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Distribution and habitat of the Eurasian Treecreeper (*Certhia familiaris*) in Corsica

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The Eurasian Treecreeper is a forest bird distributed from South-Western Europe up to Northern Asia. Two phylogenetic groups have been recently identified within this species, one restricted to Corsica Island (Mediterranean) and the Caucasus region, the other distributed over most of Eurasia and in Northern Asia. Little is known on the natural history of the Corsican population. We present here new comprehensive data on its distribution and habitat. The Eurasian Treecreeper is found from sea level to the upper limit of the forest but absent from the treeless macchia, a dominant vegetation in Corsica. Breeding occurs in a variety of tree species with a strong preference for mature stands and large trees. Its preferred habitat consists of old stands of Corsican Pines and of Sweet Chestnuts, although they are not the commonest tree species in Corsica. The current decline of Sweet Chestnut orchards confers a particular importance to the future preservation of mature stands of Corsican Pine, a patrimonial habitat of great value hosting several endemic bird taxa.

1. Introduction

The Eurasian Treecreeper (*Certhia familiaris*) is a forest bird patchily distributed in the Palearctic, relatively common from the British Isles to Northern China and Japan, through Central Europe (Keller *et al.* 2020). The species comprises two phylogenetic lineages that diverged during the mid-Pleistocene (*ca*. 1 Myr): a paleo-endemic group with an allopatric range nowadays restricted to Corsica and the Caucasus region, and a more widespread lineage, distributed over most of Eurasia and in Northern China (Pons *et al.* 2015). The Corsican population, belonging to the subspecies *C. f. corsa*, differs from other populations in morphology (Pons *et al.* 2019) and voice (Chappuis 1976, Tietze *et al.* 2008). It is nearly completely isolated, genetic introgression with Italian or French populations being very rare (Pons *et al.* 2019). Thus, this endemic population represents an important conservation unit, but current knowledge on its natural history is scarce, restricted to a few data on distribution, ecology (Thibault & Bonaccorsi 1999), and density (Arrizabalaga *et al.* 2002). In the Red-list of birds of Corsica, the Eurasian Treecreeper is considered as "Near Threatened", with a "major priority of conservation" due to its endemicity (Linossier *et al.* 2017). It is the only representative of the *Certhia* genera on the island, whereas in many other European regions the Eurasian Treecreeper is syntopic with the Short-toed Treecreeper (*C. brachydactyla*), both species interacting ecologically (Clouet & Gerard 2020).

On the continent, the Eurasian Treecreeper is a good indicator of the forest maturity (Suorsa *et al.* 2005), breeding densities being three times higher in old-grown forests than in managed forests (Virkkala *et al*. 1994). Moreover, a physiological study suggested that poor food supply to chicks reared in dense young forests, compared to scarce old forests richer in invertebrates, may decrease the body condition and survival of nestlings (Suorsa *et al.* 2003). Ancientness and maturity are two major qualities of forest ecosystems (Cateau *et al.* 2015). Among the major Mediterranean islands, Corsica (8,722 km²) still shelters forests (Quézel & Médail 2003), among which ancient forests cover less than 80,000 ha, including 15,000 ha of mature forest (Panaïotis *et al.* 2017, Torre 2014). Like most of the Mediterranean region, the largest part of the Corsican forests is composed of a mosaic of tree species, shaped by a long history of human activities. The most emblematic tree of the island, although covering only 17% of the total forested area, is the Corsican Pine (see Table 3 for scientific name of trees), an endemic subspecies of the Black Pine, also distributed in Southern Italy and Sicily (Farjon & Filer 2013). The Corsican populations diverged from the Italian group about 100,000 years ago and persisted *in situ* during the Last glacial Maximum (Afzal-Rafii & Dodd 2007). Pollen and charcoal studies showed that its range, although restricted to inland today, used to cover the whole island of Corsica in the past (Reille 1977; Thinon 1998). The Corsican Pine is recorded from sea level up to 1,969 meters (IFN 2003), but forests are distributed from Meso-Mediterranean vegetation zone (near rivers) up to Montane vegetation zone (Gauberville *et al.* 2019). Logging affected its range since the Neolithic period (Mazet *et al.* 2016) towards recent times (Bourcet 1996, Pia Rota & Cancellieri 2001), although an altitudinal reconquest started since the last century due to the abandonment of summer pastures (ONF 2006, Panaïotis *et al.* 2017). In terms of area, the Holm Oak occupies the first rank in Corsican forests with 46% of the forest cover. Coppices have been long favoured for grazing, pruning, clumping, and logging (for firewood, wood charcoal, or manufacturing) (Carcaillet *et al.* 1997). Another anthropic part of the forest is composed of Sweet Chestnut orchards (6% of the total forest of Corsica cover today) that were cultivated during the 16–19th centuries and then progressively abandoned during the 20th century due to cutting for manufacturing tannin, parasites and diseases that affected chestnut harvests, and fires that destroyed old stands (Pia Rota & Cancellieri 2001, Campocasso 2016). Cluster Pine (16% of the total forest cover today) is a typical fire-propagated Mediterranean species that occupies a large wooded area in Corsica, although old stands remain rare due to frequent fires. Beech (8% of the total forest cover) has a marginal distribution in the Mediterranean region with only two islands occupied (Quezel & Médail 2003, 158). The Cork Oak is a typical Mediterranean species that covers

a large surface in plains (7% of the total forest cover), especially in the South and the East of the island. Traditionally planted with large spacing between trees producing an open forest cover, the Cork Oak forests were managed towards collecting corks and grazing cattle (Riffard *et al.* 2008); this usage also implied that the older trees were cut when cork production decreased, thus maintaining stands artificially younger. Finally, Fir is rarely represented in pure stand in Corsica with less than 1% of the total forest cover.

Thus Corsican forests are characterized by a mosaic of tree species managed by humans at all altitudes and a dominant pine forest at higher elevations. Based on its ecology on the continent, the presence of large trees is probably a consistent factor in the Eurasian Treecreeper habitat selection on the island, but its specific preferences are currently unknown. In this study, we gathered data on its breeding range, altitudinal limits, tree species preferences, and dendrological factors. Our main objective was to define the ecological characteristics of the Eurasian Treecreeper in Corsica. This approach is essential in elaborating and supporting conservation plans for the forests in Corsica that are, like several other forested ecosystems in Mediterranean basin, threatened by modifications of land-use and frequent fires.

2. Methods

The Eurasian Treecreeper (hereafter "the treecreeper") is a discreet forest bird with few vocalizations and a short singing period that can pass easily unnoticed (Chappuis 1994). This study was conducted in Corsica (42°N, 9°S) each year from 1st March to 30th June (the core of its breeding season) in 2013–2021, using playback experiments. We observed the behavioural response of individuals to 3-min playback sessions of the nominate subspecies song (Roché 1990). To prevent the arrival of remote birds, the range of the call produced by a 4-watt transmitter was settled to less than 200 metres (this was checked by testing the device in the forest). All observed individuals were recorded, regardless of the distance to the observer. The song of the Corsican taxon differs from that of Western mainland European birds (Chappuis 1976, Tietze *et al.* 2008), but males most often strongly reacted to the playback by showing various behavioural responses (alarm, song, silent with active display). Based on its ecological preferences elsewhere in Europe (Harrap & Quinn 1996), we avoided areas without vegetation and those covers by macchia (*i.e.,* a large part of Corsica) and collected information on 890 forested sites. Responses to playback (display or vocalisation) were treated as a territorial behaviour. However, when contacted only once during at least two visits in very small grove or coppice, birds were considered as erratic. Records of treecreepers outside the forests were obtained from the literature, websites, and our own fieldwork: these data were treated as "erratic". Several previous records from ornithological literature and the web, in which the identification at the species level was not confirmed (Eurasian vs. Short-toed Treecreeper a very rare visitor in Corsica), were not included in the analysis. On each location, we defined a circular plot of 20-m radius and recorded, in addition to the presence or absence of treecreepers, the geographical coordinates and elevation, the tree species (dominant and secondary), the minimum and maximum percentage of crown vegetation cover following the methods described in Prodon (1988), the height of the highest tree and its DBH (diameter at breast height).

In this study, we restricted the term "forest" to wooded stands larger than 15 ha, whereas "grove" corresponds to wooded stand smaller than 15 ha, and "coppice" to young stands that regrow after cutting, management (*e.g.*, clump), or colonize ancient cultures and orchards. Forest categories followed the nomenclature of the Institut Forestier National (IFN 2003): "forest" corresponds to stand dominated by a single tree species, with a cover superior to 40%; "open forest" corresponds to vegetation cover between 10 and 40%; "mixed forest" defines an assemblage of conifer and broad-leaved trees. We counted treecreeper territories in each of the seven most common tree species based on the IFN maps from 2016–2017 (IFN 2016–2017). However, discrepancies were sometimes found during fieldwork between the IFN maps and the observed dominant tree species (12.6% of the plots): in these cases our data were preferred over the data of IFN's. The

mapping was conducted using the software QGIS 3.16 (QGIS Development Team 2016). Statistical analyses were performed using the free software BioStaTGV (https://biostatgv.sentiweb.fr/?module=tests) to compare the number of treecreeper territories between forest range areas (Chi²). Boxplots were drawn with the package ggplot2 (Wickham 2009) in R (R Core Team 2020) to show the altitudinal limits of the most common trees in occupied territories and the importance of each dendrometric variable according to the most common tree species. We used the package FactoMineR (Lê *et al.* 2008) to 1) perform a Principal Component Analysis in order to identify the variables most influencing the presence/absence of the treecreeper in the Corsican forests, and 2) produce logistic regressions that best explain the presence/absence variable over ecological (elevation) and dendrological quantitative characteristics, tested as independent factors. The normal distribution of values was evaluated by Shapiro-Wilk tests ($p<0.05$) and the homoscedasticity by Levene tests ($p>0.05$). The independence of variables was studied with Spearman's rank correlation coefficient: this analysis resulted in keeping only a selection of independent quantitative variables (see results). The logistic regression analysis was conducted using the glm R function, with no prior weight and using the default options. It was first conducted for all tree species, then conducted on the six common tree species for which the retained quantitative variables followed a normal distribution. We kept the most parsimonious models according to the AIC criteria (Akaike information criterion) (Burnham & Anderson 2002).

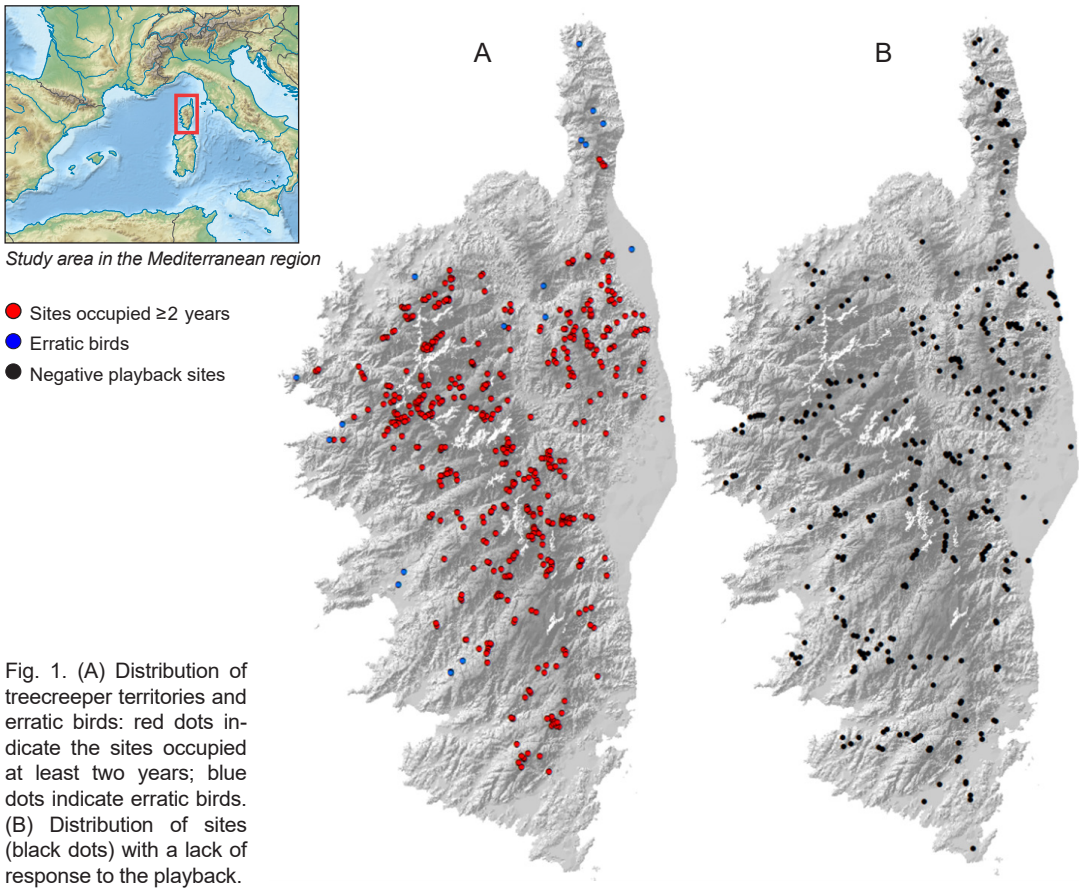

Fig. 1. (A) Distribution of treecreeper territories and erratic birds: red dots indicate the sites occupied at least two years; blue dots indicate erratic birds. (B) Distribution of sites (black dots) with a lack of response to the playback.

3. Results

3.1. Breeding range and dispersal

Over the 8 years of fieldwork, we mapped 517 sites occupied by territorial males or pairs, representing 60% of 890 sampled forested sites (Fig. 1a). Treecreeper territories range over a vast area covering most of the island, especially inland, avoiding the highest mountains (without forests) and the littoral (Fig. 1b), where treecreepers only occupy to a few scattered territories. These littoral regions also represent suboptimal habitats where erratic birds were found (Fig. 1a), composed of Cork Oaks with an open forested cover of Holm Oak coppices colonizing former orchards. The other sites occupied by erratic treecreepers corresponded to inland small forest patches, suitable in terms of habitat, but too restricted in area (less than 10 ha) to host a territory. The admixture of presence and absence data over inland area highlights the mosaic of vegetation found in Corsica, where groves and forests are patchily included within a vast zone of macchia.

3.2. Habitat preferences: forest categories

The treecreper occupied all forested categories described by IFN (2016–2017), with nearly equal balance between conifers and broad-leaved trees in absolute number (Table 1), but not in relative numbers. Indeed, the ratio of Treecreeper sites compared to the total number of plots was significantly higher for conifers (73%), mostly Corsican Pine, than for broad-leaved trees (45%) ($Chi^2_1=52.72$, $p<0.001$). The sampled treecreeper territories superimposed on a map describing the main categories of forested areas are shown in Figure 2. They were especially well-distributed in conifer forests along the mountainous central chain, and in broad-leaved forests in Northeast of the island. Conversely, they were absent from the broad-leaved forest (mainly Cork Oaks stands) in the Southeast region where visits by erratic birds were nevertheless observed.

Among the four categories of vegetation assemblage (forest, mixed forest, coppice and open forest), the treecreeper was significantly more often found in the first one ($Chi^2_3=44.17$, $p<0.001$, Table 2). Frequent occurrence of treecreepers in coppices (37%) was unexpected, but our field surveys show that these territories often include plots of large trees favourable to treecreepers.

3.3. Habitat preferences: tree species

A total of 14 tree species have been identified in all sampled treecreeper territories when the stand was monospecific, and 16 when a secondary tree species was present. However only seven tree species were well-represented in treecreeper territories: Corsican and Cluster Pines, Sweet Chestnut, Holm and Cork Oaks, Beech, and Fir.

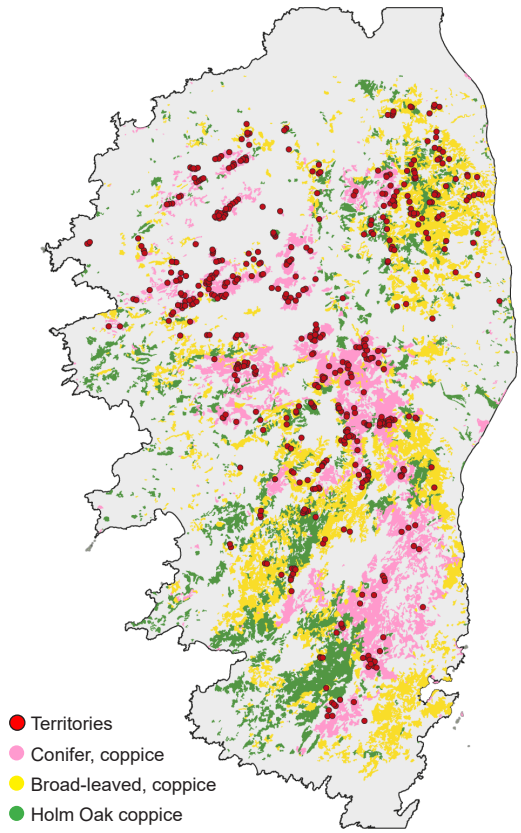

Fig. 2. Treecreeper territories on the vegetation map of Corsica (IFN 2003): conifer forests and coppices (mauve), broad-leaved forests and coppices (yellow), Holm Oak coppice (green). See Fig. 1 for reference location.

Table 1. Presence-absence of the treecreeper in the different plots presented in the IFN (Institut Forestier National) map.

IFN categories	Present	Absent	Total
Corsican Pine forest	101	28	129
Young forest of Corsican Pines	2	1	3
Cluster Pine forest	31	22	53
Pines forest	10	2	12
Mixed forest (majority of conifers)	5	3	8
Open mountain pine forest	15	4	19
Mixed conifer forest and coppice	19	3	22
Macchia with Cluster Pine	2	5	7
Macchia with pines	1	0	1
Conifers total	186	68	254
Sweet Chestnut forest	31	25	56
Holm Oak forest	5	0	5
Cork Oak forest	6	17	23
Broad-leaved forest	6	3	9
Beech forest	19	7	26
Mixed forest (majority of broad-leaved)	7	7	14
Open mountain broad-leaved forest	4	2	6
Mixed Holm Oak and coppice	26	18	44
Mixed Cork Oak and coppice	5	16	21
Mixed broad-leaved	34	43	77
Mixed pine forest and coppice (broad-leaved)	6	15	21
Coppice of Sweet Chestnut	1	0	1
Coppice of Holm Oak	15	32	47
Coppice of broad-leaved	7	16	23
Coppice of Beech	7	3	10
Macchia with Sweet Chestnut	3	13	16
Macchia with Holm Oak	9	10	19
Macchia with Cork Oak	4	9	13
Macchia with broad-leaved	4	9	13
Broad-leaved total	199	245	444

IFN categories	Present	Absent	Total	% present
Forest (total)	238	119	357	66.7
Mixed forest and coppice	90	95	185	48.6
Coppice	30	51	81	37
Open forest	27	48	75	36

Table 2. Presence-absence of the treecreeper in the different plots of vegetation assemblage defined by IFN (Institut Forestier National).

The Corsican Pine was present in *ca.* half of the territories, although its contribution decreased when including territories where this species is associated with a secondary tree species, while in the same situation the contribution of the Sweet Chestnut increases (Table 3).

Occurrence frequency of each tree species in the treecreeper territories according to the surface area of the main tree species in overall Corsican forests (open and mixed forest excluded) are presented in Table 4. Differences are highly significant ($Chi^2_6=65.07$, $p<0.001$, range areas of forests converted in log): Holm, Cork Oak, and Cluster Pine are under-represented, compared to Corsican Pine and Sweet Chestnut.

3.4. Habitat preferences: altitudinal distribution

Treecreeper territories were recorded from 12 m to 1,830 m above sea level (mean 960±345 m, median 974 m); 86% were located at medium elevations, between 501 m and 1,500 m (Table 5). The most frequent tree species on the territories corresponded to three categories: (1) Cork Oak at low elevation (below 500 m), (2) Sweet Chestnut, Cluster Pine, and Holm Oak at medium elevation (500–1,000 m), and (3) Beech, Corsican Pine, and Fir at high elevation (above 1,000 m) (Fig. 3). Rarer tree species on the territories were distributed at all elevation: Common Alder (12–628 m, n=3), Poplar (120 m, n=1), European Hop-Hornbeam (176–920 m, n=2), Italian Alder (505–791 m, n=3), Ash (796 m, n=1), Deciduous Oaks (375–1,098 m, n=9, median=814 m), and Birch (1,346 m, n=1).

3.5. Habitat preferences: dendrometry

The vegetation cover varied between species, the extreme being observed for the Corsican Pine for which the minimum vegetation cover showed a large variation (Fig. 4a). The maximum vegetation cover was higher in the broad-leaved species compared to the conifers (Fig. 4b). The diameter was quite large for all species, with a mean of 0.48 meters (Fig. 4c). The values for Sweet Chestnut which tend towards trees larger than 1m in diameter can be explained by the old age of the orchards in Corsica. Finally, height was higher for conifers than for broad-leaved trees (Fig. 4d).

3.6. Models of habitat quality

Principal Component Analysis showed that within the variables influencing the presence/absence of treecreeper in the Corsican forests, height and elevation were correlated as well as the two variables describing the vegetation cover (Fig. 5) Thus, only three variables were kept in the logistic regression analysis: diameter, height, and maximum vegetation cover. Table 6 presents the best selected models of the logistic regression for each of the most common tree species (Beech, Sweet Chestnut, Cluster and Corsican Pines, Cork and Holm Oaks) and for all tree species together. Selected models underline the significant importance of diameter (excepted for the Cork Oak), height (excepted for the pines), and vegetation cover max. (excepted for the Beech) in explaining the presence of treecreepers (Table 7).

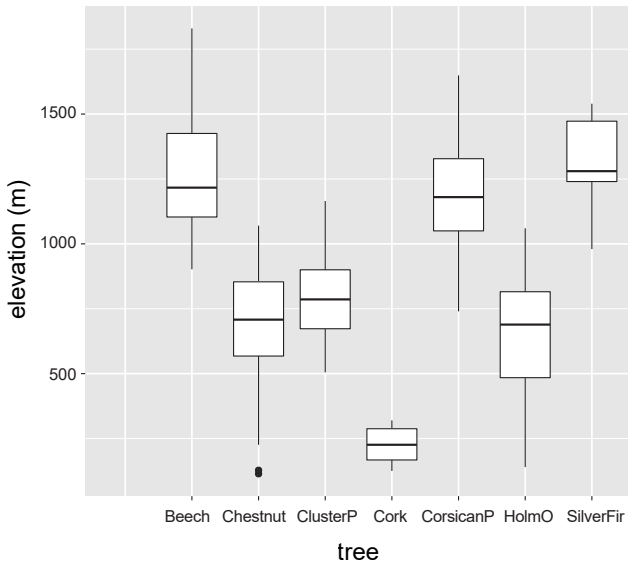

Fig. 3. Elevation of treecreeper territories in the seven main tree species.

Table 3. Distribution of tree species in the treecreeper territories (when pure [upper line] and when associated to a secondary tree [bottom lines]). Number in each cell indicates the number of sampled territories. Percentage on the third line indicates the ratio of tree species when "pure", and % on the last line indicates the ratio when these trees are associated with others. Explanation of the acronyms used on the upper line is given in the first column.

	As	Be	Bi	CP	CA	CO	CoP	DO	EHH	Fi	HO	IA	Po	SC	total
Total pure	0	30	0	29	2	5	185	5	0	4	37	0		45	342
%		8.8		8.5	0.6	1.5	54.1	1.5		1.2	10.8			13.2	100
associated with:															
Ash (As) *Fraxinus ornus* L.						1				2	5			4	
Beech (Be) *Fagus sylvatica* L.							9								
Birch (Bi) *Betula pendula* Roth							5								
Cluster Pine (CP) *Pinus pinaster* Aiton							16				4			7	
Common Alder (CA) *Alnus glutinosa* L.							1							5	
Cork Oak (CO) *Quercus suber* L.											4				
Corsican Pine (CoP) *Pinus nigra* subsp. *laricio* Maire		3	1	2						2	4			7	
Deciduous Oak (DO) *Quercus* spp.							3				5			4	
Eur. Hop-Hornbeam (EHH) *Ostrya carpinifolia* Scop.														3	
Fir (Fi) *Abies alba* Mill.		4					7								
Holly *Ilex aquifolium* L.							1								
Holm Oak (HO) *Quercus ilex* L.				5	1	1	10	1				1	1	16	
Italian Alder (IA) *Alnus cordata* Loisel									1					10	
Poplar (Po) *Populus nigra* L.														1	
Strawberry tree *Arbutus unedo* L.				1							2				
Sweet Chestnut (SC) *Castanea sativa* Mill.	1	1		5		1	6	3	1		10	2			
Grand total	1	38	1	42	3	8	243	9	2	8	71	3	1	102	532
%	0.02	7.1	0.02	7.9	0.06	1.5	45.7	1.7	0.04	1.5	13.4	0.06	0.02	19.2	100

Table 4. Number of treecreeper territories in forests according to the total surface areas covered by the main tree species (from IFN 2016–2017)

	Corsican Pine	Sweet Chetnut	Holm Oak	Cluster Pine	Beech	Fir	Cork Oak
Number of occupied treecreeper territories	243	102	71	42	38	8	8
Range areas in Corsican forests (ha)	29,741	10,183	80,668	28,100	13,928	258	11,643
Mean number of treecreeper territories / 100 ha	0.8	1	0.09	0.14	0.27	3.1	0.07

4. Discussion

4.1. Distribution and ecological characteristics

The data gathered for this study, with more than 500 sites investigated, provided a finer vision of the treecreeper distribution in Corsica than the information compiled in previous breeding bird atlases (Yeatman 1976, Chappuis 1994, Muller 2015). We confirmed that the treecreeper is present in forests from sea level to their upper limits, its range covering a large part of the island, except the treeless macchia, a dominant vegetation in Corsica. However, the median elevation of treecreepers' sites in Corsica was high (974 m), a result that we think is due to the current distribution of mature forests, more frequent in higher altitudes than on the littoral because of anthropogenic factors (Gamisans 2003). Although the treecreeper territories were found in various tree species assemblages, we demonstrated that the bird shows a marked preference for two tree species, the Corsican Pine and the Sweet Chestnut, that are not the commonest ones. This result supports previous observations, although conducted with different fieldwork methodologies, which estimated a density of breeding treecreepers twice higher in Corsican Pines (Arrizabalaga *et al.* 2002) than in Holm Oaks (Blondel *et al.* 1988). However, this preference is very likely explained by the fact that mature stands, developing a deep-seated bark favourable to invertebrates, are mainly found in Corsican Pine and Sweet Chestnut in Corsica. Thus, most of the Holm Oak range has been converted to coppices, unfavourable to the treecreeper, and the number of mature groves is very limited today, partly reduced by fires during the last fifty years. Similarly, the Cork Oak stands are too young, with a low vegetation cover, to be ecologically favourable to the treecreeper. In addition, many groves have been abandoned or transformed into subdivisions of private houses. The Beech covers a limited range and mature forests remain uncommon. When considering its vast surface, the Cluster Pine forest seems relatively under-occupied by the treecreeper. This can be explained by the great vulnerability of Pine forests to fires generating an over-representation of young stands. Lastly, other tree species woodlands like Fir or Birch, pioneering species growing in Corsican Pine cuttings, are not favourable to treecreepers probably because of their small surface areas. Similarly, the Common Alder, a species favourable to the treecreeper in marshy localities of the Caucasus (Harrap & Quinn 1996), had been over-exploited in Corsica and still declines today due to diseases and fires.

Table 5. Frequency of treecreeper territories according to the elevation above sea level (in meter)

Elevation	Number of territories (n=532)
12–500	57
>500–1,000	224
>1,000–1,500	233
>1,500	18

Forest habitat requirements of the treecreeper in Corsica are similar to those of mainland populations elsewhere in temperate continental Europe: a high rate of the vegetation cover with

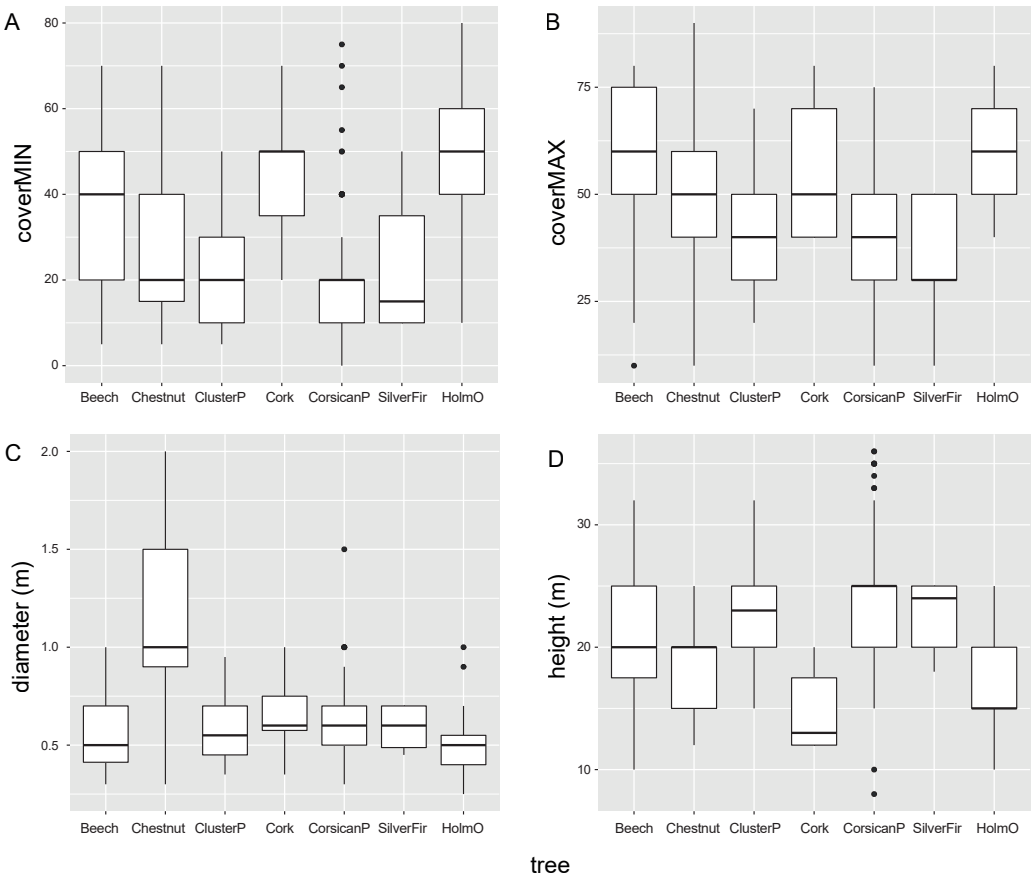

Fig. 4. Dendrometric variables for the seven main trees species in treecreeper territories: (A) minimum vegetation cover, (B) maximum vegetation cover, (C) tree diameter, and (D) tree height.

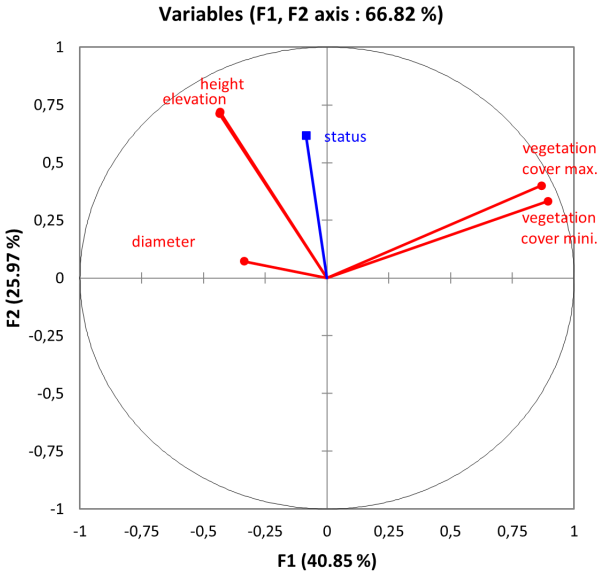

Fig. 5. F1-F2 Plane Factor Correlation Circle of the Principal Component Analysis. The active variables, corresponding to the description of the forest, are indicated in red, and the supplementary variable, that corresponds to the treecreeper's status (presence/absence) is indicated in blue.

Table 6. Selection of the best logistic regression models for all tree species together, and for each of the six commonest tree species; Fir was excluded of this analysis because of its small sample size.

Best logistic regression models	Variables	Number of variables	Deviance	Degree of freedom
Tree species all together	diameter, height, vegetation cover max.	3	1133.6	831
Sweet Chetnut	diameter, height, vegetation cover max.	3	251.7	182
Cork Oak	diameter, vegetation cover max.	2	37.5	40
Holm Oak	diameter, height, vegetation cover max.	3	232.5	177
Beech	diameter, vegetation cover max.	2	61.09	49
Corsican Pine	diameter, vegetation cover max.	2	209.9	250
Cluster Pine	diameter, vegetation cover max.	2	98.1	70

tall and large trees (*i.e.*, with a mean diameter superior to 40 cm) (Laurent 1987, Maumary *et al.* 2007). However, Martin (1982, 410) founded that in Corsica, comparatively to mainland, the treecreeper occupies a wider array of habitats ranging from forests to coppices (but see our comment for Table 2). Interestingly, in the British and Irish Isles where the Short-toed Treecreeper is absent, the Eurasian Treecreeper breeding populations are found in a wide range of habitats including lesser dense stands, parklands, gardens and even farmlands with well-treed hedgerows (Cramp & Perrins 1993, du Feu 2002). Thus, the absence of the Short-toed Treecreeper in Corsica did not lead to comparable niche expansion in the Eurasian Treecreeper, maybe in conjunction with the different origin of the lineages: recently divergent from the continent in British and Irish Isles *versus* a paleo-endemic in Corsica (Pons *et al.* 2015). The large altitudinal amplitude of the treecreeper territories recorded in Corsica is also noted elsewhere in Europe (Hagemeijer & Blair 1997, Keller *et al.* 2020), like for instance in France where the species is recorded in small numbers from the plains in Normandy, near the sea on the Riviera, and to the upper forest limit in the Alps and the Pyrenees (Muller 2015). A review of the habitats occupied across the geographical range of the treecreeper (Harrap & Quinn 1996) underlines the great adaptability of this species for which behaviour and social habits may be as important as ecological requirements and available habitat types in habitat choice.

4.2. Future changes in the Corsican forests

A significant reduction of mature stands, estimated at least to 43%, occurred in Corsica since the mid-19th century (Panaïotis *et al.* 2017). Such an important reduction was due to several factors, mainly anthropogenic: fires for pasture, logging for industrial combustible (Fontana 2004), for firewood or for the construction of railway ties (see https://youtu.be/ns.JoJS1-7Jw for Fium'Orbo), and important cutting in several public forests during 1970-90 period (*e.g.*, see Cerutti 1976 for Valdoniello forest). Conversely, natural regrowth was estimated to 25,000 ha per decade (Panaïotis *et al.* 2017), thanks to abandoned pastures recolonized by Corsican Pines in the mountains, gardens and terrace cultivations replaced by oaks and broad-leaved trees, and to the aging of Holm Oaks previously exploited for wood charcoal. These new forested areas will however not be suitable for treecreepers before at least several decades (Panaïotis *et al.* 1997), although the Holm Oak annual grown rate (m^3 ha^{-1}) can be especially high in Corsica (Bonin & Romane 1996), and might accelerate recolonization, especially in macchia which constitutes a step towards the formation of a forest. On the other hand, the abandonment of cultivated Sweet Chestnut groves reaching today a range of only *ca.* 1,300 ha (de Casabianca 2016) implying the death of the old trees and their natural replacement by others tree species, broad-leaved or conifers, would lead to the increase of unsuitable habitats for the treecreeper. Our field observations in the Cap Corse (North

Table 7. Parameters of the different selected models.

Parameters	Estimation	Std	z–value	Pr(>|z|)	Sig.
"Tree species all together" model					
intercept	–7.639114	0.564713	–13.527	<0.001	***
diameter	1.887201	0.256453	7.359	<0.001	***
height	0.262479	0.021905	11.983	<0.001	***
vegetation cover max.	0.047304	0.005145	9.194	<0.001	***
"Sweet Chestnut" model					
intercept	–7.7289	1.44166	–5.361	<0.001	***
diameter	1.39761	0.48224	2.898	<0.01	**
Height	0.24835	0.07209	3.445	<0.001	***
vegetation cover max.	0.05983	0.0108	5.54	<0.001	***
"Cork Oak" model					
intercept	–9.30897	3.4038	–2.735	<0.01	**
diameter	4.21003	2.31434	1.819	0.068	ns
vegetation cover max.	0.13593	0.05327	2.552	<0.05	*
"Holm Oak" model					
intercept	–10.13607	1.68221	–6.025	<0.001	***
diameter	9.59439	1.74827	5.488	<0.001	***
Height	0.21402	0.0797	2.685	<0.01	**
vegetation cover max.	0.04898	0.0145	3.377	<0.001	***
"Beech" model					
intercept	–7.05211	2.5481	–2.768	<0.01	**
diameter	11.38164	3.39641	3.351	<0.001	***
vegetation cover max.	0.05522	0.03093	1.786	0.074	ns
"Corsican Pine" model					
intercept	–8.17944	1.54965	–5.278	<0.001	***
diameter	14.51936	2.31462	6.273	<0.001	***
vegetation cover max.	0.09086	0.02176	4.176	<0.001	***
"Cluster Pine" model					
intercept	–8.23425	1.93935	–4.246	<0.001	***
diameter	10.05891	2.53804	3.963	<0.001	***
vegetation cover max.	0.09836	0.02765	3.557	<0.001	***

Corsica) illustrate well this situation, with a few treecreeper breeding territories found in small Sweet Chestnut groves [a recent colonization according to Marzocchi (2018)], whereas in the former gardens recolonized recently by broad-leaved trees, the observed treecreepers were only erratic (Fig. 6).

Forest fragmentation poses a major threat to animal and plant species (Rogan & Lacher 2018), and several major negative consequences have been identified in Europe for treecreepers (*Certhia* spp.): increase of nest predation (Huhta *et al.* 2004) and decline in abundance (Basile *et al.* 2016). In Corsica, treecreeper number may

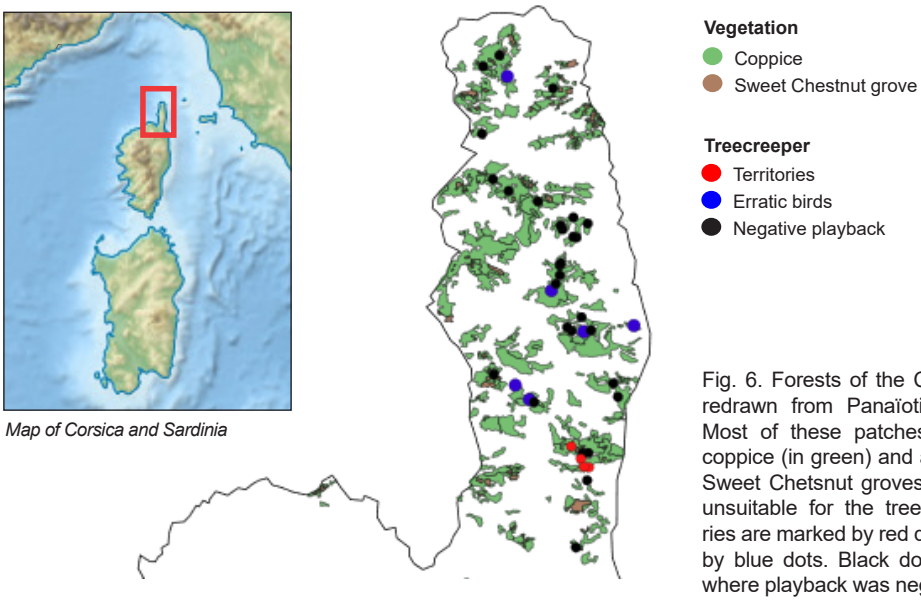

Fig. 6. Forests of the Cap Corse (map redrawn from Panaïotis *et al.* 2017). Most of these patches, composed of coppice (in green) and a few very small Sweet Chetsnut groves (in brown), are unsuitable for the treecreeper. Territories are marked by red dots, erratic birds by blue dots. Black dots indicate sites where playback was negative.

locally increase in the future, if the global forest area continues to grow, and most importantly, to mature, at least in areas where seeds and soil are still present. But, conversely the decline of the Corsican Pine forest, the main mountain habitat for treecreepers today, is a major concern knowing that recurrent fires and logging, lead to a significant loss of habitats. This also holds for the endemic and threatened Corsican nuthatch (*Sitta whiteheadi*), for which the Corsican Pine forest represents the unique suitable habitat (Thibault *et al.* 2006). Thus, its strict protection constitutes a conservation priority in Corsica where this tree species is currently more at risk to anthropogenic activities than to climate change towing to its wide ecological range (Barbet-Massin & Jiguet 2011).

Utbredning och habitat för den Trädkryparen på Korsika

Trädkryparen (*Certhia familiaris*) är en skogsfågel med utbredning från sydvästra Europa till Nordliga delar av Asien. Två fylogenetiska grupper har nyligen identifierats inom arten, en som hittas på Korsika i Medelhavet och i Kaukasus, och en annan som utbreder sig över största delen av Eurasien och nordliga Asien. Det finns begränsat med information om populationen på Korsika. Här presenterar vi nya omfattande data om dess utbredning och habitat. Trädkryparen hittas från havsnivån till den övre trädgränsen men saknas i det trädlösa macchia området, som dominerar vegetationen på Korsika. Häckningar förekommer i varierande trädarter med en stark preferens för äldre bestånd av stora träd, såsom svarttall och äkta kastanj som inte är de vanligaste trädslagen på Korsika. Det minskande antalet trädgårdar med äkta kastanj innebär att bevarandet av mogna svarttallbestånd blir allt viktigare för trädkryparen och andra endemiska arter.

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