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FACTORS CHARACTERIZING THE DISTRIBUTION OF THE SPOTLESS STARLING (*STURNUS UNICOLOR* TEMMINCK) IN CORSICA

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Abstract. The distribution of the Spotless Starling in Corsica was studied during the reproductive period of 1993 in order to determine the factors influencing the presence of breeding birds. We also tried to assess the number of reproducing pairs. The species is mainly found in intensively cultured pastures at low altitudes (below 860 m) with on average medium to high coverage of grazed area and where high and medium high maquis (wild scrub of Mediterranean lands) are scarce or absent. Although fruit cultures could be linked with the presence of reproducing birds, their influence appears to be of secondary importance. The number of reproducing birds in Corsica was estimated around 2500 pairs.

Key words: Spotless Starling, distribution, reproduction, agriculture.

INTRODUCTION

The Spotless Starling, *Sturnus unicolor* Temminck, 1820, is a west Mediterranean species present in Algeria, Tunisia, Morocco, the Iberian Peninsula and the larger west Mediterranean islands: Sicily, Sardinia and Corsica (CRAMP, 1994; YEATMAN-BERTHELOT, 1994). The Spotless Starling and the European Starling, *Sturnus vulgaris* Linnaeus, 1758, are sympatric in Catalonia (PERIS *et al.*, 1987, FERRER *et al.*, 1991). The sympatric area is still expanding through a constant progression of the Spotless Starling to the north. The species has been observed in France (Aude and Pyrénées orientales) since 1983 (CAMBRONY & MOTIS, 1994; KAYSER & ROUSSEAU, 1994; YEATMAN-BERTHELOT, 1994).

In Corsica the Spotless Starling is described as « common, but sparsely distributed » (YEATMAN, 1976; THIBAULT, 1983; CRAMP, 1994).

Our aim was to localise the actual breeding areas of the Spotless Starling throughout the island, look at densities and try to make an estimation of the Corsican population. We analysed the relationship of the birds with the agricultural land use.

METHODS

The study took place in 1993 from late March until mid-July. During the breeding season male Spotless Starlings sing very loudly. We mainly used this far-reaching song to determine the presence of starlings. We surveyed the different regions by car making regular stops of maximum 30 minutes duration. If no starlings were observed (binoculars 10X40) or heard during this period, we considered the species as absent. We revisited the regions where the Spotless Starling was noted absent, if previous reports mentioned the observation of breeding birds, if the region was neighbouring a colonised region or if the landscape offered apparently suitable habitats (absence of high dense vegetation). These searches took place between sunrise and 11.00 and from 17.00 until sunset, periods of enhanced activity (RENARD unpubl. data). Large forests (Vizzavona-Quensa-Ospedale) were excluded from our surveys because they did not offer any areas suitable for reproduction or feeding of the starling. Castagniccia was not surveyed because an intensive inventory of the region did not mention the presence of the Spotless Starling (PATRIMONIO, 1991). Castagniccia is mainly covered with chestnut forest (*Castanea sativa*), and offers very few open places for starlings to forage.

At each stop we described the possible presence of the Spotless Starling and the different landscape characteristics (see Table 1 and below for detailed description). Every observation was quantified in order to analyse the data statistically. Males were counted and categorised in four groups: no males present (= 0), isolated couple with one male (= 1), small colony composed of 10 males or less (= 2) and large colony with more than 10 males (= 3). The vicinity of other Spotless Starlings was described using the same categories according to the number of males observed during previous or following observation stops. We always used the highest observed neighbouring density in the analysis. For the presence of man-made constructions we used four groups. The division of the groups was based on the number of construction items. When no building was present, the landscape was categorised in category 0. One construction item consisting of a house with stables, stables alone, chapels, etc. was labelled category 1. Several houses with stables etc. not yet a village were categorised as 2. The last category (3) contained villages. (We defined a village as a central place surrounded by different houses.) Cities were categorised under villages, as the size difference was not always obvious and some cities actually consisted of several congregated villages. The observations were noted separately for ruins, old houses and recent constructions. We estimated the relative presence of the different types for villages and smaller construction groups. To describe the agricultural activities, we first divided the observations in two main groups: livestock and cultures. To determine the possible influence of farm animals we used the number of observed grazers during our search for starlings. In the analysis we made four categories according to the observed number and the species (2 groups). The observations ranged from absent (category 0), less than seven animals (category 1), small herd (counting possible, category 2) to large herd (counting not possible, category 3). For the species category goats and sheep were considered together as we mostly observed mixed herds, the other group contained cattle. Free roaming horses and pigs were not taken into account because of their small numbers. The vegetable, fruit and other cultures were noted if present (vineyard, orchard,

TABLE 1

Analysed environmental parameters noted during each observation stop

Groups	*Observed parameter*	*Quantification*
Birds	Estimation	0: absent 1: isolated couple (1 male) 2: small colony (2-10 males) 3: large colony (>10 males)
	Vicinity of other colonies	Number of observed males during previous or following observation stop. Categories as for estimation of bird numbers 0-3.
Constructions	Old Recent Ruin	0: no constructions 1: 1 item 2: small number (not a village) 3: village
Agricultural activity	Animals – sheep and goats – cattle	0: absent 1: less than 7 animals 2: small herd (counting possible) 3: large herd (counting not possible)
	Vineyard Orchard Olive grove Citrus Almond Kiwi Vegetables Maize Cereal Chestnut Hayfield Cork-tree	0: absent 1: present
Vegetation	Deciduous tree Conifer	0: absent 1: groups 2: groves 3: woody
	Grazing Intensively cultivated pasture Semi-intensive pasture with scrubs Wild pasture Low maquis (<50cm) Medium maquis (50cm-120cm) High maquis (>120cm)	0: <15% 1: 15%-50% 2: 50%-85% 3: 85%-100%
Geography	Altitude	Per 40 m

olive grove, citrus, almond, kiwi, vegetables, maize, cereal, chestnut, hayfield, cork-tree). The maquis vegetation was divided in three groups according to height: from low or medium to high maquis, not higher than approximately 50 cm, and 120 cm to higher than 120 cm. The presence of tree types (conifer and deciduous) ranged from complete absence (0) to groups (1), groves (2) and more or less woody (3). Grazing was quoted from 0 to 3. Zero corresponds with less than 15% grazed area, 1 with a grazed area between 15% and 50%, 2 with a grazed area between 50% and 85%, once higher than 85% we considered the area as completely grazed (=3). Pastures were categorised according to the degree of maintenance (three groups) into intensively cultivated, semi-intensively cultivated with some scrubs, and completely wild. The presence of the pastures in the landscape was described by four categories (0:<15%, 1:15%-50%, 2:50%-85%, 3: 85%-100%). We noted altitude per 40 m (topographic maps of the Institut Géographique National Paris).

For the estimation of population density we only considered reproducing birds. Non reproducing birds were not taken into account because they were difficult to assess for following reasons. If a bird is sexually active but does not succeed in attracting a mate it usually flies around prospecting possible mates or cavities. Such birds could be taken into account several times thus giving an overestimation of the number of Spotless Starlings. Other not sexually active birds could simply be overlooked as their behaviour is less conspicuous.

The impact of the individual factors on starling presence/absence was analysed with a t-test with logarithmic transformations for the continuous data (Basic Statistics/Tables module of STATISTICA 5.0 Statsoft 1994) or a P^2 -test for unordered 2xC tables for the categorical data (StatXact 3, METHA & PATEL, 1995). Sequential Bonferroni correction (RICE, 1989) was applied to prevent type I error due to multiple testing.

Because many factors can be interdependent, we applied logistic regression models (GLIM 4, FRANCIS *et al*,. 1994) to reveal the factors influencing the presence of breeding birds. A backward stepwise variable selection was utilised to obtain the minimal adequate model (CRAWLEY, 1993). We tested both the logit link-function and the complementary log-log link-function (FRANCIS *et al.*, 1994). The categorical data were entered as factor variables in the model.

RESULTS

Using our observation of 1993 we compiled a distribution map of the Spotless Starling in Corsica (Fig. 1), projected on a map indicating roughly the main agricultural areas (ANON., 1989). We used the four categories described in the methods to indicate the colony size on the map. The nests could be found in natural as well as man made cavities (roofs, walls, etc.). Some isolated pairs in the surroundings of larger colonies are not mentioned on the map due to a lack of space. For the same reason dense vegetation patches (maquis) not colonised by the Spotless Starling but situated within densely populated areas were also omitted. Except for the Niolo, Corte and the basin of Ponte Leccia, the distribution of the Spotless Starling follows the coastal areas and incurving valleys. The distribution in coastal areas also coincides with rather flat areas

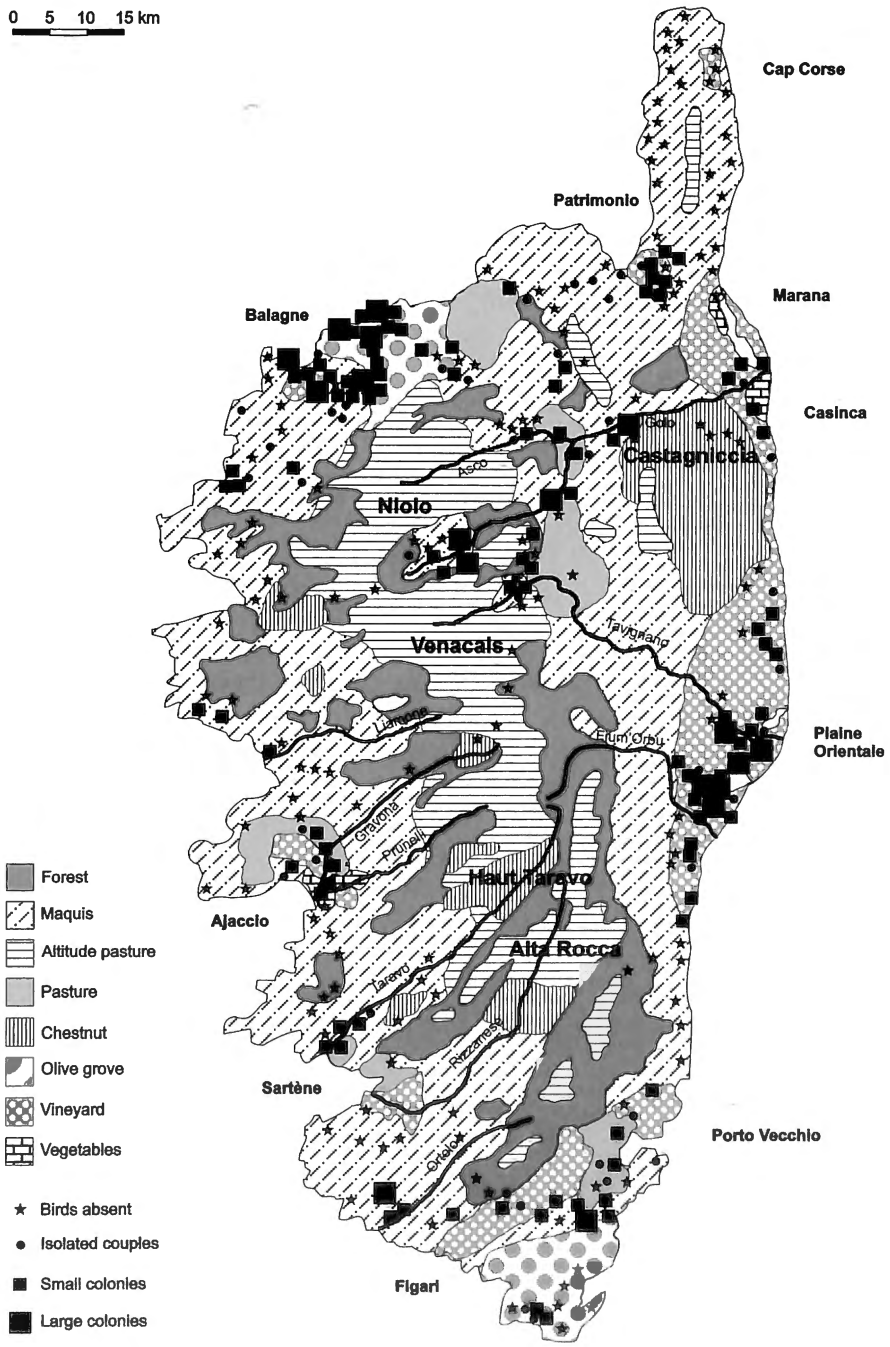

Fig. 1. – Distribution map of the Spotless Starling in Corsica during the breeding season of 1993.

(slopes less than 12%). The interior does not offer many plains, except for the Niolo. Here the Spotless Starling follows the less steep areas used as pastures. The highest Spotless Starling densities were found at the east coast and the Balagne; the Niolo can also be considered as a densely populated area as the birds were concentrated on a relatively small area (Calacuccia-Sidosi-Casamacioli). We estimated the total number of reproductive birds around 2500 pairs.

We analysed the factors determining the presence/absence of the Spotless Starling in Corsica during the reproductive period using all observation data of 1993 (Table 2). Some of the agricultural crops are only represented at a few localities (kiwi n=5, maize n=2, almond n=4) and could not be included in the analysis.

TABLE 2

*Impact of individual environmental parameters explaining Spotless Starling presence/absence. Data are summarised as mean ± SD. *: significant ($\alpha = 0.05$) after sequential Bonferoni) correction.*

Variables	*birds absent*	*birds present*	χ^2	*df*	*p*
Vicinity	0.78 ± 0.92	1.94 ± 0.78	90.954	3	<0.001*
Old constructions	2.35 ± 0.94	1.70 ± 1.14	26.499	3	<0.001*
Recent construct.	1.01 ± 0.99	1.18 ± 0.99	5.168	3	0.160
Ruins	0.84 ± 0.47	0.74 ± 0.49	5.140	3	0.162
Vineyard	0.13 ± 0.34	0.34 ± 0.48	16.123	1	<0.001*
Olive groove	0.06 ± 0.23	0.21 ± 0.41	12.151	1	<0.001*
Citrus	0.02 ± 0.16	0.13 ± 0.33	9.224	1	0.002
Orchard	0.03 ± 0.18	0.11 ± 0.31	5.241	1	0.022
Hayfield	0.04 ± 0.20	0.12 ± 0.33	5.264	1	0.021
Grazing	1.12 ± 1.36	2.04 ± 0.85	75.598	3	<0.001*
Pasture cultured	0.38 ± 0.81	1.61 ± 1.29	65.293	3	<0.001*
Pasture semi-cult.	0.55 ± 0.89	1.38 ± 1.03	42.783	3	<0.001*
Pasture wild	0.62 ± 0.88	0.83 ± 0.92	4.958	3	0.175
Deciduous trees	0.67 ± 0.97	0.17 ± 0.47	28.274	3	<0.001*
Low maquis	1.12 ± 1.15	0.83 ± 0.96	22.501	3	<0.001*
Medium maquis	1.37 ± 1.25	0.24 ± 0.63	72.036	3	<0.001*
High maquis	1.07 ± 1.31	0.03 ± 0.26	73.741	3	<0.001*
Sheep	0.63 ± 1.04	0.21 ± 0.64	15.823	3	<0.001*
Cattle	0.39 ± 0.76	0.28 ± 0.62	5.777	3	0.123
			t	df	p
Altitude	239.59 ± 281.59	133.54 ± 180.65	3.667	270	<0.001*

The presence of reproducing birds is limited by altitude as we never observed fledgelings or singing males above 860 m (Albertacce, Niolo). Significantly more birds were present at lower altitudes. Observations of nesting starlings were significantly greater near other Spotless Starling colonies (vicinity), which indicates an aggregated distribution. Old villages are significantly less favourable for reproduction of the Spotless Starling whereas recent buildings and ruins can be considered as neutral.

Olive groves and vineyards positively influence the presence of reproducing Spotless Starlings. Other orchards seem less attractive for the Spotless Starling during reproduction, only citrus fruit showing a significant positive association with the birds. Starlings are observed significantly more often in the immediate surroundings of pastures. Regularly mowed grass or extensive grass management (free roaming cattle, sheep and goat) (pastures) are very likely to offer all requirements for optimal reproduction of the Spotless Starling. As intensively grazed areas, where short grassland dominates, Spotless Starlings are also significantly more likely to be present. Hayfields with alternately (twice a year) short and high grasses are not suitable for starlings. The absence of deciduous trees significantly influences the presence of Spotless Starlings. Medium or high scrub vegetation (maquis) also repels reproducing birds. Finally, the presence of starlings was significantly associated with herds of sheep and goats, but not with cattle.

When all parameters are combined in the logistic regression model to extract the minimal adequate model, five remain in the model (Table 3). The parameter vicinity was not included in the analysis because this parameter is more an indicator that the birds were observed in a larger suitable area than it is of direct influence on the presence of the observed colony. The model shows that Spotless Starlings mainly occur in the vicinity of intensively cultured pastures at low altitudes (below 860 m) with on average medium to high coverage of grazed area and where high and medium high maquis are scarce or absent (Fig. 2).

TABLE 3

Factors affecting the presence of breeding Starlings: analysis of deviance table of the logistic model

Effect	*df*	*deviance*	$p(\chi^2)$
Maximal model	2571	184.87	
Altitude	3433	15.19	<0.001
Intens cultivated pasture	271	9.19	0.027
Grazed area		20.40	<0.001
Medium High Maquis		31.63	<0.001
High Maquis		31.96	<0.001
Null model		373.76	

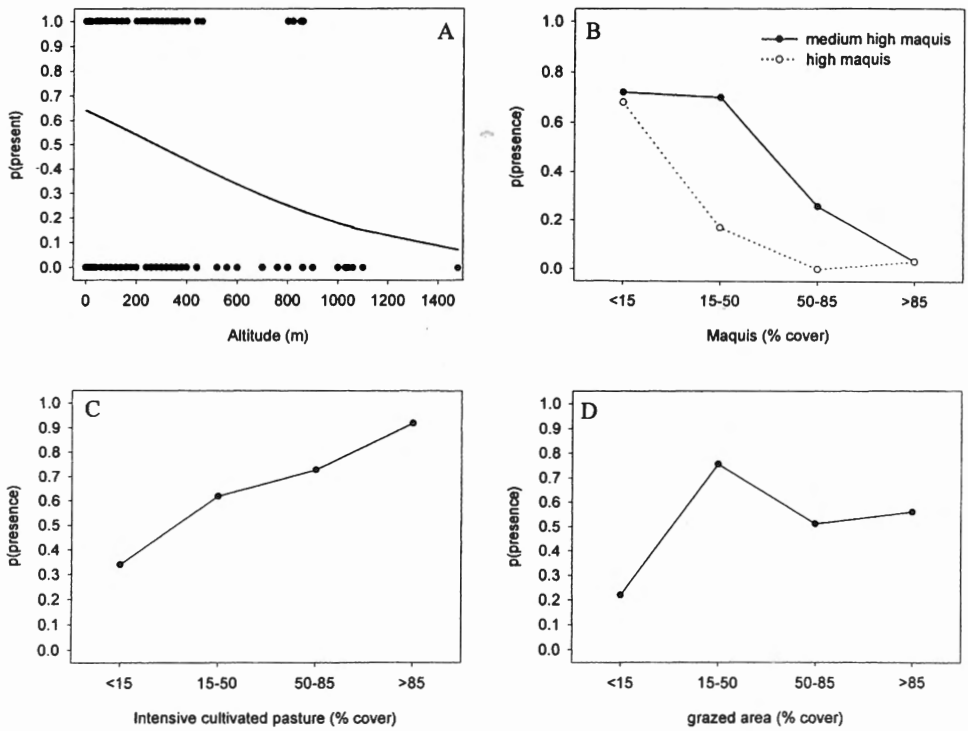

Fig. 2. – Environmental factors affecting the presence of breeding Spotless Starling

DISCUSSION

It appears the predominant factor affecting the presence of reproducing Spotless Starlings is the presence of low vegetation (intensively cultivated pastures without maquis or trees) in the immediate surroundings. It is only at a lower level that some fruit cultures (vine, olive, citrus) seem to predict the occurrence of Spotless Starlings. Some other studies concerning the distribution of the Spotless Starling in Mediterranean areas confirm our results and some contradict them. The Spanish Spotless Starling (MOTIS *et al.*, 1983) was found in every type of culture (olive groves, vineyards, almonds, etc.) and only the predominant presence of trees and scrubs stopped its expansion. Unfortunately no information is given on the period of the Spanish inventories. The period of inventory is important because during the non-breeding period, starlings tend to disperse and use other feeding sources. Our Corsican data confirm the Spanish data in that the absence of medium and high maquis had a positive influence on the presence of the Spotless Starling as did, but less pronounced, the presence of vines, olives and citrus.

There are some reports (CRAMP, 1994) of Spotless Starlings nesting in forests in Moyen Atlas (northwest Africa) making long flights from the forest to open plateaus to collect food. This indicates Spotless Starlings can also reproduce in woody areas, proba-

bly when no other nesting facilities are available. In Corsica however the Spotless Starling was never observed to nest in forests.

We found that sheep and goats appear to promote the presence of the Spotless Starlings. Starlings are often observed following grazers, catching insects disturbed by the animals. Though they sometimes exhibit «oxpecker feeding» (FEARE, 1984), eating ectoparasites while perching on the backs of cows and sheep, starlings more often practise the open bill probing or prying (FEARE, 1984) to capture hidden invertebrates on short grassland. We have to keep in mind that the effect of grazing lasts longer than the actual presence of the animals as grazers move between the different available grassland. The estimate for grazed area was also significantly correlated with the presence of reproducing Spotless Starlings (Fig. 2). Therefore we can state that domestic animals such as sheep and goats indirectly improve the habitat for the Spotless Starlings. By grazing they create the preferred foraging areas of the starling, i.e. short grassland.

It was indicated in former studies that Spotless Starlings are regularly found foraging in vineyards. In our study the presence of vineyards also increased the chance of finding the birds (Table 2). However, pastures often surround vineyards. Our statistical analysis also showed that a habitat is very suitable for the reproduction of the Spotless Starling more through the presence of short grassland rather than through the multitude of fruit cultures (Table 3). As nestlings are mostly fed with invertebrates (PERIS, 1980, RENARD unpubl. data) short grass areas provide the highest amount of prey (FEARE, 1984). STEVENS (1983) found for the European Starling that the birds feeding in orchards were mostly juveniles, probably because this food item is easy to locate and consume. The large flocks of starlings observed in the Corsican orchards, vineyards and olive groves from July onwards are therefore probably mostly composed of early migrating European Starlings and juvenile Spotless Starlings. In autumn and winter it is difficult to estimate the number of Spotless Starlings as they mix with wintering European Starlings when foraging and in dormitories. Only a few birds stay around the breeding area in winter (YEATMAN-BERTHELOT, 1994).

Because the distribution of the Spotless Starling is so dependent of the agricultural land use, it is not surprising that we only found about 2500 breeding pairs, a rather low number compared to the situation in Spain (FERRER *et al.*, 1991). Probably the small-scale agricultural activities in Corsica limit the number of Spotless Starlings on the island and extremely high densities are avoided.

The European Starling is a very successful colonizer. The rapid expansion of the species in North America is well known (43 km per year, MARGALEF, 1974 in FERRER *et al.*, 1991) and has often been connected with the expansion of agricultural areas (FEARE, 1984). The European Starling seems to be more dependent on cereal culture (MOTIS *et al.*, 1983) than is the Spotless Starling. In Spain the expansion of the first is described as a mixed diffusion with short dispersal jumps, whereas the latter shows a continuous forward movement (FERRER *et al.*, 1991). Although in Spain both species prefer areas with low vegetation, the Spotless Starling can be found in dry and high mountain areas where the European Starling remains absent (FERRER *et al.*, 1991). Combining our observations with the Spanish ones it seems the Spotless Starling is more adapted to the Mediterranean climate than is the European Starling, which chooses the «richer» areas. Where both species

are present together, the expansion rates of both drop (FERRER *et al.*, 1991); this observation seem logical as both species compete for food as well as nesting resources. The dry climate and poorly developed cereal culture in Corsica might be the reason the European Starling does not breed in Corsica, while the Spotless Starling can exploit the available resources.

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