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DISTRIBUTION, POPULATION AND BREEDING ECOLOGY OF THE CORSICAN NUTHATCH, *SITTA WHITEHEADI* SHARPE

Abstract. — The Authors have studied the Corsican Nuthatch *Sitta whiteheadi* for 4 consecutive breeding seasons (1981-84). They have assessed its distribution, status and ecological preferences during the reproductive period, aiming at a better knowledge of this bird, in view of its effective conservation in the future. The species seems to be strictly associated with old forests of *Pinus laricio* and numbers approximately 2000 pairs in total; such a low value stresses once more the need for protection of this small population, as well as a correct management of its natural biotope.

Among the limiting factors playing an important role, the following ones should be mentioned: the predation on pulli by the Great Spotted Woodpecker *Picoides major*; the pine forest fires and tree felling which lead to the alteration and contraction of the habitat, a decrease in numbers and even the disappearance of the Nuthatch from portions of its former range.

Riassunto. — *Distribuzione, status numerico ed ecologia riproduttiva del Picchio muratore corso*, Sitta whiteheadi *Sharpe*.

Vengono presentati i risultati di ricerche condotte in 4 stagioni riproduttive consecutive (1981-84) finalizzate a determinare lo status distributivo e numerico del Picchio muratore corso (*Sitta whiteheadi*) e le sue preferenze ecologiche in periodo riproduttivo, al fine di fornire valide basi per la sua futura conservazione che è parsa strettamente legata a quella delle vecchie foreste di Pino laricio e al loro modo di manutenzione e sfruttamento. Si sono portati a termine 10 censimenti campione in altrettante zone forestali, tenendo conto della loro diversa fisionomia, composizione e altimetria. L'habitat preferenziale è costituito da foreste allo stato naturale con notevole presenza di tronchi morti, schermatura media e moderata copertura, a quote comprese tra 1000-1100 e 1400-1500 (densità media 1,13 cp/10 ha). L'habitat secondario si rileva a quote inferiori e riguarda complessi forestali disetanei ove il Pino laricio entra in associazione con altre essenze (*Pinus pinaster, Abies alba, Fagus sylvatica*) che tendono ad avere il sopravvento, oltre a fustaie mature soggette a sfruttamento (asportazione di tronchi morti), o a foreste coetanee poco mature con

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un forte grado di schermatura e copertura (0,24/10 ha). La specie è assente in zone forestali devastate dal fuoco in tempi recenti. La densità media generale è risultata di 0,85/10 ha (0-1,23).

La consistenza globale di *Sitta whiteheadi*, considerando una superficie forestale a Pino laricio nelle sue varie manifestazioni di circa 24000 ha, può essere valutata attorno alle 2000 coppie, valore basso che evidenzia la necessità della protezione di questa piccola popolazione. Il territorio di una coppia varia tra i 7 e i 10 ha, anche se gran parte delle attività riproduttive e trofiche viene svolta in una zona centrale di 4-6 ha. La distanza media dei nidi è risultata di 290 m (habitat preferenziale) e di 470 m (habitat secondario). I nidi rinvenuti si trovano tra 800 e 1600 m ($x = 1260$ m), quote che sembrano rappresentare i limiti della nidificazione. Il calendario riproduttivo appare molto sincronizzato e le deposizioni (escludendo i rimpiazzi) avvengono in 10-15 giorni compresi tra la fine di aprile e la prima decade di maggio (estremi 28.4/13.5). Tutti i nidi sono ubicati in tronchi morti o marcescenti di Pino laricio; il tipo più usato (58,3%) è alto in media 14,6 m ed ha un diametro di 0,65. L'altezza media generale dei nidi è risultata di 10 m (9,7 nel tipo più usato). Nella gran parte dei casi era evidente l'utilizzo di un foro di Picchio rosso maggiore (*Picoides major*) (inizio di nido o foro di alimentazione) come ingresso del nido (nel 58,3% rivolto verso valle) che *Sitta whiteheadi* riesce poi direttamente a scavare nelle parti legnose friabili poste tra il nucleo centrale e la corteccia. Il fondo del nido è foderato con materiali vari, alcuni dei quali (aghi di pino, trucioli legnosi, ecc.) costituiscono lo strato di base, mentre la coppa è rivestita con materiali fini (piume, crini, ecc.). A volte viene utilizzata come base un vecchio nido di *Parus ater* o *Certhia familiaris*.

Sitta whiteheadi si è dimostrata strettamente sedentaria e legata al proprio territorio anche nel periodo extranuziale; controlli regolari nell'inverno 1983-84 hanno rilevato la presenza costante degli adulti nei pressi del sito di nidificazione, evidenziando così che probabilmente solo i giovani o gli adulti non appaiati compiano erratismi verticali. Tra i fattori limitanti naturali un ruolo importante sembra avere la predazione dei pulli da parte del Picchio rosso maggiore, così come disastrosi sono gli incendi che precludono per molto tempo la possibilità di nidificazione su vaste superfici. Tra le cause non naturali certamente lo sfruttamento del legname determina sensibili alterazioni dell'habitat provocando decrementi di densità o addirittura la scomparsa della specie dai settori interessati con relativa contrazione dell'areale, per cui si auspica una più adeguata programmazione degli interventi forestali.

Résumé. — *Distribution, status et écologie de reproduction de la Sittelle corse,* Sitta whiteheadi *Sharpe.*

Nous présentons les résultats de recherches menées dans plusieures stations où la reproduction eu lieu chaque année durant la période d'étude (1981-84). Le but était de déterminer la distribution de *Sitta whiteheadi* et ses préférences écologiques durant la reproduction. Nous avons suivi dix parcelles échantillons dans différentes zones forestières, en relevant la physionomie, la composition de la forêt et l'altitude. L'habitat préférentiel est constitué par les forêts de *Pinus laricio* non exploitées possèdant des troncs morts et dont le recouvrement est moyen et l'altitude, comprise entre 1000-1100 m et 1400-1500 m (densité moyenne de 1.13 couple pour 10 hectares). L'habitat secondaire est constitué, soit de forêts à des altitudes différentes, soit de forêts de pins laricio en association avec d'autres essences (*Pinus pinaster, Abies alba, Fagus sylvatica*), soit de futaies très exploitées, ou encore de forêts dont

les arbres sont trop jeunes pour que les oiseaux puissent forer une loge. La densité moyenne est alors de 0.24 couple pour 10 hectares. Enfin, l'espèce est absente des forêts et parties de forêts brûlées récemment.

Il résulte une densité moyenne de 0.85 couple pour 10 hectares (0-1.23). En considérant que la superficie boisée en pins laricio est environ de 24.000 hectares, on peut estimer que la population est de l'ordre de 2.000 couples nicheurs. Une telle valeur est faible et doit encourager à prendre des mesures de conservation en faveur de cette espèce. La dimension du territoire d'un couple varie de 7 à 10 hectares, bien qu'une grande part des activités de recherches alimentaires aient lieu dans une zone centrale dont la superficie est évaluée à 4-6 hectares. La distance moyenne entre deux nids varie de 290 m (habitat préférentiel) à 470 m (habitat secondaire).

Les nids furent trouvés entre 800 et 1600 m d'altitude, données qui semblent représenter les limites inférieures et supérieures de la nidification. La période de reproduction semble être synchronisée et la ponte (à l'exception des pontes de remplacements) s'étale sur deux semaines environ, de fin avril à la première décade de mai (extrêmes: 28IV-13V). Tous les nids sont établis dans des troncs morts ou gâtés de pins laricio. La majorité (58.3%) des arbres ont une hauteur moyenne de 14,6 m et un diamètre de 0.65 m. La hauteur moyenne du nid par rapport au sol est de 10 m. Dans la plupart des cas, il apparait que les sittelles utilisent comme base pour leur nid, un forage de Pic épeiche (*Picoides major*), ébauche de loge ou forage pour l'alimentation. Ce qui leur permet de creuser directement dans la partie tendre de l'arbre.

Le fond de la loge comprend des matériaux divers (aiguilles de pins, copeaux de bois) sur lequel en reposent d'autres (plumes, crins . . .).

La Sittelle corse, quant elle est adulte apparait sédentaire et attachée à son territoire, même en période inter-nuptiale, ce qui n'empêche pas des jeunes et des inemployés d'effectuer un erratisme vertical.

Parmi les facteurs limitant, on relève la prédation directe des poussins que le Pic épeiche peut effectuer; mais ce sont surtout les incendies qui constituent le principal facteur limitant en privant les oiseaux de vastes superficies favorables à leur reproduction.

Une exploitation forestière ne tenant pas compte de la nécessité de conserver des sites potentiels de reproduction (arbres morts ou en partie morts) dans des parcelles d'une dizaine d'hectares chacune amènera une diminution de son aire de répartition. La conservation d'une espèce aussi territoriale est étroitement liée au mode de gestion de son habitat.

1. - Introduction.

We believe that an appropriate way to remember the centennial of the discovery of the Corsican Nuthatch (*Sitta whiteheadi*) in Corsica (John Whitehead collected the first specimen in 1883 and in the following year documented breeding) might be to publish the results of research conducted from 1981 to 1984 and aimed at determining, besides its present distribution and demographic status, the various aspects of its ecology and reproductive biology. This information will establish a base for future conservation, which seems to us to be strictly bound to the forest

management of old stands of Laricio Pine. The Corsican Nuthatch was studied in the years following its discovery (WHITEHEAD 1885; JOURDAIN 1911), but was then somewhat overlooked until LOHRL (1960-61) carried out detailed research on its reproductive biology and behavior; these studies, together with others on the calls of the species (CHAPPUIS 1976), were decisive for its definitive specific separation from *Sitta canadensis*, until then considered a very similar or conspecific form (VAURIE 1957). Later on, certain aspects of its breeding were studied (HOBSON 1964) and some general observations were gathered (BRICHETTI 1978, 1979). Other information could be drawn from general reports of the Corsican avifauna, but owing to their heterogeneity our knowledge concerning this interesting insular endemism is very patchy, especially for various aspects studied by ourselves (THIBAULT 1983).

Sitta whiteheadi is believed to belong to the « Sittelles mésogéennes » group, of pan-mediterranean origin, whose palaeobiogeographic reconstruction has been extensively dealt with by VIELLIARD (1978) and resumed by LEDANT (1978) in a study comparing *Sitta whiteheadi* and *Sitta ledanti*, a species surprisingly discovered in 1975 on the algerian Djebel Babor (VIELLIARD 1976; LEDANT 1977).

2. - Methods.

Field research, took place during 4 breeding seasons (23-27/4, 1-15/6/1981; 22/5-5/6/1982; 28/5-5/6/1983; 3-16/6/1984). We carried out 10 standardized censuses in different forest areas, chosen so as to cover most of the species range (Fig. 1A). Meanwhile we collected information on many aspects of its ecology and breeding biology. We integrated this information with the observations collected by Brichetti in May of 1977, of 1978 and of 1980. In September 1980 and from 24/10/1984 to 19/10/1984 observations on territoriality during the non-breeding period were performed.

We carried out Strip Censuses on linear transects 3000 metres long (in three cases the length was halved) and 200 m wide (this width roughly corresponded to that of a territory). In forest area no. 3 we verified this choice, walking along a transect of double width (1500 $\times$ 400 m) and recording at the end very similar densities. Along each strip, we found the nests and we recorded every contact with those territorial pairs, which had the majority of their territory within the transect. Two researchers walked in the same direction at a distance of about 100 m from one another, stopping every 100 m to stimulate the pairs acousti-

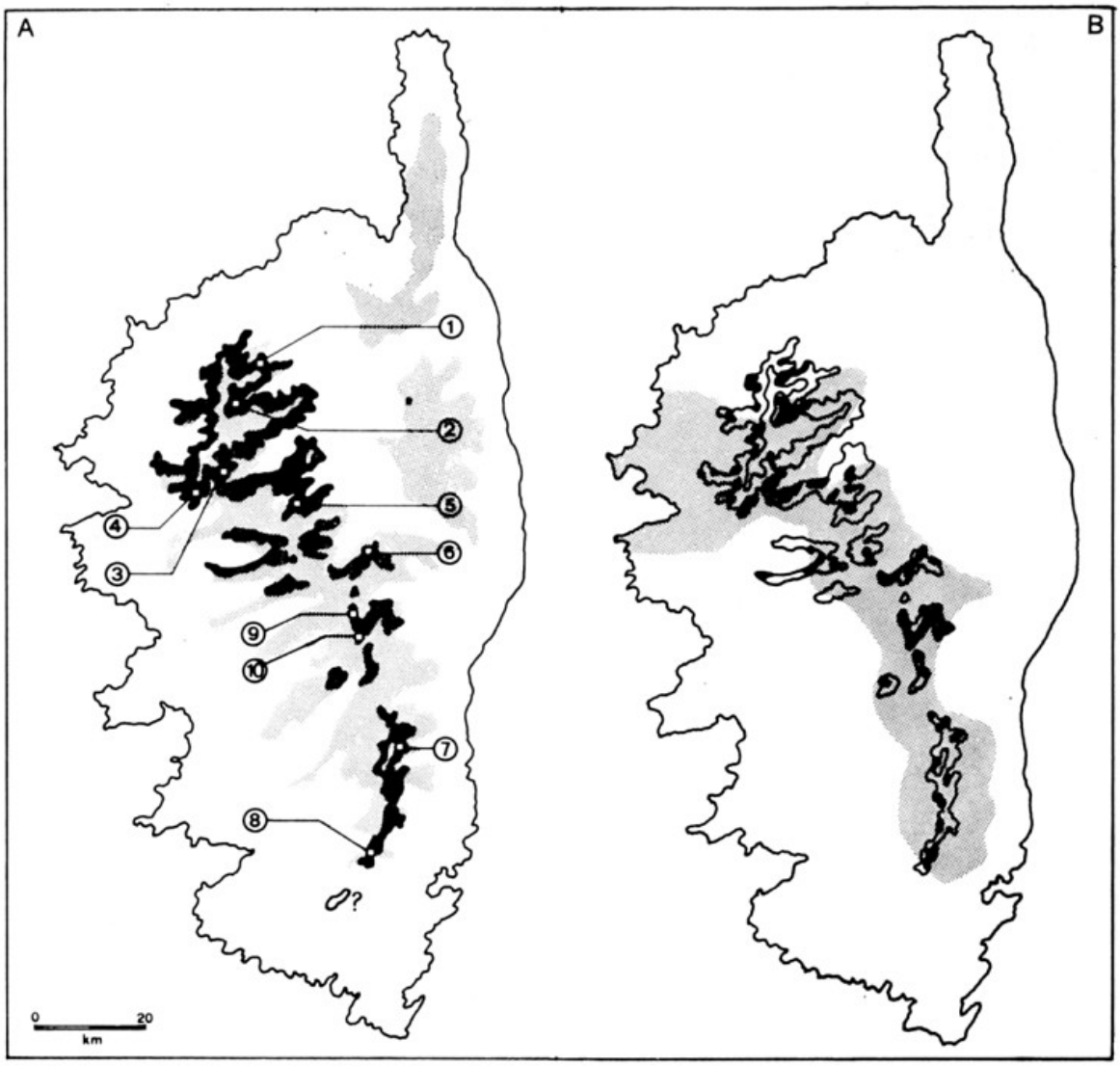


Fig. 1. — (A) Range (*in black*) of Laricio Pine *Pinus* (*nigra*) *laricio* in Corsica (marginal presences and close associations with *Abies alba* are also included). Areas with a yearly pluviometric regime extending from 1000 to 2000 mm (*in grey*). The numbers indicate the forest localities of sample censuses: 1 - Tartagine-Melaya; 2 - Carrozzica; 3 - Valdo-Niello; 4 - Aitone; 5 - Restonica; 6 - Rospa-Sorba; 7 - Bavella; 8 - Ospedale; 9 - Ghisoni; 10 - Marmano-Col de Verde; ? - breeding zones needing confirmation (M. Cagna).
(B) Forest areas with Laricio Pine under management and exploitation (*in black*). Area included in the Regional Natural Park (*in grey*). Both maps were redrawn from DUPIAS *et al.* (1965).

cally with a tape recorder. The total time needed to cover the strip was 6-8 h. About 200 h were employed for the research, and 525 hectares were censused. The transects were planned so as to cover both old and

pure stands of Laricio Pine from their lower to their upper limit (optimal habitat) and less mature forests subject to forest management or mixed with other tree species (suboptimal habitat). We therefore placed the transects in those areas of the forest which in our opinion corresponded for their structure to these two main types of habitat (*white* and *grey* areas of Fig. 2). In every area sampled the habitat structure was described with a conventional method (EMLEN 1956).

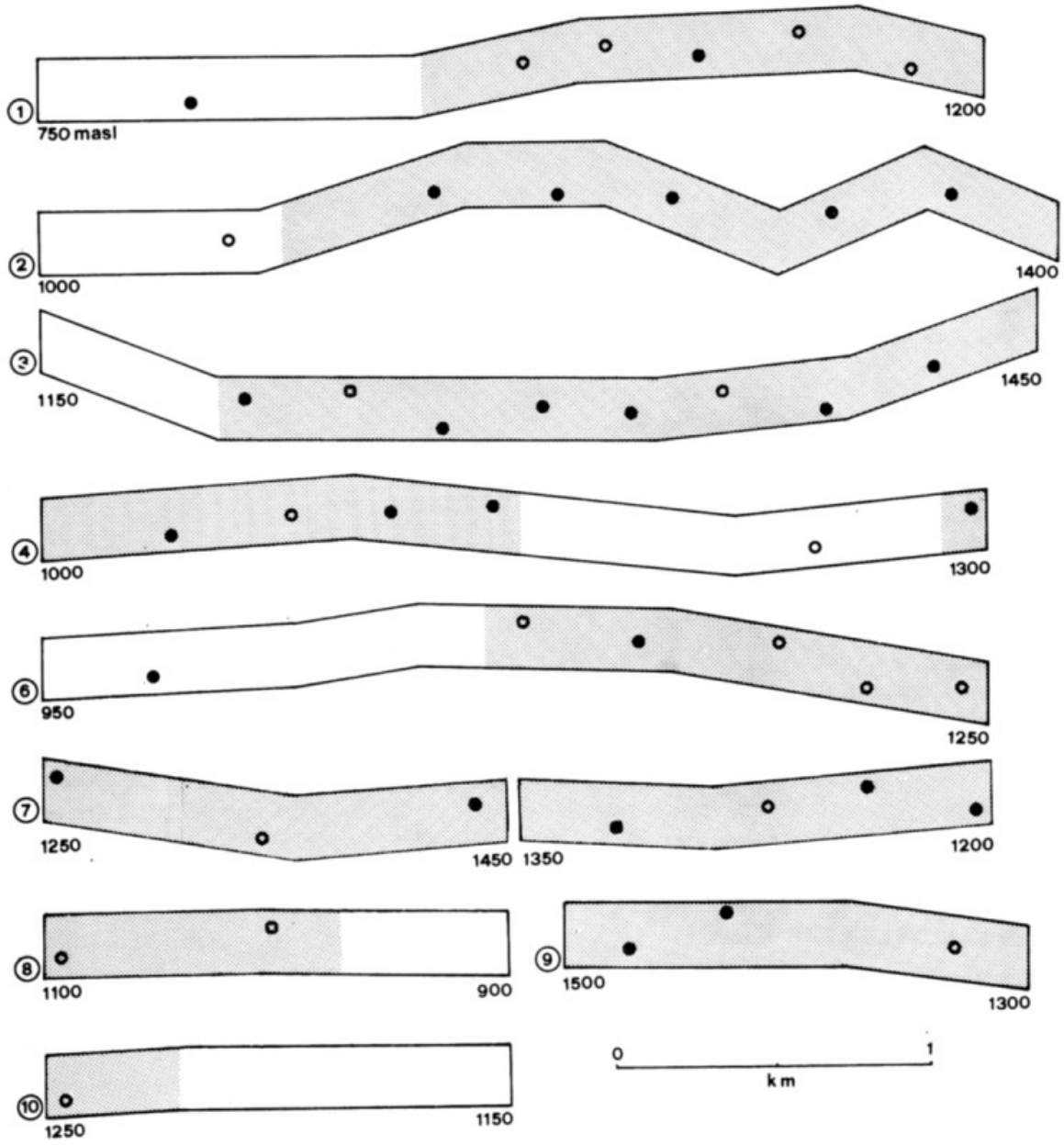


Fig. 2. — Sample transects (*in white* suboptimal habitat; *in grey* optimal habitat) with indication of nests found (*full circle*) and of contacts with territorial pairs (*empty circle*). Transect number 5 is not reported as it gave a nil result.

3. - Characteristics of the Pinus laricio forests.

Sitta whiteheadi is bound throughout the year, and more closely during the breeding period, to the Laricio Pine forests *Pinus* (*nigra*) *laricio*, growing around the great mountainous massifs of the island (Cinto, Rotondo, Renoso, Incudine). These forests characterize the fairly summer dry areas (July-August) of the mountain horizon, with precipitations chiefly concentrated in the autumn and winter. Such forests reach their most characteristic structural physionomy between 900-1000 and 1300-1400 m, while at lower altitudes (up to about 800 m, with local exceptions up to 450-500 m) they become associated with Cluster Pine (*Pinus pinaster*) (typical tree of the upper Mediterranean horizon, extending on sunny slopes up to above 1000 m) and at higher altitudes they reach 1600 m and colonize the top of certain rocky ridges in scattered groups, reaching the uppermost limit of high arboreal vegetation at 1750-1800 m. Among the other trees mixing with the locally encroaching and dominating Laricio Pine are the European Beech (*Fagus sylvatica*) in very damp areas (e.g. Vizzavona Forest), the Silver Fir (*Abies alba*) in the most rugged and least accessible areas where it tends to expand downwards or to invade locally the stands of Laricio Pine (e.g. Aitone Forest). The European White Birch (*Betula verrucosa*) forms groupings at the upper limit of forests and occupies open and well lighted clearings.

The Laricio Pine is very longeval and develops slowly to a maximum height of about 50 m (max. diameter 2 m), with a linear and stately trunk topped by the characteristic enlarged crown, which determines a moderate degree of coverage. Young trees have a piramidal shape and the coverage is high. It flowers in May, grows on deep, fresh and light soils, preferentially siliceous, and is fairly exacting concerning the degree of humidity. In the most typical sites the bush stratum was almost totally absent, whilst a rich undergrowth of *Erica arborea* develops at low altitudes (the northern slopes of the Mediterranean zone, with a less damp climate). The pluviometric regime varies generally between 1000-1300 mm yearly, with extremes of 750-1000 in the lower parts of the valleys and 1200-1800 in the upper, inner areas (Fig. 1B). The forests are exploited when the trees are 300 years (270-360) old, the trunk is 0,8-1 m wide and the height is 25-40 m (DEBAZAC 1964, DUPIAS *et al.* 1965, SIMI 1981, and information from the Direction départementale Agricolture et Office national forêts).

4 - Results.

4.1. *Breeding habitat.*

The link between the breeding habitat of *Sitta whiteheadi* and Laricio Pine forests is very strict and denotes its extreme ecological specialization. Therefore the future of this important endemism is directly bound to the future of the forests and depends upon the management of the old stands of Laricio Pine, which form the true forest estate of Corsica and are therefore subject to regular management and exploitation (Fig. 1B). All the nests found are included in a wide elevational belt ranging between 800 and 1600 m (Fig. 7), while sightings of individuals at higher altitudes are sporadic (max. 1800 m).

The *optimal habitat* (average density 1.13 pairs/10 ha) is between 1000/1100 and 1400/1500 m (max. between 1200/1350 m, mean = 1240) and coincides with the central and upper part of those old pure stands which are not subject to management, which have a mean degree of screening, and which are characterized by the scattered presence of many dead and rotting trees, still standing, and by wide clearings, determining a moderate coverage (Fig. 3,4). The ground is generally fairly sloping, while undergrowth is absent or limited to a low herbaceous, bushy or stony layer; streams, brooks and rocky outcrops are frequently present. Trafficked roads, houses and power lines do not seem to affect the species distribution negatively. The presence of associated arboreal species, such as *Pinus pinaster* at lower altitudes, or *Abies alba* and *Fagus sylvatica* at middle and upper altitudes is tolerated, provided that it is quite secondary and negligible and does not modify the physionomic structure of the Laricio Pine stands.

The *suboptimal habitat* (average density 0.24 pairs/10 ha) generally lies at altitudes below 1000 m and is characterized by forests of varying age where the above mentioned associations tend to balance each other, to the detriment of the Laricio Pine. Low densities were also observed at different altitudes in those mature stands under total or partial management (particularly in those where dead trunks have been felled), and in young uniformly aged forests characterized by a noticeable percentage of trees of medium and low height and by a high degree of coverage and screening (Fig. 6). The same low densities are also found above c. 1500 m, in situations frequently near the upper limit of arboreal vegetation, where trees are scattered, often stunted and well spaced from each other, especially in view of the presence of a steeply sloping rocky substratum and of prohibitive life conditions (Fig. 5).

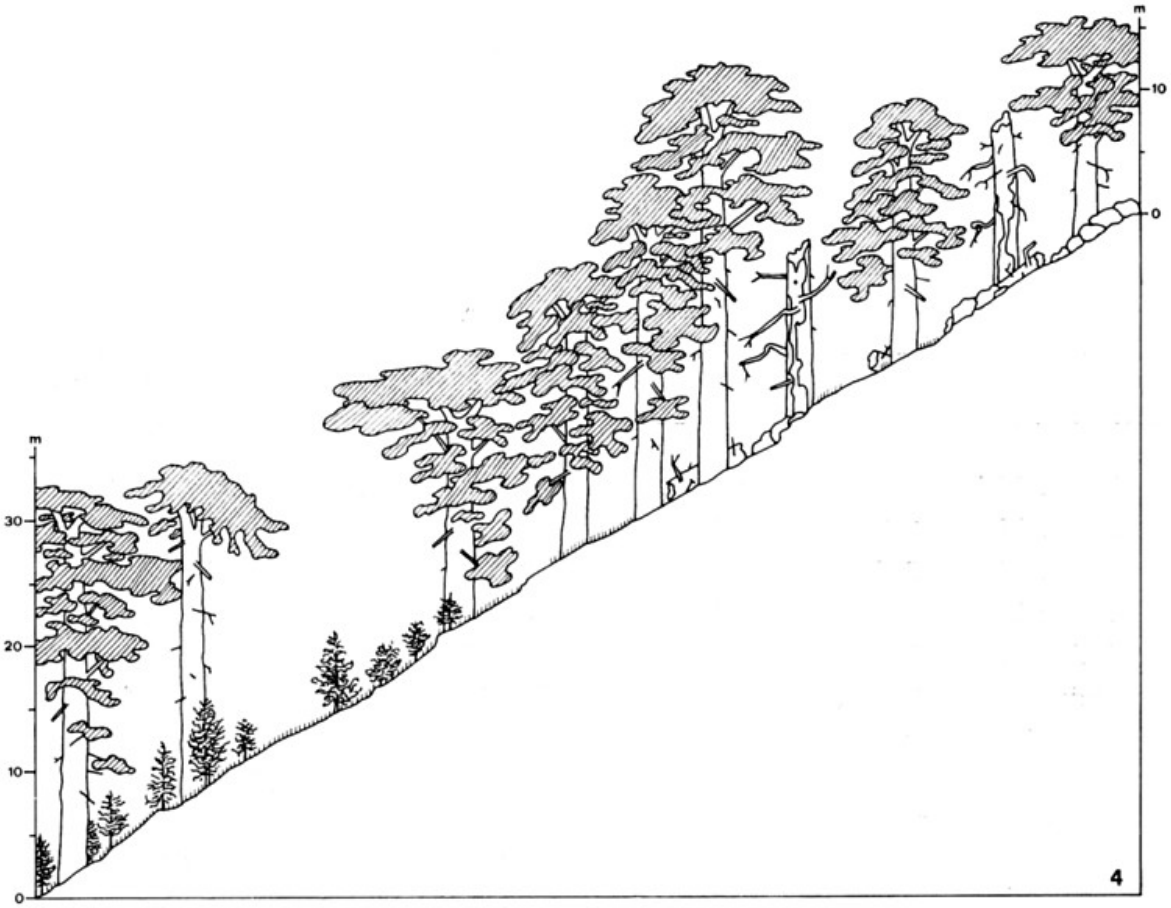


Fig. 3, 4. — Vegetation profile recorded in a Laricio Pine forest section (100 × 10 m) representing an example of optimal habitat, as can generally be found in the central areas of forests (3) or in the upper third of their range, generally difficult to reach and left to natural evolution (4) (cfr. Tab. I).

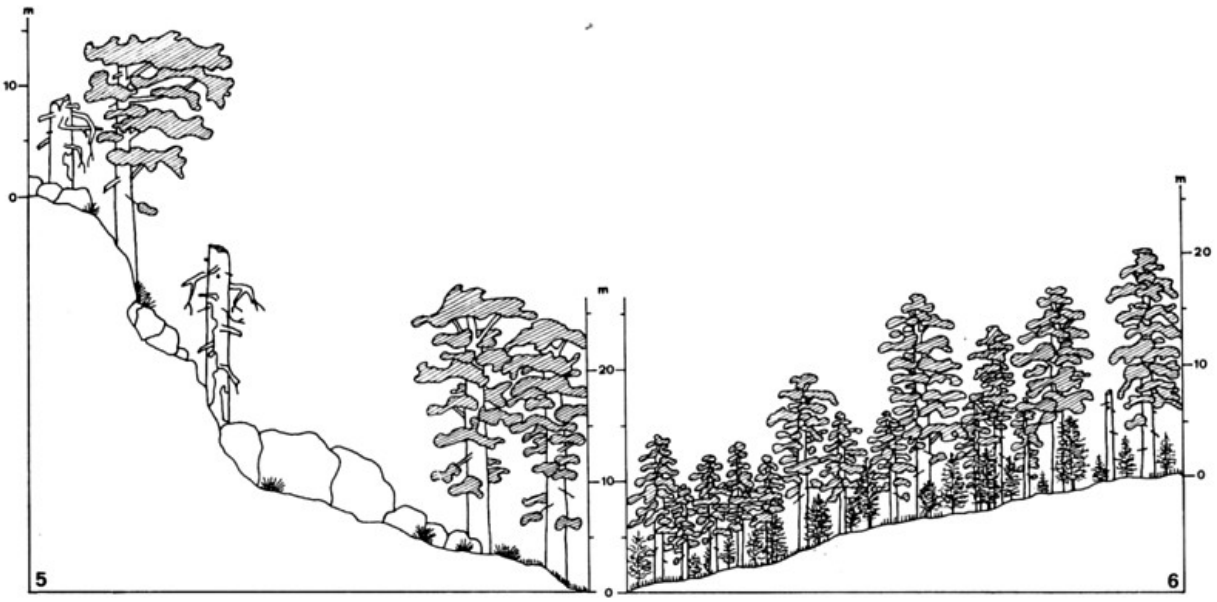


Fig. 5, 6. — Vegetation profile recorded in a Laricio Pine forest section (50 × 10 m) representing an example of suboptimal or secondary habitat at the upper (5) or lower (6) limit of forests (cfr. Tab. I).

TABLE I. — Structure of the habitat of the Corsican Nuthatch. Averages and ranges in brackets.

	Optimal habitat	Suboptimal habitat
Upper Height 1st Layer (m)	22.6 (18-30)	20.7 (18-25)
Lower Height 1st Layer (m)	11.8 (5-20)	8.7 (4-15)
Upper Height 2nd Layer (m) *	5.4 (4-8)	5.7 (3-10)
Lower Height 2nd Layer (m) *	1.2 (1-2)	1.2 (1-2)
Incidence 1st Layer %	87 (60-100)	60 (50-70)
Incidence 2nd Layer % *	21(0-40)	40 (30-50)
Screening 1st Layer	4.6 (middle—/middle)	6.2 (middle+/high)
Screening 2nd Layer *	5.4 (middle/middle+)	6.5 (middle+/high)
Coverage 1st Layer **	0.21	0.43
Slope (degrees)	34	33
* When present %	62.5	100

** (Average diameter of the foliage)^2/(Average distance of the trunks)^2.

4.2. *Distribution.*

The range of *Sitta whiteheadi* coincides with that of the above mentioned forests, extending over the whole median range of the island, from Tartagine Forest in the North to Ospedale Forest in the South (Fig. 1A). Even if the 10 censuses did not permit sampling of all the potential range, the information gathered during our research records that the species is distributed in more than fifteen suitable forests, although with variable densities, and despite apparent environmental similarities. The values in fact ranged from 0.8-1.2 pairs/10 ha at Valdo Niello, Bavella, Aitone, Tartagine-Melaya, Rospa-Sorba, Ghisoni and Carrozzica to 0-0.6 at Ospedale, Marmano - C. de Verde and Restonica. No Nuthatches were present in recently burned forests. The lack of range continuity in some areas (especially in the centre of the isle) depends upon the presence of numerous penetration valleys characterized by vegetation typical of the upper Mediterranean horizon or by a particular diffusion and consistency of *Fagus sylvatica.* Other small distributional gaps may be correlated with particular local situations,e.g. wide burns, as in Restonica Forest (point n. 5), largely devastated by a fire (early 80's) favoured by the conspicuous presence of *Pinus pinaster.* The census carried out along the entire floor of the valley (1350-750 m) recorded a complete absence of the species, which probably found shelter in the uppermost marginal areas, which were spared by fire. The past presence of the species in various parts of this forest was documented by LOHRL (1960-61).

4.3. *Population.*

Former observations induced us to think that *Sitta whiteheadi* inhabits the various forests with variable consistency and density. Therefore we planned the sample transects in order to cover different environmental situations. The average densities (pairs/10 ha) obtained in the 10 censuses are:

Tot. range	Optimal Range	Suboptimal Range
0.85 (0-1.23)	1.13 (0.92-1.5)	0.24 (0-0.6)

In quite favourable environmental situations (where we noticed small groupings of pairs with contiguous territories), we recorded higher densities (1.7-2). Such densities, observed on very few occasions, have a merely indicative value and cannot be used for extrapolations. This seems to occur in the lowest two thirds of forests under management, which are abandoned by pairs who concentrate exclusively on the upper third,

there reaching saturation. The extension of a pair's territory usually varies between 7 and 10 ha, even if most breeding and trophic activities take place in a core of 4-6 ha. Territories have a slightly oval shape and, relative to nest position, are more extended on the side of the valley. In optimal areas, territories are generally contiguous and smaller (average nest-to-nest distance 290 m; extreme values 210-390 m), while in marginal areas pairs need a larger territory, which is more difficult to evaluate (average nest-to-nest distance 470 m; extreme values 400-500 m). In one particular situation two nests were only 120 m apart, but in this case the two nests were separated by a ridge acting as a barrier. In areas with optimal densities the spacing of territories appears to be regular and homogeneous; we found this while checking the validity of the sample transect in the same area (cfr. Methods) and we recorded at very similar densities (1.23 instead of 1.16/10 ha) in both cases.

These results, which did not include sporadic sightings of non-paired males, allow us to estimate, with reasonable accuracy, a total breeding population of about 2000 pairs, on the basis of a suitable forest surface of about 24000 ha.

4.4. *Breeding.*

4.4.1. Breeding season.

From the examination of some nests (reachable without risk of damage), it appeared that there is a certain synchronization in the beginning of egg-laying, which takes place within 10-15 days between the end of April and the first ten days of May (extremes 28-4/13-5) (Fig. 8). Advances or delays of some days are certainly caused by particular, accidental situations of an environmental and climatic nature. In the rainy spring of 1984 a general delay of about a week was recorded. Altitude differences do not seem to affect breeding time. We do not think that first egg-laying normally occurs after the middle of May, but that those observed towards the end of the same month are replacement clutches. The question of a possible second egg-laying remains still open, but we were not been able to confirm or to disprove it for lack of adequate data.

Considering a period of time ranging between one and two weeks (depending upon weather conditions) for nest building, the first pairs should begin nest building from the second week of April on. Hatching normally takes place between mid and late May and fledging between the first and the last week of June, with delays until the beginning of July.

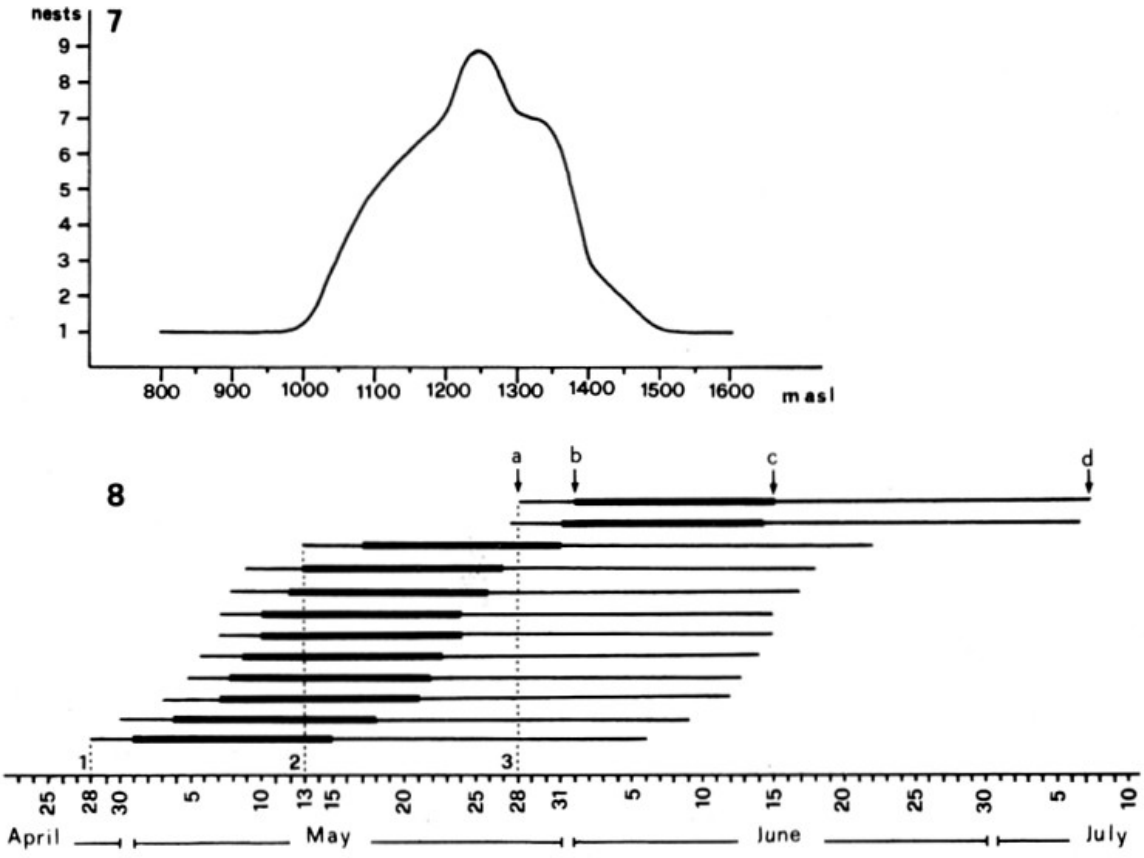


Fig. 7. — Frequency of breeding relative to elevation (n = 55 nests or contacts with territorial pairs).

Fig. 8. — Breeding cycle (a-b egg laying; b-c incubation (14 days); c-d hatching to fledging (23 days)), reconstructed on the basis of the content of some examined nests (n = 12) and displayed in chronological order. More precocious (1), later (2) and replacement clutches (3).

4.4.2. Choice of trunk.

All the nests found were placed in trunks of the Laricio Pine, confirming the observations of other authors. The abundant presence of dead or rotting trunks, spoiled by numerous feeding or nesting holes of the Great Spotted Woodpecker (*Picoides major*), is essential for nest building. The typology and occupation values of the various trunks are graphically represented in Fig. 9. Most nests are found in trunks of medium or great size (type A), totally or partially deprived of bark, and bearing branch stumps in their upper half. Great concentrations of such trunks in wide clearings seem to be avoided by *Sitta whiteheadi* who prefer a casual distribution of these trunks (single trunk or small scattered groups). This fact may be correlated with the presence of the Great Spotted Woodpecker which turned out to be a fairly important limiting factor.

A type of trunk which reminded us, for its size and height, of a « telephone pole » (type B) is also used to a considerable extent. This trunk, normally deprived of most of its bark, can be more frequently found on very steep slopes, exposed to the effects of avalanches which confer upon it its characteristic truncated and branchless aspect.

The third type of trunk (C), which is frequent towards the upper limit of the forests, is a dead tree with a stately appearance, often completely deprived of bark but with numerous branches or stumps in the uppermost part, or in the upper two thirds. This trunk, upon which we recorded the highest nest (26 m), quite often shelters a pair of woodpeckers, which may explain the low percentage of occupation. Types A and (especially) C, with their still compact and tough structure, offer greater opportunities of being re-used in the course of time, while type B is very vulnerable to natural events (avalanches, landslides, collapse of nearby trees).

Sometimes, in marginal or managed areas, quite peculiar trunks, which do not correspond to precise typologies, are also used (types D1-3). In two cases the pines in question were green, excluding the top, which was dead, and which housed the nests. In a third case the pine was small, without leaves, but completely covered with bark, and in a fourth case the nest, the lowest found by us (1.60 m), was placed in a small dead trunk, which was truncated and in close connection with a completely green tree. We think that such atypical situations result, again, from attempts to avoid discovery in the continuous searching of dead trees by the Great Spotted Woodpecker.

Forest areas which were more richly endowed with suitable trunks (Types A, B, C) were also more frequented by the species. Every transect was classed into three categories according to the recorded number of trunks suitable for nests (I = 0-15; II = 16-30; III = + 30) and the corresponding density values (0.3; 0.7 and 1.1 pairs/10 ha) seemed to correspond to the density of trunks. The orientation of the nest's hole relative to cardinal points despite showing a certain preference for the NW, which is the main orientation of the forests, did not prove very meaningful. On the other hand it was noticed that most entrance holes face downhill (58,3%), i.e. towards that part of the territory which the pair usually exploits for its various breeding and trophic activities (Fig. 11). Our observations confirmed that the flight routes followed by the pair on leaving the nest during the brood-rearing period are directed towards the crowns of pines in the underlying area and are for the most part set at an angle of 40°-50°; only rarely are they directed uphill, which is due to the scant number of holes facing towards this way (16.6%).

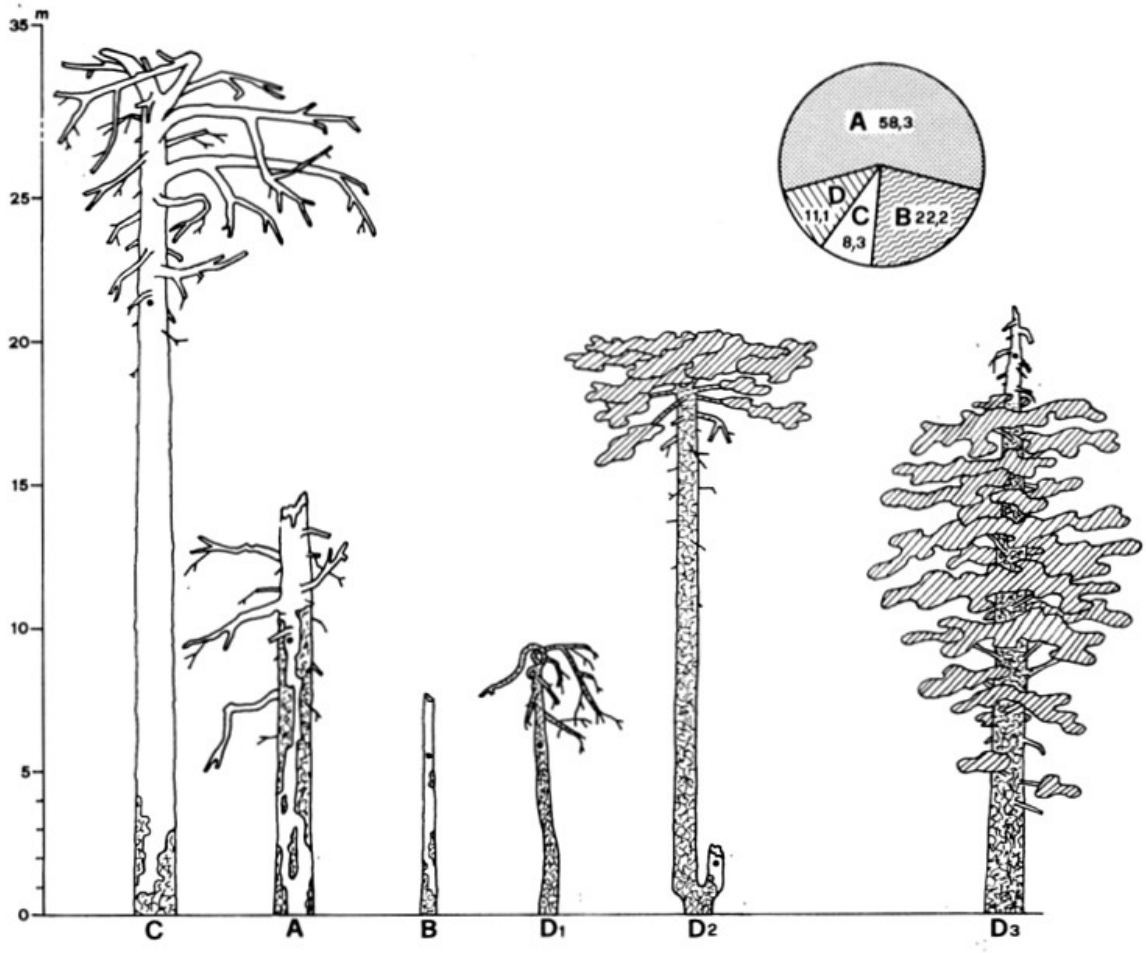


Fig. 9. — Types of trunks used for breeding, drawn in scale according to their average (A, B, C) or real (D1-3) size and occupation percentages (cfr. Tab. II).

4.4.3. Characteristics of nest.

The structural characteristics that Laricio Pine trunks maintain after death allow *Sitta whiteheadi* to build their nests, which have an entrance hole devoid of any lining. Between the thick bark and the central core (compact and irregularly star-shaped) one finds a soft and crumbly layer, which the bird can easily remove (Fig. 10C), the rotting of which is facilitated not only by the activity of xylophagous insects but also by water seeping in through trunk cracks and from the generally truncated top. This rotting process extends with time to the whole trunk, starting at the upper end; this might explain the presence of most nests in the upper third of the trunk; this choice also depends upon a greater likelihood of safety from terrestrial predators, and upon the greater ease of reaching the crowns of high pines for trophic purposes.

An entrance hole, originally opened by the Great Spotted Woodpecker (feeding holes or not completed nests), was recorded in at least 55.6% of the cases (round, more or less well preserved holes); an irregularly (usually oblong) shaped entrance also reminded us of the woodpecker's initial work (Fig. 10). The later work of the Nuthatches does not usually present any particular difficulty and may be slowed down only by a certain firmness of the middle layer. Persistently bad weather (snowfalls and rain) may also delay building, as also observed by LOHRL (1960-61).

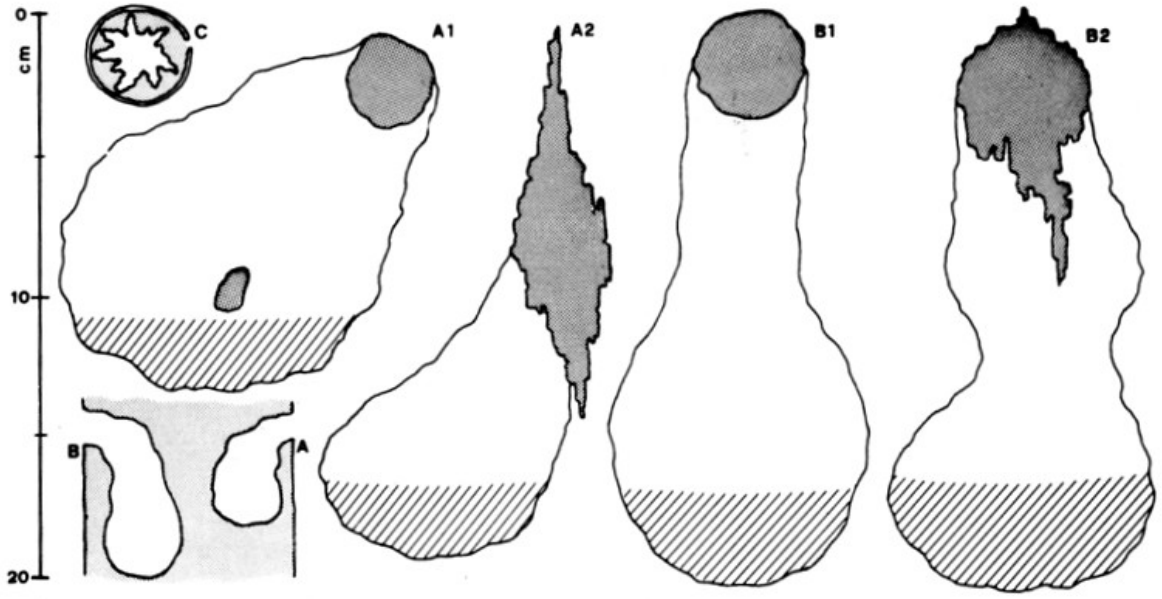


Fig. 10. — Types of holes and nests. The entrance is almost always the work of the Great Spotted Woodpecker *Picoides major*, which was an important factor of predation (A1 preyed nest); transverse section of a dead trunk of Laricio Pine (C).

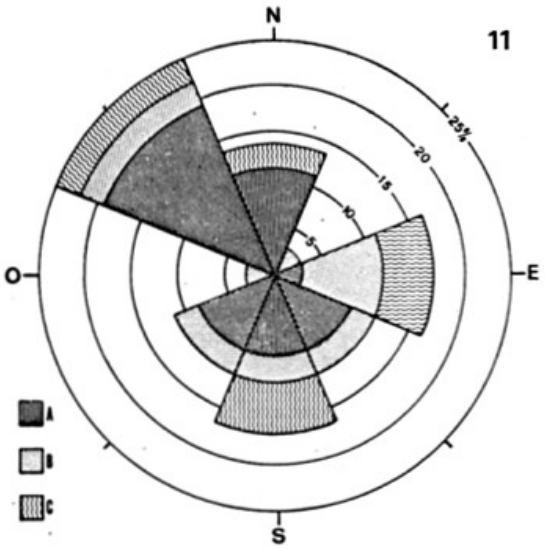
The examination of the internal section of some nestholes (after fledging) revealed at least two main types. The first is flask-shaped and similar, except for its smaller size, to a woodpecker's nest and is probably built after the woodpecker has already carved the internal woody layer downwards (Types B1, B2) through a large opening (4-5 cm). The second type is less elaborate and expands laterally to a smaller (3-4 cm) or irregular shaped entrance hole (Types A1, A2). While in the first case the depth of the cavity may reach 20 cm, in the second it rarely exceeds 12 cm. Quite often (55,5%), the entrance hole is overlooked by a branch stump, which is used by the pair as a roost and which may also function as a cover for the hole.

TABLE II. — Characteristics of nesting site (n = 36 nests). Averages and ranges in brackets.

Trunk type	A	B	C	D	Total
Occupation percentage	58.3	22.2	8.3	11.1	100
Height of trunk (m)	14.6 (7-22)	7.5 (3.5-15)	34 (30-40)	13.3 (2.2-22)	14.5 (2.2-40)
Basal diameter	0.6 (0.4-0.9)	0.3 (0.25-0.4)	1 (0.8-1.2)	0.5 (0.3-0.9)	0.6 (0.25-1.2)
Altitude (m a.s.l.)	1290 (1050-1600)	1212 (800-1550)	1333 (1150-1450)	1137 (1100-1200)	1260 (800-1600)
Slope (degree)	34 (15-45)	36 (10-45)	26 (15-35)	27 (20-35)	33 (10-45)
Height of nest	9.7 (4-17)	5.6 (2.7-10)	21.3 (13-26)	11.6 (1.6-20)	10 (1.6-26)

4.4.4. Nest materials.

The examination of 8 nestholes enables us to observe that the materials used to line the cavity are quite various, and that their quantitative ratios are casual (Fig. 12). The shape of the nest itself is generally oblong (7 × 8.5 cm) and roughly corresponds to the size of the incubation chamber. In general there is a basal layer of coarser material (pine needles, woody chips, bark fragments, etc.) that makes up most of the nest structure, while the inside of the cup is lined with soft and thin elements (animal hairs, vegetable threads, down, etc.). Material (e.g. pine needles) may be brought in during the brood-rearing stage too. Certain lining material (hairs, threads, down, etc.) are present in every nest, while other, coarser material is used only on certain occasions (pine needles 37%; moss and lichens 62%; chips and bark 75%). In some cases, the nests seem to be built over those abandoned by other forest species (e.g. cases n. 4, 8). Often, cavities close to each other on the same tree are alternatively inhabited, while on certain occasions we noticed that two entrances were used to enter one nest (the secondary one usually being a longitudinal crack in the bark), especially in trunks in advanced stages of decay.



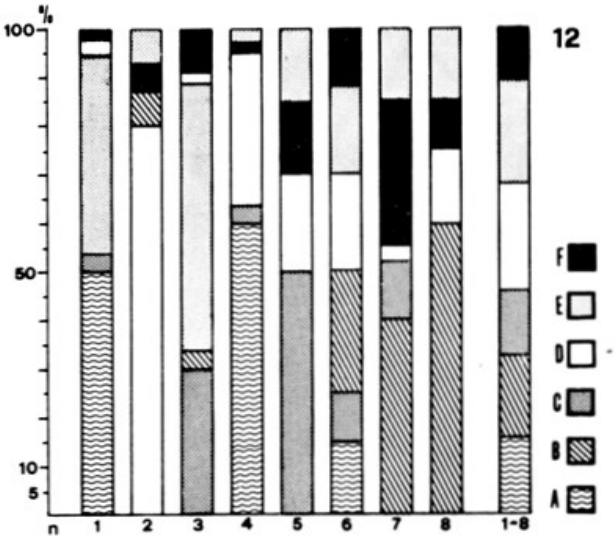


Fig. 11. — Orientation of nest entrance relative to main cardinal points and morphology of the valley; towards valley side (A); sidewards (B); towards mountain side (C). The various possible orientations have been grouped in 8 cardinal points and intermediate values have been included in the nearest one.

Fig. 12. — Volume of various materials used in the building of 8 nests and their average percentage: A - pine needles (6-11 mm); B - moss, lichens; C - woody chips, bark fragments; D - vegetable fibres, small roots; E - feathers and down (especially of the species itself); F - animal hairs.

4.5. *Sedentariness.*

Sitta whiteheadi is strictly sedentary for most of the year and may be forced to make altitudinal vagrancies during winter months because of abundant snow. All authors agree that this happens quite regularly.

During various stays in Corsica, between April and October, we never observed the species below 750 m. On the contrary we observed strong territoriality in the adults in the post-breeding period. Towards mid-September of 1980, acoustic stimulation under one trunk sheltering the previously occupied nest (1350 m) caused the flocking first of the adults, then of two others individuals (juveniles?) who appeared to be less interested in the call. At mid-October of 1983, in the same locality, the stimulation enabled us to verify the presence of a still highly territorial pair. The marked sedentariness and territoriality hypothesized by ourselves, at least among adults, were confirmed by the researches of Jean Quiriconi (Regional Natural Park) who, upon our request, checked, 3-4 times per month, three breeding sites at about 1100 m (Aitone Forest), getting as many as 55 contacts out of 56 trials. These results, particularly interesting if we consider the unfavourable climatic and environmental conditions of the 1983-84 winter, induce us to think that only the juveniles undertake altitudinal vagrancies (possibly non-paired adults as well).

4.6. *Limiting factors.*

Among the natural factors limiting the number and diffusion of *Sitta whiteheadi,* probably one of the most important is the predation on nestlings by the Great Spotted Woodpecker. Our observations led us to direct verification of a case of predation in a nest which, at the first check, contained c. 10 day old pulli; ignoring the entrance hole, which was too small (3 cm), the woodpecker drilled a new, oblong shaped one (1×2 cm) exactly calculating the location of the nestlings which it then extracted one by one, leaving blood, down and thin nest material around the walls of the hole (Fig. 10, A1).

Considering that the breeding seasons of the two species are fairly synchronized, it is likely that preyed pulli make up a pretty important trophic source for woodpecker nestlings. We realized that woodpeckers were interested in the presence of *Sitta whiteheadi* nests, as quite often they were the first to answer our acoustic stimulations. Furthermore, the fact that high densities of woodpeckers may be found in areas inhabited by the Nuthatch and that the Nuthatch is largely dependent upon its

holes induces us not to underestimate the importance of this type of predation.

Although we cannot avail ourselves of direct observations, we think that eggs and nestlings make up a trophic source for certain species of small rodents and reptiles. The cohabitation with other birds on the same trunk (*Apus apus* 3 cases; *Muscicapa striata* 2 cases and *Parus ater* 1 case) did not seem to establish territorial or trophic competition.

Among other natural factors negatively affecting breeding success (besides the collapse of the trunk, or of part of it, caused by various events, i.e. landslides, strong wind, fall of nearby trees, etc.), periods of persistent bad weather, particularly in the first days after hatching, cannot be overlooked.

Forest fires (whose caused by various factors but always dependent upon man's presence) deserve separate treatment, as they are undoubtedly the « natural events » which will heavily undermine the presence of the species for a long time in wide forest areas. The census carried out in Restonica Forest (two years after its partial destruction) gave negative results, revealing furthermore very low density of the Great Spotted Woodpecker itself. While in future years woodpeckers will be able to use burned trees, the lack of the soft, median woody part and especially of living trees will damage the presence of *Sitta whiteheadi* for a time span which is difficult to evaluate.

From our studies it is clear that in forests under management and exploitation, densities decrease to a noticeable extent, especially in areas where the optimal habitat is altered by the felling of the various types of dead trees used for breeding. In the upper part of the Valdo-Niello Forest, a re-check census, carried out after management operations (partial removal of dead trees), recorded a decrease of 60% of the breeding pairs. In particular a pair that had bred for four years in the same trunk definitively abandoned the territory after its felling. Also locally harmful are the wide clearings opened in the high arboreal vegetation in order to build roads and ski-tracks. Furthermore, a good percentage of dead trunks felled in late spring and in summer may contain active nests.

5. - Discussion.

We believe that our study fills some gaps in the knowledge of this interesting insular endemism, considered worthy of special protection in Europe (PARSLOW & EVERETT 1981) and satisfying at least 7 of the 13 qualifications proposed by ADAMUS & CLOUGH (1978) to evaluate the

fitness of a species for conservation: nest fidelity, seasonal sedentariness, localized spatial distribution, rarity, endemism, habitat specialization and scientific value. The breeding habitat of *Sitta whiteheadi* is provided by Laricio Pine forests extending from 800 to 1600 m (extreme altitudes at which occupied nests were found), while we think that sporadic sightings of individuals (singing ones too) at high altitudes (max 1800 m) (*pers. obs.*; Thibault *pers. comm.*) must consist in simple vagrancies for trophic or casual reasons, in a quite marginal section of the breeding territory. Slightly lower breeding altitudes (min. 760 m) have been recorded by LOHRL (1960-61). The presence of the species in forests where the Laricio Pine is absent or scantily represented is totally meaningless and marginal; in Aitone Forest density has changed from 1.47 pairs/10 ha in the old Laricio Pine forests to 0.38 in the part mixed with *Fagus-Abies-Pinus*. Recently, the species has been observed in a thicket of *Pinus pinaster* in a beech wood (Castaniccia), where breeding is thought to be possible (Miège in THIBAULT 1983). The present distribution of *Sitta whiteheadi* coincides with that of the Laricio Pine, and there are at least 16 forests (*pers. observ.*; THIOLLAY 1967) where its presence in the breeding period is known. Old sightings on the Montagna di Cagna (Jourdain in THIBAULT 1983) have not been confirmed for lack of specific research; the Laricio Pine is absent in this isolated massif of the extreme South, being replaced in the upper areas by *Abies alba*.

The estimated breeding population is about 2000 pairs. This differs by about 30% from the figure given by LOHRL (1960-61) at the end of the 50's (c. 3000 pairs), which was estimated on a forest surface of 43750 ha and on the basis of territories of about 10-15 ha. Without criticizing his method of calculation, which perhaps did not take into account all the different forests and altitudes, we think that the species has probably suffered a decrease corresponding to that of its breeding habitats in the last few decades; this conclusion only holds if forest values correspond to reality.

The breeding season appears to be well synchronized, and egg-laying takes place within 10-15 days, between the end of April and the first ten days of May; these results do not differ from those of other authors, excluding JOURDAIN (1911) who locates the period of greatest presence of complete broods at around May, 25th-26-th. We recorded substitution broods, but we cannot confirm possible second laying, which might be deduced from Furnkranz's observations (in LOHRL 1960-61) concerning juveniles which are still fed by parents on 13th of August at 900 m (Restonica Forest).

All the nests found were situated in trunks of the Laricio Pine, the trunks being dead (88.9%) or still partially living. Among the various authors consulted, only Schiebel (in FRIDERICH 1923) reports a nest placed in an old beech at the edge of an area accupied by pines. The lowest nest was placed at 1.60 m, the highest at 26 m, a value exceeded by WHITEHEAD's observations (1885), who in the same type of trunk found nests at a height of 22-32 m.

Entrance holes are mostly due to the initial work of the Great Spotted Woodpecker (breeding or feeding holes), a fact recorded by various authors, except WHITEHEAD (1885) who considers their utilization to be pratically non-existent. The materials employed to line the cavity are quite various, as are their quantitative ratios; the inside of the cup is reminiscent of a tit's nest, while the base generally consists of a considerable layer of coarse material, which in some cases seemed to be more recent than that of the upper layer, suggesting that old nests of the *Parus ater* and the *Certhia familiaris* might have served as a base, because of the presence of noticeable amount of moss and pine needles respectively. Even if re-checks of cavities used in previous years have not yielded useful data, we think that the *Sitta whiteheadi* might re-use its old nests, as also hypothesized by LOHRL (1960-61).

Our observations in the non-breeding periods revealed a strict sedentariness of the species throughout the year, at least among the adults, who remain near their breeding site and display territorial behaviour. We think that winter sightings in chestnut groves or even in gardens in villages on the floor of valleys (at 300-600 m) or near the West coast of the isle (GIGLIOLI 1890; PAYN 1927; THIBAULT 1983) relate to juveniles or non-paired adults (often mixed with groups of *Paridae*).

Among natural limiting factors, we think that nestling predation by the Great Spotted Woodpecker must not be underestimated, particularly if we consider that the two species share the same habitat and have fairly synchronized breeding seasons. The fact that the *Sitta whiteheadi* was particularly alarmed by the predator's presence has been noticed by other authors too, especially in the brood-rearing period (LOHRL 1960-61; SIMON 1970). But certainly the most important factors limiting the number and distribution of the species are to do with the state of health of natural environments. While extensive fires determine the disappearance of the species for a time which is difficult to evaluate, improper forest management may cause noticeable density decreases and break the continuity of an already fragmented habitat.

The Regional Natural Park, wherein lies almost the whole range of the species (Fig. 1B), guarantees an organic application of proper ma-

nagement principles. The forests of Laricio Pine will need in the future a series of interventions arranged between Park and forest Agencies, aimed on one hand at the legitimate exploitation of timber, on the other at securing the conservation of the physionomic structure of the *Sitta whiteheadi*'s habitat (BRICHETTI & DI CAPI *in preparation*).

6. - Acknowledgements.

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