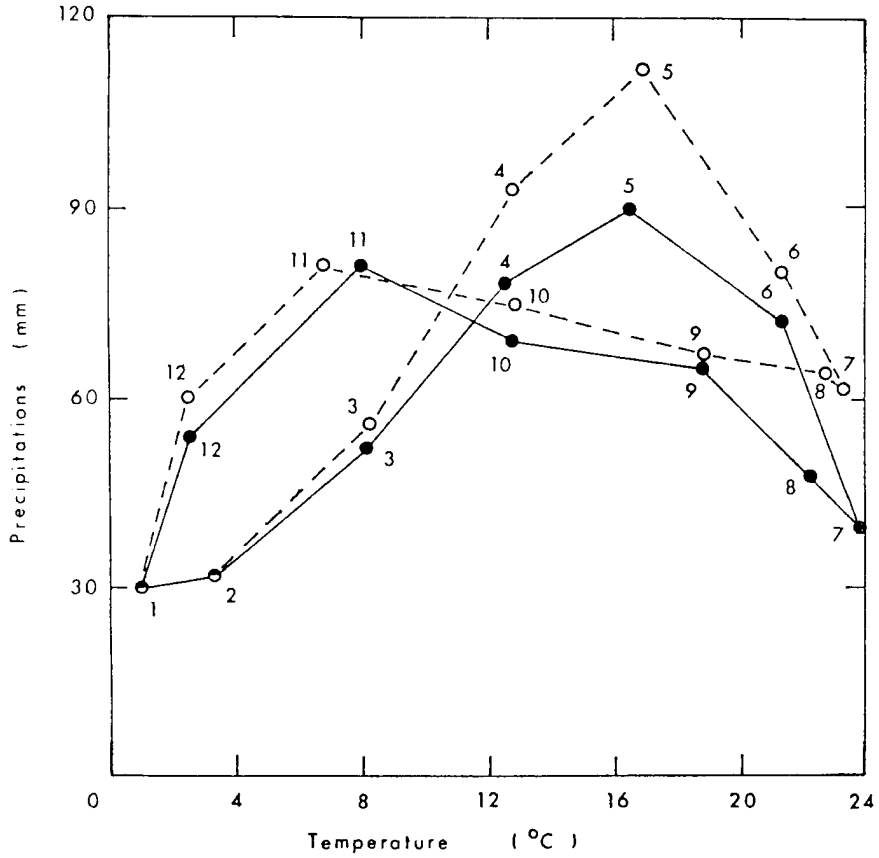

Fig. 2. Climatograms of Carmagnola (—) and Turin (----)

In the first research area 110 Pallid Swifts (47 adults and 63 pulli) were marked with rings of the Italian Ringing Scheme I.N.B.S. From 1985 some individuals were also marked by bleaching spots on their plumage (Cucco *et al.*, 1987; Malacarne and Griffa, 1987).

CLIMATE

Climatograms of Turin (where many hundred pairs of Pallid Swift breed) and Camargnola (30 km south of Turin) are shown in Fig. 2. They exemplify the climate in the central part of the region, where the study was done. This climate can be typified as continental since the average annual temperature excursion reaches 23°C and the average annual rainfall 712 mm. The rainfall pattern, with a main peak in May and a secondary one in November, can be defined according to Mennella (1967) as "sub-littoraneous padaneous". From June to late October atmospheric conditions are favourable, with high temperatures and few rainy days.

In May 1984, rainfall was particularly high in the whole region; in this month 20 rainy days were recorded and the average temperature reached 19.4 C, lower than in April. The meteorological station in Bra (20 km south of Carmagnola) recorded a monthly rainfall of 300 mm which is the highest value in 120 years of station activity (Perosino and Rosso, 1984; Perosino, pers. comm.). The spring of 1985 was also particularly rainy and cold.

RESULTS

Arrival and departure dates

Pallid Swifts prolong their stay on the breeding grounds considerably. First arrivals are generally noticed in the first half of April although, most birds settle down in the first days of May.

Departures begin at the end of July or early August, but a good number of birds remain in the breeding area until late October or early November, and few are still there at the beginning of December.

Table 1 shows the earliest and latest observations in the region: when the first observed bird was not surely identified, we have also reported the date of the first noticed *Apus* sp. Probably earlier dates are to be referred to the Pallid Swift, because the Common Swift, at least in some years, arrived with a delay of 7-10 days, as ascertained in 1986 and 1987.

In contrast, departure dates for Pallid Swifts are far later than those of Common Swifts which leaves the breeding colonies in mass at the end of July (beginning of August) and for which there are no positive records later than September (G.P.S.O. 1982-1987).

The regularity of late departures for Pallid Swift was proved by Pulcher

Table 1. Dates of first and late observations in Piedmont

Year	First obs.		Late obs.
	A.pallidus	*Apus* sp.	*A. pallidus*
1970		17.04	
1971		11.04	
1972		29.03	
1973		14.04	14.11
1974	02.05	13.04	
1975	17.04	07.04	
1976	02.05	15.04	
1977	18.04		
1978			30.11
1979	14.04		16.12
1980	08.04		04.12
1981	10.04		26.11
1982	12.04		03.11
1983	15.04	11.04	05.12
1984	10.04	06.04	09.12
1985	09.04	08.04	12.11
1986	09.04		20.11
1987	04.04		05.11

(1985) in Moncalieri (Turin), where he found 4-5 nests still occupied on 20 November for five consecutive years.

Nest fidelity

Thanks to controls of 18 ringed birds (42% of marked adults) it was possible to verify a high nest-fidelity among adults (67% did not change nest); the oldest swift (individual "f" in Table 2) was found in the same nest again each year for four years, from 1978 to 1984.

We also observe individuals that shift from one nest to another in different years ("b", "d", "j","k", "n"), and also from spring to autumn ("k", "o").

Moreover, in three cases, we noticed that the same nest was attended by three different birds in the same year (number 14 in 1979, 13 and 25 in 1984). Probably, in the case of nest 14, one of the 3 birds had just casually visited the nest before the arrival of its legitimate owners, but individuals "o" and "q" were substitutive partners of "b" and "r", respectively (see Table 4).

Fidelity of young birds to the colony seems very low, because none of 63 ringed young returned.

Table 2. Controls of adult *Apus pallidus* ringed at nest in Carmagnola

Year	1976	1978	1979	1980	1983	1984	1985
Indiv	Controlled-up in nest number						
a	6	6	6	6			
b			6		25	13	
c		10	10				
d			10		13	13	
e		11	11				
f		11	11		11	11	
g		12	12				
h						11	11
i			13		13		
j			13			25	25
k			14			10	
						6	
l		14	14				
m			14			14	
n						15	13
o						15	
						13	13
p		17	17				
q			25			25	
r						25	25

Note: only one control per year is shown, except when the same individual was recorded in different nests.

Table 3. Breeding season of Pallid Swift in Carmagnola. Number of clutches started every half-month interval (? = no observation).

Year	1976	1978	1979	1983	1984	1985	1986	Total
01-15 May	-	-	-	2	-	2	-	4
16-31 May	3	6	4	6	-	2	3	24
01-15 Jun	2	3	2	6	3	2	7	25
16-30 Jun	-	-	1	1	9	1	1	13
01-15 Jul	3	1	2	1	-	1	1	9
16-31 Jul	-	-	-	-	1	-	1	2
01-15 Aug	1	1	-	-	-	-	-	2
16-31 Aug	?	?	?	-	-	-	-	
01-15 Sep	?	?	?	4	7	-	-	11
16-30 Sep	?	?	?	1	3	-	-	4
Totals	9	11	9	21	23	8	13	94

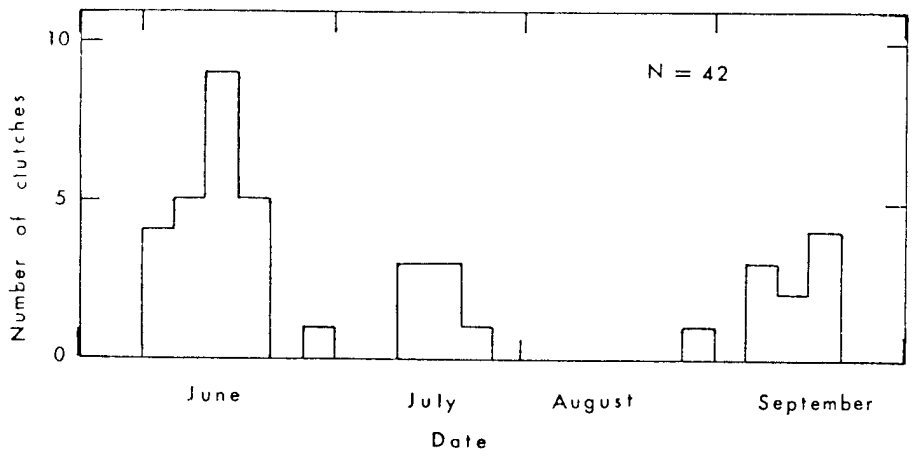

Fig. 3 Breeding seasons of Pallid Swift. Figure shows number of clutches laid during five days intervals in Saluzzo, 1984.

Breeding season

The breeding season of Pallid Swift in Piedmont extends from mid-May to the last ten days of November (Boano, 1979; Pulcher, 1985).

Table 3 and Fig. 3 show data about the start of laying in Carmagnola and

Table 4. Occupation of nests in 1984 at Carmagnola for two successive breedings.

Nest	7	11	12	13	14	15	17	18	19	20	23	25
June-July	++	?f	uv	bd	?m	?z	?y	?	?	?w	?	jr
September	st	hf	?v	bo	?m	--	?	--	?	?w	?	qr

letter = ringed individual (*Apus pallidus*)
? = not-ringed individual
++ = pair of *Apus apus*
-- = not re-utilized

Note: Number of nests and letter referring to birds as in Table 2.

Saluzzo. In both cases a bimodal distribution is evident, with May-June and September peaks.

In Saluzzo we noticed a third, less important peak in July. Probably this intermediate peak is due to replacement clutches, since these occured only in nests where a previous clutch had been lost.

September clutches represent genuine second broods, layed by part of the already successful breeding pairs; the percentage of second broods varies from 0 to 77% in Carmagnola (1983-1986), while in Saluzzo it was 42% in 1984.

We are sure that the September clutches are genuine to a second broods not only because the same nests were re-occupied, but because six ringed birds were involved (cf. Table 4).

Clutch size

Table 5 shows the sizes of clutches observed in Carmagnola and Saluzzo.

In spring-summer broods (N=91) three-egg clutches are the most common (N=48; 69%), while two-egg clutches are less frequent (N=21; 30%) and single-egg ones are very rare (1, 1%).

Table 5. Distribution of clutch sizes of *Apus pallidus* (years 1979, 1983 to 1986).

Time	Clutch size (eggs)			tot. clutches
	1	2	3	
01-15 May	-	1	3	4
16-31 May	2	2	9	13
01-15 Jun	1	14	25	40
16-30 Jun	-	4	14	18
01-15 Jul	-	6	3	9
16-31 Jul	1	3	3	7
01-15 Aug	-	-	-	-
16-31 Aug	1	-	-	1
01-15 Sep	-	13	3	16
16-30 Sep	4	4	-	8
All months	9	47	60	116

In autumn broods (N=25) two-egg clutches are the commonest (N=17; 68%), while single-egg clutches increase in number (N=5; 20%) and three-egg ones decrease (N=3; 12%).

Incubation and nestling period

Owing to the non-daily checks, we are able to supply only the extreme values noticed in the Saluzzo colony. The incubation period ranges from the extremes of 20 to 24 days (prudentially calculated from the observed values of 18.5 +/- 1.5 and 25 +/- 1 days).

Values (>24 days) far higher than the average are known even for the Common Swift, and are due to a temporary desertion of the clutch (Lack and Lack, 1951b).

Incubation starts with the second egg, since we have never seen adults incubating one egg (except in fairly rare cases when it constitutes the entire clutch). Laying interval, as reported in only four cases, may be 2 (1 instance) or 3 days (3 instances). Hatching is commonly asynchronous, at least in three-eggs clutches. The fledging period is variable, ranging from 43 (42 +/- 1) to 47 (exact) days. The available data are all based on to the first or replacement layings in Saluzzo.

The hatching sequence affects the fledging date, so that often the last-born bird flies away one or two days after its siblings.

Breeding Success

Breeding parameters listed in Table 6 are useful to estimate the breeding success of the species. Data concerning springtime nestings (first and replacement) are here separated from those concerning autumnal nestings. In cases where a replacement clutch was laid we did not consider the number of eggs laid for the first time in order to avoid changing the "clutch size" parameter.

The hatching rate (hatched/laid eggs) is 72% for the first nesting and 43% for the second. An unusual minimum was recorded for first clutches in 1985, when only 13% of eggs hatched, while in Carmagnola none of the 17 eggs laid in autumn 1984 hatched.

These failures may be linked either to handling during the ringing process (the birds seem to be more affected during autumnal breeding), or to biological and climatic reasons: in October 1984, during a few particularly cold and rainy days, seven pairs of birds of which at least one partner was handled and three

Table 6. Breeding success of Pallid Swift in Piedmont.

	Carmagnola												
Year	1975	1976	1978	1979	Part. Tot.	1983	1983	1984	1984	1985	1985	1986	1986
Clutch	I	I	I	I	I	I	II	I	II	I	II	I	II
a	2	8	9	9	28	14	5	13	10	8	0	14	0
b	2	5	8	5	20	12	4	11	0	1	0	13	0
c	6	18	25	22	71	41	10	38	17	15	0	34	0
d	6	10	20	14	50	30	8	30	0	2	0	29	0
e	5	9	16	9	39	26	8	22	0	2	0	23	0
c/a	3	2.3	2.8	2.4	2.5	2.9	2.0	2.9	2.7	1.9	0	2.4	0
e/a	2.5	1.1	1.8	1.0	1.4	1.9	1.6	1.7	0	1.5	0	1.6	0
b/a	100	62.5	88.9	56.5	71.4	85.7	80.0	84.6	0	12.5	0	92.8	0
d/c	100	55.5	80.0	63.6	70.4	73.2	80.0	78.9	0	13.3	0	85.3	0
e/c	83.3	50.0	64.0	40.9	54.9	63.4	80.0	57.9	0	13.3	0	67.6	0

Notes: a-nesting pairs; b-breeding pairs; c-laid eggs; d-hatched eggs; e-fledged youngs; c/a-clutch size; e/a-brood size; b/a-%successful pairs; d/c-hatching rate; e/c-fledging rate.

pairs of completely undisturbed birds deserted their nests at the same time.

The very bad breeding season in 1985 could be the result of the high mortality rate suffered by adults during two consecutive springs (1984 and 1985). In 1984 swift mortality was certainly high in Saluzzo and other towns in Piedmont (Cucco, 1985) and, during May 1985, in spite of a lesser number of rainy days than the previous year, adult mortality in the Carmagnola colony was high, when three individuals were found dead in the nest and ten colour-marked ones vanished.

Probably the high variability in percentage of pairs starting a second brood, and particularly the nil values recorded in Carmagnola after 1984, may be due to these unfavourable climatic conditions.

One-egg clutches are quite insignificant as a help to the breeding success of the species: in Saluzzo, out of 97 eggs regularly hatched, only one comes from a single-egg clutch, 47 from two-egg clutches and 49 from three-egg clutches.

Fledging rate (fledged young/laid eggs) is also higher during the first breeding (61%) than the second (41%). In spite of the apparently slight difference between these two values, the contribution of the second breeding to the annual productivity is poor, considering the percentage of pairs that breed twice.

	Saluzzo		TOTALS		
Year	1984	1984	Part. Tot.	Part. Tot.	TOT.
Clutch	I	II	I	II	I
a	24	10	73	25	101
b	21	6	58	10	78
c	61	19	189	46	260
d	46	12	137	20	187
e	42	11	115	19	154
c/a	2.5	1.9	2.6	1.8	2.57
e/a	1.8	1.1	1.6	7.6	1.52
b/a	87.5	60.0	79.4	40.0	77.2
d/c	75.4	63.1	72.5	43.5	71.9
e/c	68.8	57.9	60.8	41.3	59.2

Restricting the analysis to the years in which we have records about both broods (1983-1986), we find that out of 134 fledged young only 19 (14%) are derived from autumn broods.

This figure may be an overestimate, since probably young leaving nests in November suffer a higher mortality compared with those which fledged in July. In 1984 we have three observations of young fledging in October and found dead in the immediate surroundings of the colony; a similar event was never seen during summer.

DISCUSSION

Studies on the breeding biology of the Pallid Swift are scarce, while we have many accurate works concerning the Common Swift; outside Piedmont, the main contributions to Pallid Swifts breeding biology were carried out in Gibraltar (Finlayson *in* Cramp, 1985) and in Corsica (Thibault *et al.*, 1987); to these we shall refer for comparison.

Arrivals, first and second broods and departures from colonies in Piedmont take place 30-40 days later than in Gibraltar, southern Spain and North Africa (Finlayson *in* Cramp, 1985; Rodriguez de los Santos and Rubio Garcia, 1986).

Table 7. **Breeding success of Pallid Swift in Gibraltar** (Fynlayson, 1979 *in* Cramp, 1985) **and Corsica** (Thibault *et al.*, 1987).

	a	c	d	e	c/a	d/c	e/c
Gibraltar							
I brood	19	55	48	28	2.89	87	53
II brood	22	43	28	13	1.95	65	30
Corsican Islets							
I brood	39	99	92	83	2.54	93	84
No second brood (1)							

(1) only 8 clutches (3% of 249) in September: all failed.

This delay matches well with the onset of springtime, which occurs about 4-5 days later for each northward shift of one degree of latitude (Hopkins, 1938 *in* Perrins, 1985), scoring 36-45 days for the nine degrees separating Gibraltar from our research area.

In the Corsican islets we can see a shorter stay, since the arrival of the birds is first seen at the end of April and they tend to migrate during September (24 April - 5 October) (Thibault *et al.*, 1987); even the start of laying occurs a little later compared with the Piedmont data.

Comparison of reproductive parameters with Gibraltar and Corsican data (summarized in Table 7) shows:

a) a higher hatching rate in both southern populations;
b) a slightly lower fledging rate (statistically not significant) in Gibraltar;
c) a much higher fledging rate in Corsica ($chi^2 = 17.23$, $P < 0.001$).

For a better evaluation of productivity as a whole, it should be remembered that in Piedmont only 34% of the pairs lay, on average, a second clutch and only half of them breed successfully.

These values are lower than those recorded in Gibraltar (respectively 63 and 31%). The difference in percentage between pairs laying a second clutch in the two areas is not, however, singificant, nor is the difference between the contribution to the total of young fledged yearly by second broods in Piedmont and Gibraltar (14% and 22% respectively). Moreover, equivalent values for

Table 8. Breeding success of different populations of *Apus apus*

	GB	CH	CS	I
Laid eggs	258	213	99	62
% hatching	74	76	70	72
% flying	58	65	62	58

(GB = Great Britain, Lack and Lack, 1951b; CH = Switzerland, Weitnauer, 1947 *in* Cramp, 1985; CS = Czechoslovakia, Pellantova, 1975 *in* Cramp, 1985; I = Italy, Boano, 1979 and unpubl. data).

Saluzzo 1984 and Carmagnola 1983 are respectively 21% and 23%, the same for Gibraltar in 1979.

Nevertheless, it seems probable that, at the latitude of Piedmont, the consequent delay in breeding implies raising the young in full autumn, with a higher energetic cost of the second brood. Thus the breeding success of the second brood can be very low.

A different breeding strategy seems to be adopted by the breeding birds on the Corsican islets where no second brood is raised. Nevertheless, it is possible to see no lower production of young, thanks to the high success of the first brood.

Thibault *et al.* (1987) proposed that climatic conditions (heavy rains in October) jointly with the characteristics of the natural nesting sites (more exposed to rain) on the islets, could be the cause of this peculiar behaviour. In the nearby town of Bastia the same authors found the Pallid Swift double breeding in buildings.

Given the double-breeding possibility of the Pallid Swift, we can expect a higher production in comparison with the Common Swift, which breeds only once. In fact, we noticed that hatching and fledging rates are similar to those found for the Common Swift in many European countries ((Table 8). Since the parameters of breeding success are practically the same for the two species at the first brood, the second brood should then allow the Pallid Swift a yearly production of young larger than that of the Common Swift.

Nevertheless, considering:
- that in some years the number of pairs that stays for a second brood can be very small,

- that young that fledge in late November suffer from a high mortality due to food shortage and low temperatures,
- that adult mortality is probably higher due to a larger energetic expense, then the advantage of the second brood at our latitude can be outweighed.

The breeding biology of the Pallid Swift appears to be very different from *Apus apus*, especially for what concerns the number of broods per year and the pattern of the breeding season. In this sense *A. pallidus* fits perfectly in a trend common to members of the genus *Apus* where there is a reduction of the number of yearly broods, from species breeding at equatorial latitudes to those reaching higher latitudes. At the extremes we find that *Apus caffer* with an Ethiopian distribution is triple-brooded and the Eurasian *Apus apus* has only one brood per year (Cramp, 1985).

According to Lack and Lack (1951b), this pattern is probably due to food availability, which is restricted in northern regions to a short summer period and, conversely, is extended to the entire year in equatorial regions.

The double breeding of Pallid Swift could then be considered as a "southern" life history trait of the species, a peculiarity indeed restricting the chances of an expansion of its breeding range further north; the breeding strategy of the Common Swift, with only a single, highly synchronized brood per year, appears to be the best fit for northern climates.

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SUMMARY

A large population of Pallid Swifts breeds in some towns of Piedmont (NW Italy) under continental climate. Arrival and departure dates, nest fidelity, breeding season and breeding success were here studied in two towns (Carmagnola, province of Turin and Saluzzo, province of Cuneo). The birds begin to arrive in the first half of April and the last ones leave the region only in November or in the first days of December. Some pairs raised two broods. The first clutch is laid from mid-May to July, with most in the first half of June (second half of June in some years). In July some replacement clutches are laid, but true second clutches started in September, when a highly variable percentage of birds (on average 34%) nest for a second time. The breeding success of the first brood is very similar to that of the Common Swift; the autumn breeders suffer, on the contrary, a high failure rate and their contribution to the annual reproduction rate is often very low.

The results are compared with other studied populations of Pallid Swifts (Gibraltar and Corsica) and with some aspects of the breeding biology of the Common Swift.

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RESUME

Une importante population de Martinets pâles niche dans certaines villes du Piémont (nord-ouest de l'Italie) où règne un climat continental. Les dates d'arrivée et de départ, la fidélité au nid, la saison et le succès de nidification sont analysés pour deux villes (Carmagnola, province de Turin,

et Saluzzo, province de Cuneo). Les martinets arrivent à partir de la première moitié d'avril et les derniers quittent la région en novembre, voire dans les premiers jours de décembre. Deux nichées sont réalisées par an. La première ponte est déposée de mi-mai à juillet, avec un maximum dans la première moitié de juin (seconde moitié de juin certaines années). Des pontes de remplacement peuvent être trouvées en juillet, mais la seconde ponte régulière ne commence qu'en septembre, lorsqu'un pourcentage hautement variable d'oiseaux (x = 34%) entame une deuxième nidification. Le succès reproductif est similaire à celui du Martinet noir pour les premières nichées. Un taux d'échec important caractérise les secondes pontes dont la contribution à la productivité annuelle est souvent faible. Les résultats sont comparés avec ceux d'autres études de cette espèce (Gibraltar et Corse) et avec certains aspects de la biologie de la reproduction du Martinet noir.

SAMENVATTING

Een grote populatie Vale Gierzwaluwen broedt in enkele steden van Piemont (noordwest Italië). Het klimaat is er continentaal. Aankomst en vertrek, trouw aan de broedplaatsen, verloop van het broedseizoen en broedsucces werden bestudeerd in twee steden (Carmagnola, provincie Turijn en Saluzzo, provincie Cuneo). De eerste aankomsten situeren zich in de eerste helft van april en de laatste vogels verlaten de streek slechts in november of tijdens de eerste dagen van december. Elk jaar worden twee broedsels grootgebracht. Het eerste legsel wordt van midden-mei tot juli geproduceerd met een maximum in de eerste helft van juni (in sommige jaren in de tweede helft van juni). In juli kunnen enkele vervanglegsels worden aangetroffen, maar het begin van de tweede leg valt slechts in september, wanneer een sterk variërend percentage van de vogels (gemiddeld 34%) voor een tweede maal broeden. Het broedsucces van het eerste broedsel is vergelijkbaar met dat van de Gierzwaluw. Het tweede broedsel kent daarentegen weinig succes en de bijdrage ervan tot het jaarlijks voortplantingscijfer is dikwijls zeer laag. De resultaten worden vergeleken met die van andere bestudeerde populaties van de Vale Gierzwaluw (Gibraltar en Corsica) en met bepaalde aspecten van de broedbiologie van de Gierzwaluw.

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