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The Autumn Migration of the Red Kite *Milvus milvus* through the Pyrenees

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ABSTRACT

Since 1981, the French association «Organbidexka Col Libre» has been conducting a monitoring of transpyrenean migratory species; in this purpose, four passes (Lizarrieta, Lindux, Organbidexka at the western extremity, and Eyne on the eastern part of the chain) were shown to have a major importance. Within the Order Falconiformes, the Red Kite was the first species to be monitored. Most Red Kites migrate between early September and mid-November, and they cross the Pyrenees essentially via the western part of the chain, the passage at Lindux seeming the most dependent on meteorological conditions. Birds tend to travel during the hottest hours of the daytime, as other soaring species do. Red Kites are generally gregarious on passage. Except at Organbidexka where suitable places are scarce, they congregate in large numbers before roosting. Juveniles would migrate later than older individuals, although their migratory activity is spread over the same period.

Concerning demographic trends, the numbers of transpyrenean Red Kites have been declining since 1990, probably due to a decrease of the survival rate in this species. As the location of the wintering areas north of the Pyrenees is well known, it would be easy to perform censuses of the North Pyrenean wintering populations. Consequently, the Red Kite appears as a choice example as part of a monitoring of transpyrenean migratory species. However, taking into account meteorological variables would yield more accuracy to our estimates.

INTRODUCTION

Millions of birds fly through the European continent every year before reaching their wintering areas.

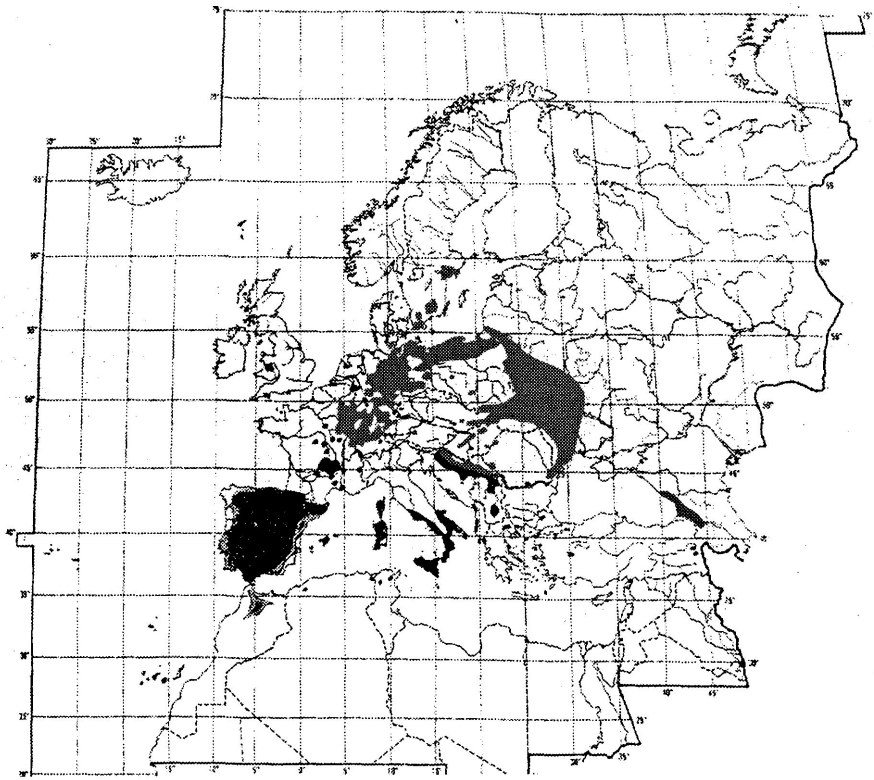
Soaring birds in Europe utilize three main flyways on passage: (i) birds from eastern Europe and western Asia cross the Bosphorus and the Middle East (Israel) and spend the winter in East Africa; (ii) birds from central Europe utilize the central flyway (Sicily, Malta and Tunisia); (iii) birds from western Europe and western Russia travel over the western flyway; some of them aiming for Iberia and the others crossing the Straits of Gibraltar to winter in Africa. The species involved can differ from one flyway to another (Finlayson 1991).

The French association «Organbidexka Col Libre» has based its work on the previous studies in Sweden (Falsterbö, Ottenby) (Edelstam 1972, Ulfstrand *et al.* 1974, Roos 1978 & 1985,) , in Spain (Gibraltar) (Bernis, 1980) and in the United States (Hawk Mountain, Pennsylvania) (Broun 1949, Spofford 1969, Nagy 1977, Roberts 1984) and has been conducting a monitoring of some transpyrenean migrants since 1988. Before carrying out this project, it was necessary to know the way in which the species behave while crossing the Pyrenees, the main sites of passage, the proportion of individals which cannot pass because of unfavourable meteorological conditions and are drifted from one site to another. The species studied are the Black Stork *Ciconia nigra*, the White Stork *C. ciconia*, diurnal raptors, the Crane *Grus grus* and two Columbiform species, the Wood Pigeon *Columba palumbus* and the Stock Dove *Columba oenas*.

Within the Falconiformes, the Red Kite *Milvus milvus* was the first species to be monitored. It appears as a vulnerable species, due to its confined range (Fig. 1). The *milvus* subspecies breeds almost exclusively in Europe. The breeding range of the most important non-Iberian populations lies approximately from southern Sweden to southwestern France, via Germany. There are other small populations in Poland, Latvia, Lituania, Byelorussia and Ukraine. Austria, Hungary, Roumania and ex-Yugoslavia also shelter a few dozens of pairs. In southern Europe, the Red Kite breeds in Italy and in the Iberian Peninsula. It also breeds in Mograb, but in limited numbers. The *fasciicauda* subspecies breeds in the Cape Verde Islands but its populations are close to extinction (Cramp & Simmons 1980, Gensbol 1988).

The Red Kite is a partially migratory species, which winters north of the Sahara. Its main winter quarters are situated in the western Palearctic (Cramp & Simmons 1980). Very few individuals seem to cross the Mediterranean: less than ten were seen between 13 August and 8 October 1971 at the Bosphorus (Acar *et al.* 1977); likewise 11 migrants were recorded

Figure 1. Distribution range of the Red Kite *M. milvus* (After Cramp & Simmons 1980).



in 1981 at Suez, Egypt (Bijlsma 1981). A small number of birds join Tunisia via the Strait of Messina and Cap Bon. Bernis (1980) has counted 24 to 103 individuals at Gibraltar (in 1977 and 1974, respectively). Moreover data from ringing recoveries confirm the high prevalence of the west-European flyway, including birds from Harz, Germany (Meineke & Gatter 1982). Records from centro-European individuals wintering in Britain, Austria, Italy, Sicily, Sardinia, Roumania and Balkans seem to be scarce (Bernis 1974, Bernis 1980, Géroudet 1984, Cramp & Simmons 1980, Stubbe 1982, Schonfeld 1984).

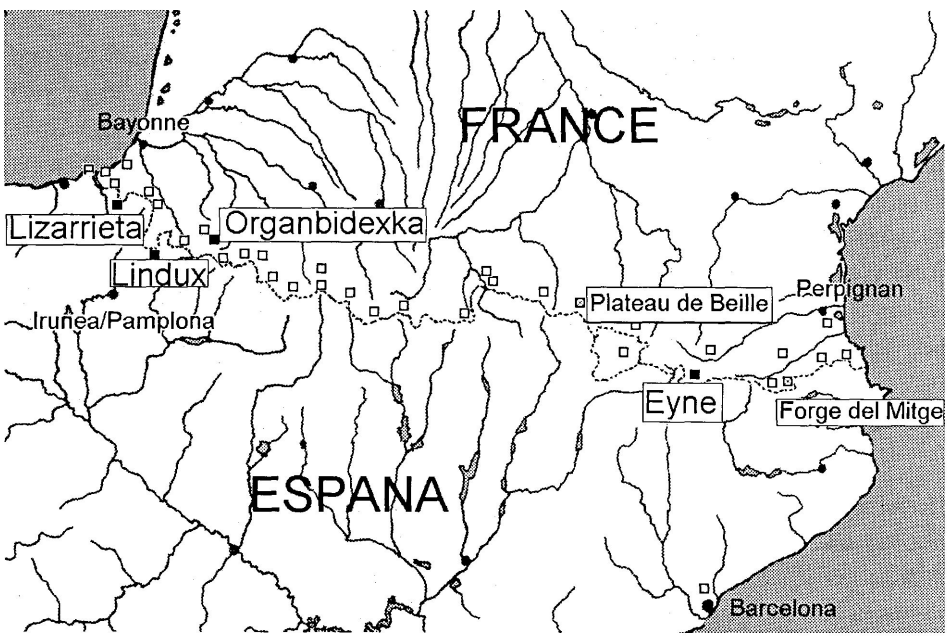
STUDY AREA AND METHODS

The Pyrenees spread between the Atlantic Ocean and the Mediterranean Sea. As they are approximately oriented from west to east, they represent a barrier. Birds which arrive at the foot of the northern slope usually travel at low or moderate altitudes. Soaring species rise in the air only if they are constrained or if they can benefit from peculiar meteorological conditions, i.e. thermals, temperatures, winds. So, they can either fly over the obstacle or round it.

Situations which favour a migratory activity across the Pyrenean chain are scarce: frequent Atlantic depressions cause strong westerly winds to blow, bringing clouds, so that the visibility in valleys is reduced. Southerly winds also blow very often, and they make raptors reluctant to fly against them. Consequently many birds skirt the chain until they find a valley which is approximately oriented southwards and where visibility conditions enable them to reach the Spanish slope easily.

Since 1979, Organbidexka Col Libre had been prospecting 36 sites or valleys throughout the chain in order to identify the main transpyrenean flyways (Fig. 2). A comparison of the number of migrants at each locality has shown that four sites had a major importance. These sites gather almost one million pigeons (25 to 30% of the migrating flow) and 60,000 to 70,000 raptors, the latter belonging to 19 regular species, plus 9 irregular or vagrant species: the Plateau d'Eyne is situated above the Tet valley, which issues at the Rio Segre in Catalonia. The field work at this locality has been carried out from 1987 until 1991. The three other sites are in the Basque Country: Organbidexka Pass, in Haute-Soule; Lindux Mountain, where the Aldudes and Valcarlos valleys join each other; and Lizarrieta Pass, above the Cuvette de Sare. Our survey has been conducted at Organbidexka since 1981, at Lindux and at Lizarrieta since 1988. Considering all sites, the time devoted to

Figure 2. Pyrenean sites prospected, and situation of the six main ones.



observation corresponded to more than 250,000 observer-hours.

Migrants have been identified and numbered by visual obsevation, using binoculars and telescopes (for details and applications to other species, see Devisse & Urcun, 1994.). At the same time it was necessary to collect data concerning 28 parameters (17 for meteorological conditions, 7 for each bird observed and 4 for the sampling methods. These parameters are summarized in Table 1. (For details, see Devisse & Urcun, 1994).

Table 1. Main variables collected during the field study of bird migration.

Meteorological variables	*Bird variables*	*Observer variables*
Direction of winds (ground, air)	Time when leaving the observation sphere	Number of observers
Wind speed (ground, air)	Species	Name (experience)
Minimal and maximal temperatures	Number of individuals	Assiduity
Diurnal temperature	Sex and age (if possible)	Detection
Meteors (type, duration, quantity)	Status (migrant, resident)	
Clouds (type, altitude, extent of cover)	Particularities (pectoral bands, colour marks, moult)	
Visibility		

Concerning the longitudinal distribution of the transpyrenean passage, our results have been drawn from the following calculation (Sagot 1989): for each species (i) we pool data over all years y for each site i; (ii) the percentage of the flow over each site is given by the following formula:

$$P_i = \frac{N_i \frac{d_{y,O}}{d_{y,i}}}{\sum_i N_i \frac{d_{y,O}}{d_{y,i}}}$$

where $d_{y,O}$ is the number of working days at Organbidexka (where the study has been conducted since the longest period of time), $d_{y,i}$ the number of working days at each site during the period of migration in this species, and N_i the number of individuals observed at the site.

Two age classes have been determined: juveniles (first year) and «old» (more than one year old) individuals. Age-ratios have been calculated by dividing the number of juveniles by the number of birds of known age (juveniles and «old» birds). Juvenile Red Kites have greater and lesser coverts tipped white on both upper- and underwing, and a paler body. Furthermore in some cases, their outer primaries have not yet completed their growth, so that the trailing edge of the wing is not parallel to the leading edge (Cramp &

Simmons 1980, Gensbol 1988).

The top-day has been defined as the day when the greatest number of migrating individuals has been counted.

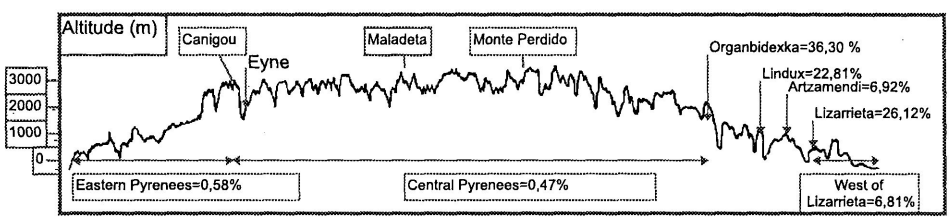
For all tests, probability levels<0.05 were considered significant. Hours are GMT ones.

RESULTS

Flyways utilized during transpyrenean migration.

The passage took place essentially in the Basque Country. The central and eastern Pyrenees only gathered 1% of the theoretical flow of migrants, whereas 85% of birds crossed the chain via Lizarrieta, Lindux and Organbidexka Passes (Fig. 3). The repartition of the flow between the different Basque sites depended on meteorological conditions. Nevertheless it did not vary very much in the course of the years. Organbidexka was the major locality (39 to 59% of the western passage). Lindux and Lizarrieta each gathered from 20 to 33% of the western passage.

Figure 3. Distribution of the passage of Red Kite throughout the Pyrenees.

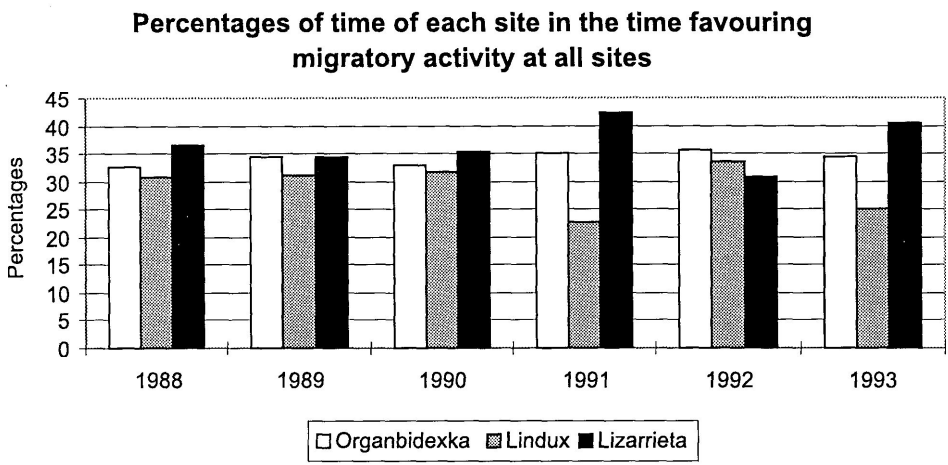


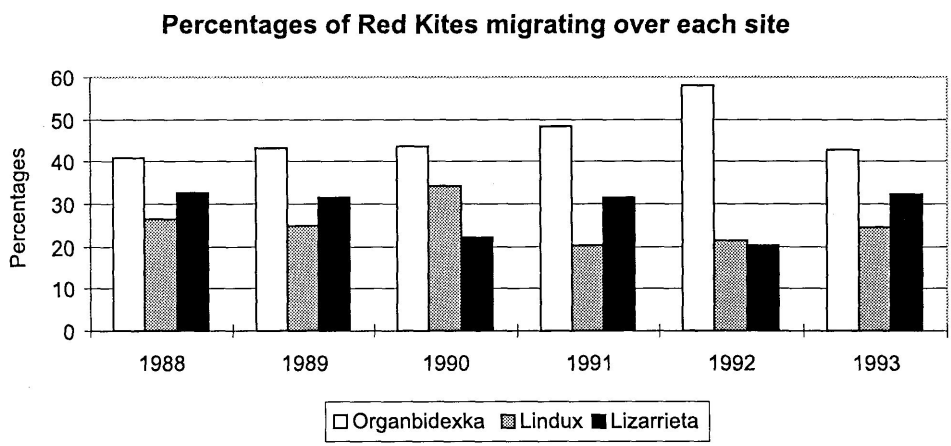
When the weather conditions at Organbidexka were unfavourable, birds tended to head westwards to pass via Lindux, if possible. Otherwise, they drifted to Lizarrieta, at the extremity of the chain. A similar phenomenon occurred when the meteorological situation at Lizarrieta was bad, birds tending to move eastwards (Fig. 4). So the occurrence of the passage at Lindux appeared as the most dependent on weather conditions.

Seasonal timing.

Migration occurred from early September until mid-November (Fig. 5). Very few individuals were recorded as migrants before 15 August. They were probably immatures or non-breeding adults.

Figure 4. Distribution of passage with respect to meteorological conditions on the main western sites.





There were three main periods: at the end of September, during the second week of October and after 20 October. During the latter period, movements were less intensive.

Concerning Lizarrieta, it is to be noted that field work could not be carried out during the entire period of migration in 1994, due to the lack of observers. So, if we consider the main western sites during the 1988-1993 period (Table 2), the top-day did not take place at the same dates from one year to the next; the proportion of the flow involved seldom exceeding 30%. By contrast, the dates when 10%, 50% and 90% of migrants have been recorded were relatively constant. At Lizarrieta, migrants might be concentrated within a shorter period than at the other western localities and migratory activity

Figure 5. Seasonal timing, all sites, all years.

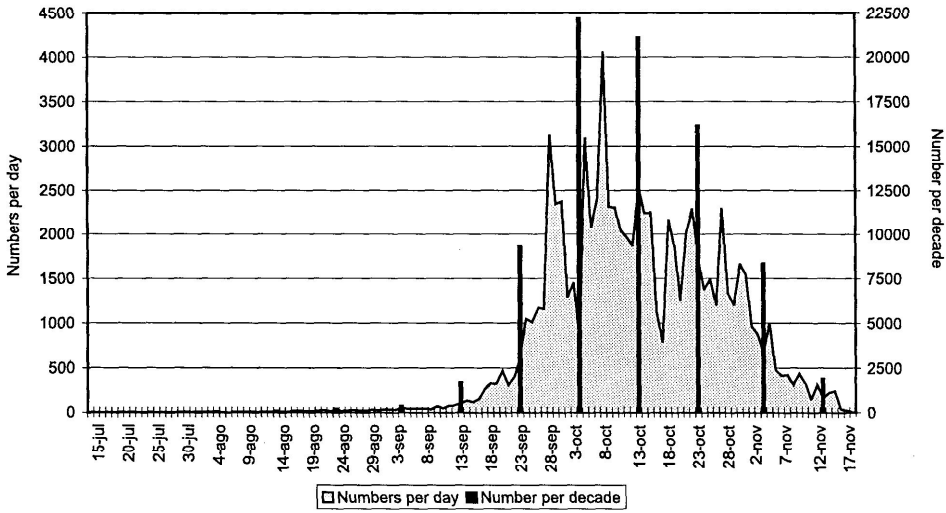


Table 2. Phenology of the migration of Red Kites at the three main Basque sites (n=6 years, from 1988 until 1993). The Duration column corresponds to the period situated between 10% and 90% of passage. Multiple comparison Tukey's test: * mean values for Lizarrieta and Organbidexka differ significantly from one another, but not from that for Lindux; *° significant difference between Lizarrieta and the other localities ($P<0.05$).

	10% of passage	*50% of passage*	*90% of passage*	*Duration (days)*	*Top-day*
Organbidexka	29 Sptember±3.3	15 October±5.1	2 November±2.4	34±4.1	19 October±9.2
Lindux	30 September±4.5	14 October±6.1	2 November±6.32	33.3±2.4	11 October±8.0
Lizarrieta	5 October±3.9	16 October±6.5	30 October±4.3	24.3±6.6	15 October±9.7
ANOVA					
Kruskal-Wallis test	$F_{2, 15}$=4.72*, P=0.026 H_2=5.89, P=0.053	$F_{2, 15}$=0.27, P=0.767 H_2=0.30, P=0.858	$F_{2, 15}$=2.18, P=0.148 H_2=2.90, P=0.234	$F_{2, 15}$=5.22*°, P=0.019 H_2=5.97, P=0.051	$F_{2, 15}$=1.14, P=0.346 H_2=2.39, P=0.303

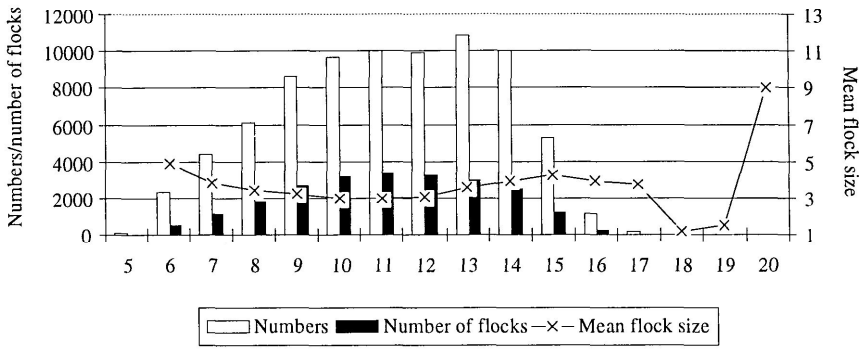
might start later than at Organbidexka (for statistics, see Table 2).

The passage at Eyne seemed to occur earlier than in western Pyrenees: 10% of the flow has been recorded on 10 September, 50% on 25 September and 90% on 10 October.

Horary timing.

Red Kites tended to migrate between 9.00 and 14-15.00 GMT (Fig. 6). The passage was significantly less abundant before 7.00 and after 15.00 at Organbidexka from 1981 until 1994, and at the three main western localities between 1988 and 1994 (ANOVAS gave respective values of F: $F_{12, 163}$=46.1, $P<0.0001$, Tukey's test: df=163, $P<0.05$ and $F_{15, 77}$=18.96, $P<0.0001$, Tukey's test: df=77, $P<0.05$).

Figure 6. Horary timing, allsites, all years.



Size of flocks.

Red Kites tended to be more gregarious during the period of intensive movements (Fig. 7). The mean flock size increased steadily from the second decade of September, becoming largest in October (ANOVA: $F_{12, 138}$=23.2, P<0.0001, Tukey's test: df=138, P<0.05), some groups involving up to 100 individuals. The birds passing before 1 September were solitary in most cases. Flocks were also largest between 6.00 and 8.00, except at Organbidexka, and between 14.00 and 16.00 (For the western sites, between 1988 and 1994: ANOVA: $F_{15, 75}$=5.93, P<0.0001, Tukey's test: df=75, P<0.05; see also Fig. 6).

Seasonal variations of the age-ratio.

Variations per decade were significant (ANOVA: F12, 135=3.85, P<0.0001). On the whole, the age-ratio seemed to decrease with time (Fig.

Figure 7. Seasonal variations of mean flock size, all sites, all years.

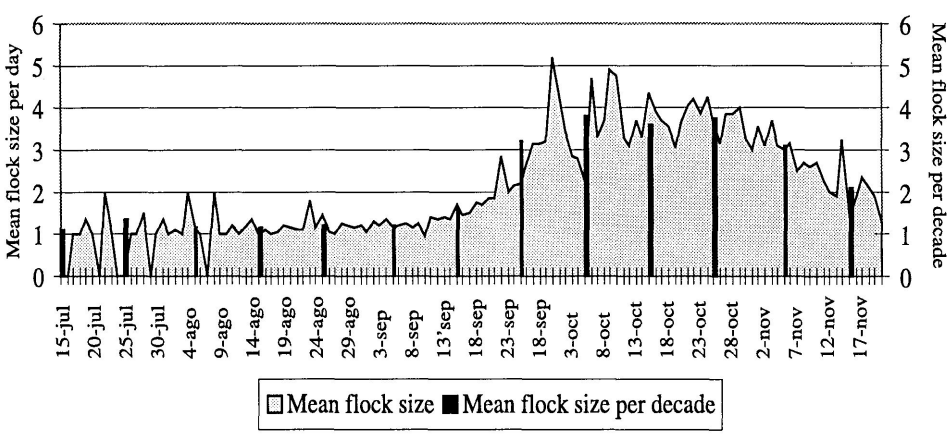
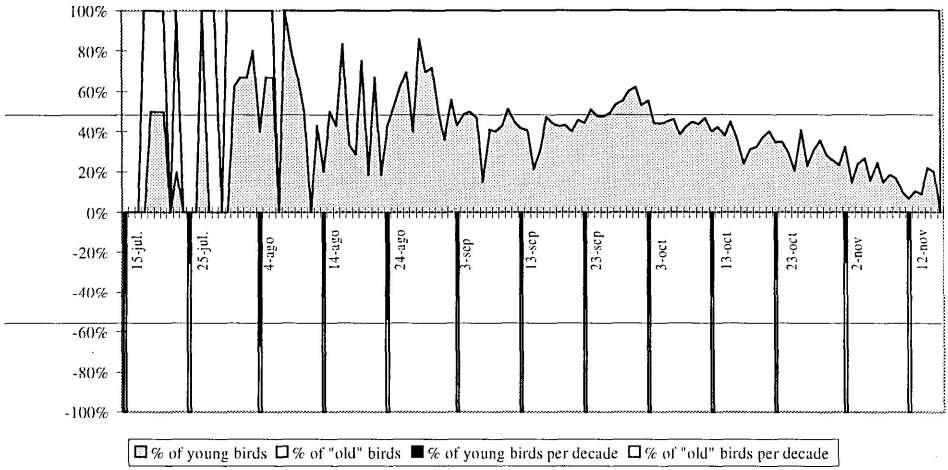


Figure 8. Seasonal variations of the age ratio, all sites, all years.

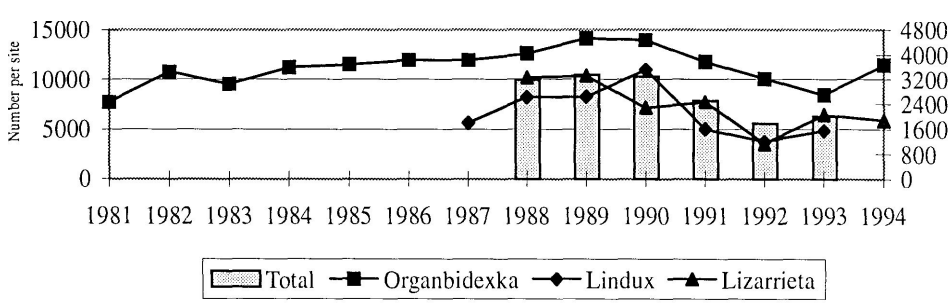


8), the highest values in August (Tukey's test: df=135, $P<0.05$) corresponding to the dispersal of the local fledglings. The migration period of juveniles was spread over the same period as that of older birds. However young birds showed a slight tendency to concentrate in late September and early October.

Demographic trends.

The passage at Organbidexka was increasingly important until 1989-1990. Then a dramatic decrease (39% between 1990 and 1993, see Fig. 9) has been occuring at all sites. Likewise, the values of the age-ratio (mean: 41.7±9.4%, n=14 years) were lowest in 1991, 1992 and 1994 (35.2, 30.7 and 30.0% respectively, data pooled over the three western sites). However, there was no correlation between the age-ratio and the number of migrants annually recorded (Spearman rank correlation coefficient, Organbidexka: r_S=-0.32, $P>0.2$, three main western sites: r_S=-0.063, $P>0.5$, both n=14 years), the

Figure 9. Interannual variations of the number of Red Kites migrating via the three main western sites.



proportion of juveniles varying in any direction from one year to the next, although significantly (c^2_{13}=188.4, P<0.0001, data pooled over the three western sites).

DISCUSSION

Phenology and population dynamics.

Red Kites travel towards the southwest. Like other soaring species, they tend to migrate during the warmest period of the day. As they migrate late in autumn, they cannot rely on thermals; so they cross the Pyrenees at a low altitude, via the western extremity. Concerning the mean flock size, horary variations can be explained by the roosting phenomenon. As there are very few places suitable for roosting north of Organbidexka, the kites recorded in the morning at this locality have not been able to congregate in large groups before the previous night and before taking off at dawn. But on the whole, Red Kites seem to be gregarious on passage, so that is difficult to know whether a solitary individual observed before September is a migrant or not, because of the presence of a resident population at the foot of the northern slope of the western Pyrenees. The dispersal of fledglings also takes place at the same time, so that the values of the age-ratio in August may be overestimated. Nevertheless, very few individuals seem to be concerned. Consequently, the errors caused by these phenomena are negligible and have not been taken into acount in the study of the population dynamics and the migrating behaviour in this species, which partially winters north of the Pyrenees.

Concerning the latter point, data from ancient studies are available: Red Kites can remain in Sweden (Ulfstrand 1970), West Germany (Ortlieb 1982, Wuttky *et al.* 1982) or in Switzerland (Juillard 1972, 1977). However, the main wintering area is situated in France, especially at the foot of the western Pyrenees where the wintering population size has been estimated between 1000 and 1500 individuals (Sagot, 1991). Much fewer birds (200 to 400) winter in eastern France (Riols, *in litt.*) or in Auvergne (Lallemand, com. pers.). More and more Red Kites have been wintering north of France and in northern Europe for several years, but this phenomenon concerns a very little part of the population only (Gensbol 1988). Consequently, the changes occurred in the overwintering strategy of this species are not sufficient to explain the decrease of the number of migrants since 1990. Although censuses conducted were not exhaustive, the size of the wintering populations in the Basque Country does not seem to have increased at the same time. The values of the age-ratio on the Basque sites were very low in 1991, 1992 and 1994, but no correlation was found between the age-ratio and the number of migrants annually recorded, suggesting that the decline of the transpyrenean numbers

would be caused by a decrease of the survival rate rather than by a higher rate of breeding failures.

Monitoring the transpyrenean migrating population of Red Kites.

The Red Kite has been known as a transpyrenean migratory species for a long time. Miègemarque (1902) had observed groups involving 50 to 100 individuals in the Pyrénées-Atlantiques region. Hainard (1950) noted passage via Gavarnie, in the central part of the chain. Lack and Lack (1953) recorded individuals passing throughout the chain, but they only spent a few days on the western part in October. Ashmole *et al.* (1957) observed 37 migrants at Gavarnie during a 15 days study. Finally, Vignes (1981, *in litt.*) carried out a study from 4 October until 15 November and from dawn to 13.00. His estimates were about one hundred individuals. For the first time, our results provide information about the pattern of migration in this species. However, the shape of the seasonal curve for each site varies from one year to the next, depending on meteorological conditions; only two peaks, or even one main peak and two little ones can occur, movements being concentrated within a shorter period (Bried 1992). Moreover, our data suggest a different geographical origin of the individuals recorded over the eastern part of the chain. At last, they show that more than 95% of migrating Red Kites cross the Pyrenees via the western extremity, even if the calculation performed by Sagot (1989) in order to estimate the passage over the different sites (see Study area and Methods) minimizes the importance of «ancient» localities, where studies have been conducted during the entire period of migrartion and for several years. But as a compensation, the role of the sites where field work has been carried out during the period of intensive movements only or under optimal conditions, is overestimated. So, and on the whole, this mathematical model does not distort the reality too much. Furthermore, the location of the wintering zones is known, so that the size of the population wintering north of the Pyrenees could be easily estimated.

Consequently, the Red Kite seems to be a choice example as part of a monitoring of transpyrenean migrating species. However a study of the correlations between meteorolgical variables and the number of birds recorded (migrating and wintering individuals), and a calculation of the theoretical numbers which would allow for the days when the meteorological conditions are favourable, would yield more information, so that our estimates could be more accurate.

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