

Common Swifts (*Apus apus*) nesting in mature pine forests in Corsica

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Abstract

Tree breeding in holes has been recorded for the Common Swift (Apus apus) mainly in Northern Europe and Siberia. This behaviour, considered as ancestral, has also been noted in Corsican forests. Although marginal in terms of numbers, it is a perennial phenomenon. We present here a synthesis on the distribution and the characteristics of nesting sites, and we compare these breeding sites to the occurrences in continental Europe and Northern Africa. Our data add to the body of arguments in favour of the preservation of mature forests of the Corsican Pine on the island.

Introduction

Several species of birds breed today mainly in human constructions, like the House Sparrow (*Passer domesticus*), swallows (*Cecropis daurica*, *Delichon urbica*, *Hirundo rustica*) or swifts (*Apus* spp., *Chaetura pelagica*), although some of their populations are still breeding in natural sites, such as tree holes, caves, or

cliffs. Among them, the Common Swift (*Apus apus*) is a common breeder in Corsica (Western Mediterranean). Its distribution has been stable since the beginning of the 20th century, although numbers have decreased locally in the city of Bastia (Faggio 1999). On the island, the Common Swift breeds in houses and buildings in most towns and villages, colonizing new buildings, especially when roofs are covered in traditional stones. It shares a few urban sites with the Pallid Swift (*Apus pallidus*), mainly in the city of Bastia. The Common Swift in Corsica is not known for breeding in cliffs, whereas these sites are occupied by the Pallid Swift and the Alpine Swift (*Tachymarptis melba*) on coastal areas and in the mountains (Thibault & Bonaccorsi 1999). Breeding sites in tree holes have been recorded for the Common Swift (Roger & Fossé 2001; Prampart 2019) mainly in Northern Europe and Siberia, regions where buildings are rare and scattered (Voous 1960). This behaviour, considered as ancestral (Gory 1997), has also been recorded in Corsica. We present here new data on the Common Swift breeding in tree holes in Corsica and we compare these breeding sites to the occurrences in continental Europe and Northern Africa.

Key words: Apodidae, bats, Common Swift, Corsican Pine, hole breeder, mature forest, Pinaceae, Vespertilionidae

Methods

The Common and Pallid Swift are sometimes difficult to identify in flight, and the Pallid Swift has only been documented in Corsica since the 1930s (Mayaud 1936). Therefore, the validity of the records from the 19th and early 20th centuries, which only included the Common Swift, should be treated with caution. However, all recent occurrences of swifts breeding in tree holes in Corsica refer to the Common Swift (hereafter “the swift”), identified on the basis of call (Malacarne *et al.* 1989), morphology, and plumage coloration (Vinicombe *et al.* 2014), suggesting that the Pallid Swift does not use tree holes in Corsica; however this species has been rarely reported to breed in trees (Cramp 1985). Our dataset

was established by checking breeding sites between 1996 and 2019. Tree holes occupied by swifts were found during two kinds of investigations: 1) during surveys of bat populations using telemetry (Beuneux *et al.* 2010) on the Greater Noctule Bat (*Nyctalus lasiopterus*) and the Leisler’s Bat (*Nyctalus leisleri*); the same trees were sometimes used by both bats and swifts, 2) by looking for prospectors flying between trees that indicate occupied sites; we name “prospectors” the non-breeding birds circling and attempting to perch in occupied trees (Genton 2010; named “bangers” by Lack & Lack 1952). The equipment used to visualize tree cavities consisted of a mirror probe or an endoscopic camera (custom made by Opto Vision). The location and elevation of the sites were recorded using a GPS, supplemented by a description of the trees according to the following variables: tree species, vitality, number of cavities, diameter at breast height (1m30), height of trees and cavities (measured with a clinometer), and cavity type (natural or hole of a Great-Spotted Woodpecker *Dendrocopos major*, the only woodpecker species that excavates cavities in trees on the island). Nesting sites were mapped with the software QGIS (QGIS Development Team 2009). We use the term snag to refer to a standing dead tree and hole for the breeding site. Statistical analyses were conducted using the free software BioStaTGV (<https://biostatgv.sentiweb.fr>). Significance was assumed at $P < 0.05$, values are reported as mean \pm standard-deviation.

Results

Distribution and number

Figure 1 shows the location of the 12 forests for which historical and/or contemporary data indicate the presence of the swift with arboreal breeding in Corsica. Moreover, two historical sites have not been confirmed during recent surveys: i) the Ospedale Forest, where breeding was reported at the beginning of the 20th century (Jourdain 1908-09). This forest has been altered by clear cuts, fires and the construction of a dam that flooded part of the area. ii) the Saint-Antoine Forest, where breeding has only been recorded once in 1997 (P. Fournier, pers. com.). The map also shows other forests, regularly visited by naturalists, where swifts have not been contacted: Corsican Pine *Pinus nigra laricio* (Ascu, Bonifatu, Calenzana,

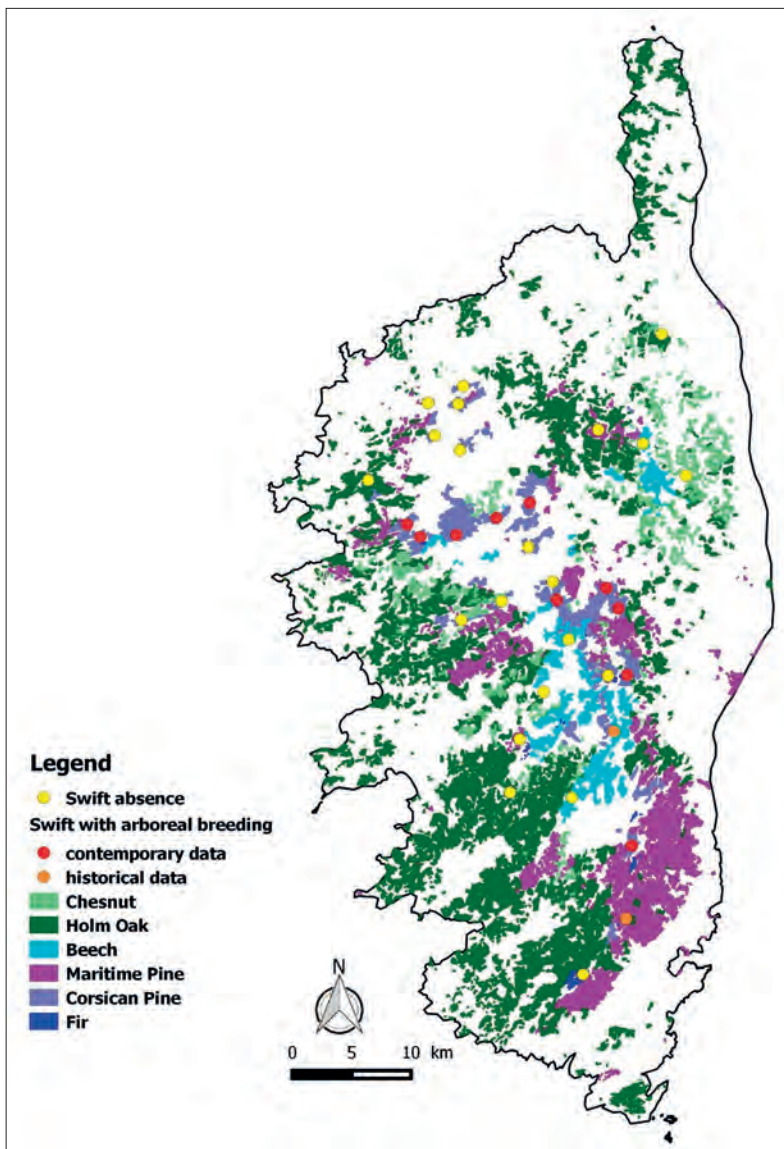


Figure 1 – Range of main tree species and arboreal nesting sites of Common Swift in Corsica (vegetation map drawn from Anon. 2003).

Guagnu-Libiu, Marmanu, Melaja, Restonica, Tartagine, Verghellu); Fir *Abies alba* (Cagna); Beech *Fagus sylvatica* (Coscione, Santu Pietru d'Accia, Vizzavona); Maritime Pine *Pinus pinaster* (Pineta, Pineto); Holm Oak *Quercus ilex* (Fangu, Ste-Marie de Siché, Stella); and Chestnut *Castanea sativa* (Castagniccia region). Most swift nesting sites are situated in the largest forests (e.g. Valdoniellu, Rospa Sorba), and curiously they are lacking from smaller (Ascu, Melaja, Tartagine, Calenzana), or very isolated ones (Verdanese).

All breeding sites were found in Corsican Pines, although we cannot identify with certainty the pine species (Corsican Pine or Maritime Pine) where Jourdain (1908-09) found swift nests in Ospedale forest. The forests with swifts are part of a vast wooded but fragmented massif, in inland Corsica. Their remoteness from villages where swifts are breeding in houses is not relevant: the median distance to the nearest village with swifts does not differ significantly between forests with breeding swifts and those where they were not found ($x = 5.45\text{km} \pm 2.69$, $n = 11$; $x = 6\text{km} \pm 1.49$, $n = 10$, forests with or without breeding swifts, respectively; Kruskal-Wallis test, $P = 0.47$). In the sample observed, the number of prospectors ranged from two to six individuals per site. Our observations refer to isolated pairs, and in one case two pairs (2 nests in the same tree in Valdoniellu), and no colonies comparable to urban sites were found. Two occupied holes in the same tree in Corsican forests are mentioned [Jourdain (1908-09), Moltoni & Bricchetti (1977)], and Hobson (1964) wrote: "There was also a colony of nesting Swifts [*Micropus apus*] who had nests in holes in the tree"; however it is more likely that they were prospectors flying around the snag housing at

least one occupied nest. Numbers of nesting sites found during the study period in two areas were respectively 9 in Rospa Sorba forest (0.79km²) and 12 in Valdoniellu forest (0.80km²), although we cannot consider them as densities because they were not checked during the same year. The total number is estimated at less than 100 breeding pairs (Table 1).

Very few data are available regarding the breeding period of arboreal swifts in Corsica: 1) three fresh eggs on 25th May (Jourdain 1908), 2) one fresh egg on the 26th May (Jourdain 1909); 3) one video from the 30th of June 2007 showing two chicks, the eldest of which had an estimated age of 25-30 days (see Suppl. Mat.); the nest was empty on the 19th of July; 4) two chicks ready to fly on the 13th of July 2018. Several occupied snags were checked at several occasions, the longest periods being 12 and 19 years.

Habitat description

The arboreal breeding sites range from 890 to 1,600 metres altitude, whereas the elevation of breeding sites in Corsican towns and villages vary from sea level to 1,050 metres (the altitude of the highest village). The sites occur predominantly in snags ($n = 23$), more rarely in living trees ($n = 5$) where the holes are found in lightning strikes. They are large and tall, all found in mature stands (Table 2a). Eight sites are former Woodpecker holes and three natural cavities. They are situated in clear forests (where all diameters of trees are represented), or clearings that correspond to windthrow, seeding cuts, or areas of tree mortality caused by the armillary fungus (*Armillaria* sp.). These are mature forests with some trees between 150 and 400 years of age (Anon. 2006).

Table 1 – Estimated numbers of breeding pairs of Common Swifts in Corsican forests between 1996 and 2019.

Forests	Number of pairs	Year of first record	Year of last record
Aitone	1-3	1998	2019
Bavella (Zonza municipality)	1-3	2019	
Casamaccioli	1-3	2013	2013
Lonca	5-10	2006	2019
Melu	5-10	1999	2018
Noceta-Rospigliani	1-3	2018	2018
Petrapiana-Poggio	2-5	2004	2019
Rospa Sorba	15-20	2006	2019
Valdu Niellu	15-20	2015	2019
Vivariu	1-3	2006	2006
Total	47-80		

Table 2a – Characteristics of the nesting sites used or visited by the Common Swift in Corsican pine forests.

	Median	Mean	Number
Elevation (m)	1,248	1,234 ± 184	33
Tree height (m)	21	19 ± 8	19
Diameter at breast height* (cm)	70	76 ± 23	17
Mean height of holes (m)	12	13 ± 3	9

* most snags had no bark

Table 2b – Characteristics of sites used by bats in Corsican Pine forests (from Groupe Chiroptères Corse 2018).

	Median	Mean	Number
Elevation (m)	1,200	1,194 ± 135	279
Tree height (m)	20	20 ± 9	269
Diameter at breast height (cm)	64	65 ± 24	267
Mean height of holes (m)	12	13 ± 7	132

Discussion

Tree nesting: a rare but regular phenomenon in Corsica

Arboreal reproduction of swifts was regularly observed in Corsica during our study period, several snags being occupied over several years. This phenomenon was reported during the first ornithological survey in 1883-1884 (Whitehead 1885) and has been regularly observed since then. Typical habitat is the clear forest of Corsican Pines where the trees are spaced enough to allow easy access to the holes; nevertheless, see above for a possible breeding site in Maritime Pine in Ospedale forest. Although marginal in terms of numbers, it is a perennial phenomenon. Undoubtedly, an ancestral habit, it could have declined with the urbanization that began on the coasts during the Antiquity, but mostly from the Genovese colonization in the 14th century; the inland urbanization occurred later (Arrighi & Olivesi 1990). The Corsican Pine diverged from the Italian populations about 100,000 years ago (Afzal-Rafii & Dodd 2007), with a continuous presence on the island ever since, even during the last ice ages (Leys *et al.* 2014), suggesting an old presence of the swift as well.

A nesting habitat shared with bats

Research on forest bats in Corsica (Groupe Chiroptères Corse 2018; Beuneux *et al.* 2010; Courtois *et al.* 2011) has shown that

distribution is relatively similar, although larger to that of the swift, occupying also the largest forests (Rospa Sorba, Valdoniellu), but smaller ones (Ascu, Tartagine). Roosting habitat of the Greater Noctule Bat and the Leisler's Bat, two species which outnumbered other bats species, is close to that of the swift. These bats roost in large diameter pines (Table 2b); of 349 roosting sites localized, 79% were in Corsican Pines. Of the 279 trees occupied by bats in Corsican Pines which contents could be examined in May-June (period of presence of swifts), at least five were also occupied by swifts. Bats mainly use Woodpecker holes (58%, n = 189), but also natural cavities.

Corsican forest sites compared to those in continental Europe

The habitat and breeding habits of arboreal swifts do not differ from those found in continental forests. Low number of pairs per snag appears common to this type of breeding (Poland: Mayer & Wilson 2011; Scotland: Summers 1999), a likely consequence of the restricted number of available holes. However, depending on the quality of the forest, density could be relatively high (29 pairs in a 23.5ha study plot; Günther *et al.* 2004). In Scotland the mean nearest neighbour distances between nest trees was 0.82km (range 0.22-1.86km) (Summers 1999). As in Corsica, the trees occupied in Europe are old, aged 200-400 in Germany, and at least 140 years in Scotland (Table 3). The preferred species are conifers and oaks rather than Beech and Chestnut trees which are only used occasionally (Table 4). The use of Woodpecker holes by swifts differs of that of the Corsican Nuthatch (*Sitta whiteheadi*), which avoid using these holes to limit the risk of predation of chicks (Thibault & Villard 2005). Jourdain (1912, p. 67) wrote the following: “[...] a newly made Woodpecker's hole proved to contain a broken Woodpecker's egg, some days old, and a fresh Swift's egg, thus furnishing strong circumstantial evidence that the Swift sometimes ejects the Woodpecker.” Elsewhere in Europe the swift is known to eject chicks from holes, sometimes adults, of passerines species [House Sparrow and Tree Sparrow (*Passer montanus*), Common Starling (*Sturnus vulgaris*), White Wagtail (*Motacilla alba*), and Black Redstart (*Phoenicurus ochruros*) (Cramp 1985; Maumary *et al.* 2007)] and occupy empty or occupied holes of various

Table 3 – Tree species used by the Common Swift in Europe and North Africa.

Tree species	Age	Countries/ Localities	Comments	References
<i>Carpinus</i> sp.	mainly in stand with trees older than 100-150 years	Poland		Mayer & Wilson (2011) cited by Prampart (2019)
<i>Cedrus atlantica</i>		Algeria; Morocco	Low number of data; breed in snag in mature forest in Djebel Babor and Atlas	Vielliard (1978), Thévenot <i>et al.</i> (2003)
Conifers		Pologne	Sometimes	Prampart (2019)
Conifers (including pines)	“old conifers forest”	Finland		Väisanen <i>et al.</i> cited by Prampart (2019); Eisto (2006)
<i>Fagus sylvatica</i>		Germany	“Holes in beeches <i>Fagus sylvatica</i> are less suitable”	Günther <i>et al.</i> (2004)
<i>Larix</i> sp.		near Baikal Lake, Russia		Fefelov (2004)
<i>Phoenix canariensis</i> and <i>P. dactylifera</i> (Palm trees)		Southern Iberia	Seems restricted to urban areas	Herrera & Ramírez (1975), Ferrero <i>et al.</i> (1983), Finlayson (1992), Cortes (2004)
<i>Pinus nigra laricio</i>	150-400 years (this work)	Corsica I.	Regular breeding, but in very low density in a small number of localities	This work
<i>Pinus</i> spp.		Germany, Sweden	Old pine stand	Ägust (1992), atlas SOF (1990) cited by Prampart
<i>Pinus</i> spp.		near Baikal Lake, Russia; Lettonia	Breed solely or in colony in Woodpeckers holes, with a majority in pines	Fefelov (2004), A. Avotins cited by Roger & Fossé (2001); Estafev <i>al.</i> (1999) cited by Prampart (2019)
<i>Pinus sylvestris</i>	> 140 years	Scotland	Ancient native pinewood Tree height averaged 17.3m, mean diameter at breast height (DBH) 85cm, n = 10	Summers (1999, 2004)
<i>Populus</i> spp.		Poland, Sweden, Lettonia, Norway		H. Mikkola cited by Prampart (2019); A. Avotin & A.T. Mjøs cited by Roger & Fossé (2001)
<i>Quercus</i> sp. (cf. <i>robur</i>)	300-400 years (Zahner & Loy 2000) cited by Roger & Fossé (2001) “Typical for all sites is the high age of the tree stock”; 250-350 years (Günther <i>et al.</i> 2004)	Germany	high density in some forests (up to 29 pairs/10ha)	Günther <i>et al.</i> (2004)
<i>Quercus</i> sp.		Tunisia	“... nest above all in dead branches of tall oak trees standing out from the forest”	Isenmann <i>et al.</i> (2005)
<i>Tilia</i> sp.		Germany	As alternative species where oaks are declining	Günther <i>et al.</i> (2004)

woodpecker species (Voous 1960; Roger & Fossé 2001), but see Genton (2009) for difficulties experienced by swifts regarding nest-boxes.

A threatened habitat

A decline in the swifts’ arboreal breeding is noted in most countries where it was regular (Germany, Poland, and Finland). The main causes for this decline have been identified in relation with forest management (Günther *et al.* 2004; Mayer & Wilson 2011; Prampart 2019), rather than with a decline of aerial

plankton. Indeed, urban populations supported by nest boxes or favourable building arrangements are stable in Germany (Schaub *et al.* 2016). Tree-breeding swifts are especially good indicators for historical ancient forests with very old trees (Günther *et al.* 2004). The Corsican Pine grows slowly and it can become a very large tree living several centuries (Gauberville *et al.* 2019). Thus, the current Corsican Pines forests are in that matter exceptional, considered as “ancient forests” (i.e. being in place more than 150 years ago; Cateau *et al.* 2015) but their preservation is threatened. Compared

Table 4 – Use of trees for occasional breeding in trees by the Common Swift (F = France, S = Switzerland).

Tree species	Countries/localities	References
<i>Aesculus</i> sp.	Sully-sur-Loire (F)	D. Chavigny cited par Roger & Fossé (2001)
<i>Betula</i> sp.	Poland (frequency unknown)	Prampart (2019)
<i>Castanea sativa</i>	Tecino (550m asl) (CH)	Beaud (2010)
<i>Fraxinus</i> sp.	Parc de la Grange, Geneva (CH)	Beaud (2010)
<i>Larix decidua</i>	only two data from the 19 th century (CH)	Beaud (2010)
<i>Phoenix</i> sp.	Pau (F)	de Vries cited by Roger & Fossé (2001)
<i>Pinus sylvestris</i>	urban area, Spain	Bernis (1988) cited by Casaux Rivas (2004), Anon (1989)
<i>Platanus</i> sp.	Angers, Sully-sur-Loire, Mérignac, Bouchemaine Trèbes (probable) (F), Vandœuvre (CH)	Beaud (2010); Prampart (2019); D. Chavigny cited by Roger & Fossé (2001); Nicolau-Guillaumet & Williams (1982)
<i>Populus alba</i>	Parc de la Grange, Geneva (CH), Lettonia, Norway	Beaud (2010), Roger & Fossé (2001)
<i>Quercus</i> cf. <i>robur</i>	Chapelle-sur-Erdre (F)	Certin & Carpintero cited by Primpart (2019)
<i>Quercus</i> sp.	Spain (probable breeding)	De Juana (1996)
<i>Thuja plicata</i> (mature)	Chênes-Bougeries (CH)	Beaud (2010)
<i>Ulmus</i> sp.	Surrey, United Kingdom	Wheatley (1994), Roger & Fossé (2001)
« nidificanto entro il tronco di un vecchio pino secco ». Is it a regular breeder in Calabrian pine forests ?	Calabria, Italy	Moltoni (1964)

to the «carte géographique de l'état-major» established between 1864 and 1866, which described the forest cover of Corsica during the 19th century, the current forest cover has increased, but mainly for young stands (Panaiotis *et al.* 2017). Moreover, the range of ancient forest has decreased by half (54% at supra-mediterranean vegetation zone and 59% at montane vegetation zone that constitutes the typical range of the Corsican Pine) (Panaiotis *et al.* 2017); this decrease corresponds to the increase of agricultural activities in the mountains (Rota & Cancellieri 2001). Currently, mature forests of Corsican pine with a high proportion of trees of one century old in the public domain cover only ca. 13,000ha. However, forestry management varied over the past 150 years. In early 19th century, forests were heavily grazed by livestock, with numerous fires occurring, and the trees were relatively spaced out but older and more or less harvested; they were probably very favourable for swifts. In the mid-19th, the volume and area of exploited forest increased considerably, with the creation of numerous service roads allowing access to remote forests (491km between 1853 and 1884). More recently, there was a spectacular development of new forest service roads (732km from 1973 to 1994), resulting in the deforestation of hundreds of hectares of forest. We are currently witnessing the development of a so-called “regular” forestry management, where clear cut areas can exceed 10 hectares. In addition, forest fires

have not stopped, destroying hundreds of ha of old stands (see Thibault *et al.* (2019) for threats regarding the Corsican Pine forests and the consequences on the Corsican Nuthatch). Since the 2000s, a return to “irregular” forestry management is gradually taking place, with a significant change affecting 63% of production forests (Guy *et al.* 2017). Applied for almost two decades, the instruction to keep the snag standing is obviously very favourable to many vertebrates and invertebrates. The Corsican Pine is covered by the European Directive on the Conservation of natural habitats (sub-mediterranean pine forests with endemic black pines, n°92/43/CEE from 21st May 1992), but no nature reserve has been strictly implemented yet. The very large Corsican Pines are indispensable for the presence of mammals and birds, rare species (noctules), endemics to Corsica and Sardinia [Great-Spotted Woodpecker (*D. m. harterti*), Mediterranean Flycatcher (*Muscicapa tyr-rhenica*)], or endemics to Corsica [Corsican Nuthatch, Corsican Tree Creeper (*Certhia familiaris corsa*)]. However, Corsican Pine snags disappear quickly (Courtois 2020) and maintaining mature living trees sustaining a greater biodiversity (*i. e.* living trees with cavities) in unexploited forests is crucial to uphold the hosting potential of Corsican forests. The range and the number of large trees are declining in all regions of the world, despite their important role in the ecology and dynamics of forests (Lindenmayer *et*

al. 2012; Lindenmayer & Laurance 2017; Lutz *et al.* 2012), usually for multiple causes (drought, fires, logging, pathogens, etc.), and the Corsican forests are not excluded from this global phenomena.

Electronic supplementary material for this paper is available at http://ecologia-mediterranea.univ-avignon.fr/electronic-app_2020-46-1_thibault/ (video showing two chicks of Common Swifts filmed in their hole on 30/06/2007 by J.-Y. C.)

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