

STATUS AND CONSERVATION OF THE RED SQUIRREL (*Sciurus vulgaris*) IN PORTUGAL

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ABSTRACT - The historical and recent status and distribution of the red squirrel (*Sciurus vulgaris*) in Portugal are analysed using published data, preserved material and unpublished information. In the past the red squirrel occupied the whole of Portugal, but died out towards the end of the 16th century. Now, however, red squirrels have moved back in from Spain and recolonised forests in the north of the country. An important factor limiting the distribution of squirrels in the past was the availability of suitable habitat which provide shelter and food, such as conifer woods. Hunting pressure may also have affected numbers. In Portugal the conservation status of *S. vulgaris* is Rare.

Key words: Red squirrel, occurrence and conservation

INTRODUCTION

The red squirrel (*Sciurus vulgaris* L., 1758) is an abundant and successful rodent throughout most of its range. It is found over most wooded parts of Eurasia, from Ireland in the west to Japan in the east and from the tree-line of Scandinavia to the Mediterranean sea in the Balkans (Corbet, 1978). In Portugal, after an absence of four centuries, red squirrels were recently recorded in pine forests (*Pinus pinaster*) in the most northern part of the country (Petrucci-Fonseca and Mathias, 1987; Mathias and Petrucci-Fonseca, 1992). In this paper we consider the extinction of the species in the 16th century and the recent recolonisation of the north of Portugal by squirrels moving in from Spain. Management options for conserving the red squirrel are also discussed.

MATERIAL AND METHODS

We have used information obtained from a literature review, from questionnaires and

from museum collections. Data from the literature concern the number of sightings, the year and localities recorded. Comments about whether the populations were increasing, declining or stable have also been noted. Questionnaires were aimed at seeking information on the occurrence, distribution and potential threats to red squirrels in Portugal.

Craniometrical and morphological data have been collected from specimens kept in the Natural History Museum (NHM), London, and Museu Bocage (MB), Lisbon. Twenty eight specimens of both sexes have been examined: SPAIN (NHM): *S. v. infuscatus* Cabrera, 1905 - Cierdilla, Madrid, 2 males and 2 females; La Granja, Segovia, 1 male (7.10.17.1 male, paratype); Valla Trueso, Avila, 1 male; *S. v. numantius* Miller, 1907 (= *S. v. infuscatus*) - Arrechavaleta, Victoria, 2 males; Pajares, Asturias, 1 female; Panticosa, Huesca, 1 male and 1 female; Pinares de Quintanas, Burgos, 1 female (8.8.4.52 female, type); Potes, Santander, 1 male and 2 females; *S. v. seguræ* Miller, 1909 (= *S. v. infuscatus*) - La Sagra, Grana-

da. 1 male: Sierra de Segura, 2 males and 3 females (8.9.24.3 female, type); FRANCE (NHM): *S. v. alpinus* Desmarest, 1822 (= *S. v. fuscoater*) - Basses-Pyrénées, 1 male; GREECE (NHM): *S. v. fuscoater* Altum, 1876 - Mt.Olympus, 1 male and 2 females; JUGOSLAVIA (NHM): *S. v. fuscoater* - Sarajevo, 1 male; GERMANY (MHM): *S. v. fuscoater* - Rudolstadt, Thuringen, 1 male (95.4.18.7 male, type); PORTUGAL (MB): *S. v. infuscatus* - Viana do Castelo, Minho, 1 female (90.02). The individuals were measured by standard techniques.

HISTORICAL INFORMATION

The first known fossil remains of *S vulgaris* in Europe (*S. warthae*-*S. whitei*-*S. vulgaris*) were referred to the lower Pliocene (Chaline and Mein, 1979) but the first remains of red squirrels found in Portugal were hemimandibles from the epipaleolithic shell mound of Cabeço de Arruda (Santarém, central Portugal), dated 5.000 to 6.000 y.a. (Telles-Antunes, 1985). Apparently these hemimandibles belong to an old Iberian stock that included large-sized specimens of an indeterminate subspecies but which were probably close to the extant Iberian group *infuscatus-hoffmani*.

Telles-Antunes (1985) examined historical and toponymic data and believes that red squirrels were widely distributed in the north of the country from the Middle Age up to the 16th century. This author suggested that these animals were immigrants from the mountains of Leon and Cantabrian and belonging in the subspecies *alpinus*, a post-glacial invader in the Iberian Peninsula (Valverde, 1967). However, no remains have been found to test this idea. In the centre and south of Portugal, red squirrels were less abundant but larger in size. They were almost certainly related with the Iberian stock *infuscatus-hoffmani*, which seems to be confirmed by the fossil hemimandibles of Cabeço de Arruda.

By the 16th century, due to an increased deforestation, especially in relation to farming and the naval industry, red squirrels became confined to small areas and by the end of the century had become extinct in Portugal.

RECENT DATA

1. Occurrence and distribution

After an absence of four centuries, red squirrels can now be found in the north of Portugal where they have colonised from Spain (Petrucci-Fonseca and Mathias, 1987; Mathias and Petrucci-Fonseca, 1992). During the 1985-86 hunting season (October to February), the first three identified specimens, were shot in conifer woods (*Pinus pinaster*) in three Minho's localities: Monção, Ponte de Lima and Vila Nova da Cerveira. Since then several specimens were captured or observed from nearby localities, also pine woods.

The present distribution of *S.vulgaris* in Portugal is included in Figure 1. The map has been drawn using two kinds of data: sightings and shooting. All references concern the most northern part of the country.

2. Description

Measurements. Most of the material studied (made available by hunters) was already mounted and, as such, external or cranial measurements could not be taken. We only could measure one subadult lactating female, recently shot and offered to the 'Museu Bocage' (Lisbon): body measurements - total length 420.0mm, tail 185.5mm, hind-foot 54.7mm, ear 28.1mm; cranial measurements in Table I.

Colour. The specimens from Portugal examined show two distinct colour patterns which suggest the occurrence of two main colour phases in these populations. These

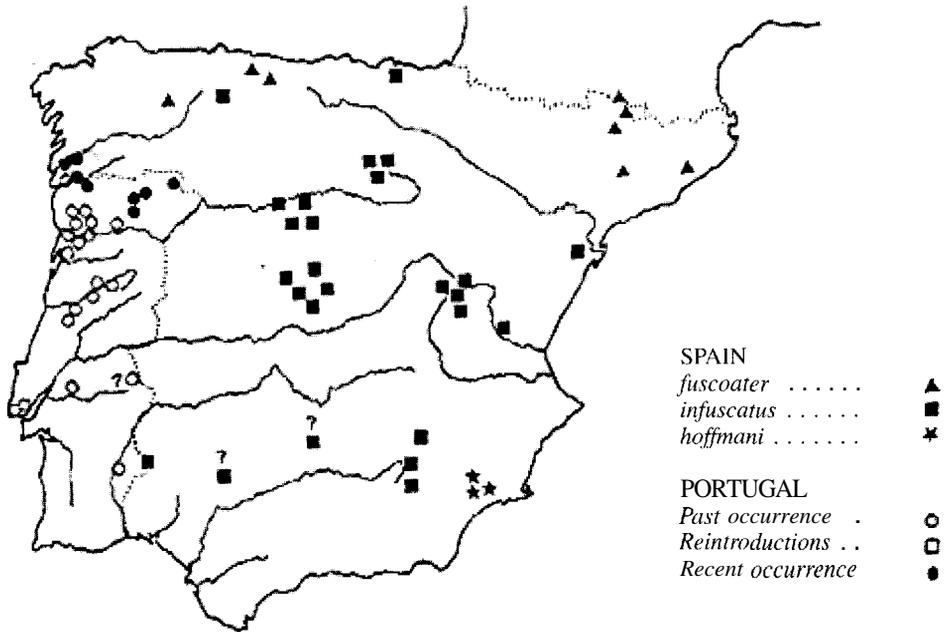


Fig. 1 – Past and recent occurrence of *S. vulgaris* in Iberian Peninsula (data from Spain adapted from Valverde, 1967; historical data from Portugal adapted from Telles-Antunes, 1985)

are: (i) a red phase, characterised by a reddish brown general colour, becoming brown on the head and around the eyes, and (ii) a dark phase characterised by the very dark brown colour on the back, extending forward to the head and outer surface of legs. The extension of white on the ventral surface of the body was variable, but never restricted to median region. In all of the specimens analysed the ear tufts were well developed and very dark brown. Recent field sightings confirm the occurrence of red and dark squirrels, but no information on their relative proportions in the populations is available.

Taxonomic status. Seven subspecies of the red squirrel have been reported in the Iberian Peninsula on the basis of difference, in size and colour. These are: *infuscatus* Cabrera, 1905; *baeticus* Cabrera, 1905; *nummantius* Miller, 1907; *seguræ* Miller, 1909; *russus* Miller, 1907; *alpinus* Desmarest,

1822 and *hoffmani* Valverde, 1967 (Cabrera, 1905; Miller, 1907, 1909; Valverde, 1967). However, only three of these forms have been accepted by recent authors. They are: *fuscoater* Altum, 1876 (synonyms: *alpinus*, *russus*); *infuscatus* (synonyms: *baeticus*, *nummantius*, *seguræ*) and *hoffmani* (Ellerman and Morrison-Scott, 1951; Sidorowicz, 1971; Corbet, 1978).

At present the range of *S.v.fuscoater* seems to be restricted to the most northern part of Iberia, including the Spanish slopes of Pyrenees, while *S.v.infuscatus* is referred from almost every mountain range of Iberian Peninsula. The main differences between *infuscatus* and *fuscoater* is that the former is larger (Table I). Moreover, both forms occur in two colour phases, a light phase and a dark phase which in *fuscoater* often includes melanic individuals (e.g. Cabrera, 1905; Sidorowicz, 1971).

The subspecies *hoffmani*, known only from Murcia and Sierra de Espuña (Spain), in-

TABLE I. Cranial measurements (minimum, maximal and mean) of *S. v. infuscatus* (incl. *numantius* and *segurae*) from Spain and from Portugal. *S. v. fuscoater* (incl. *alpinus*) from France (FR), Greece (GR), Jugoslavia (JL) and Germany (GM), .

Skull measurements (mm)	<i>S. v. fuscoater</i> (FR,GR,JL,GM)	<i>S. v. fuscoater</i> (FRANCE)	<i>S. v. infuscatus</i> (SPAIN)*	<i>S. v. infuscatus</i> (SPAIN)**	<i>S. v. infuscatus</i> (PORTUGAL)*
Condylobasal length	47.3 - 48.1 (47.64)	43.2 - 50.6 (50.36)	49.1 - 52.9 (50.77)	43.2 - 55.0 (47.92)	47.9
Zygomatic width	30.8 - 32.1 (31.29)	29.0 - 32.3 (31.28)	31.8 - 34.8 (33.12)	28.5 - 36.4 (32.93)	32.1
Nasal length	15.5 - 17.4 (16.13)	-	17.0 - 19.9 (17.96)	-	16.7
Nasal width	7.2 - 8.7 (8.09)	-	8.4 - 10.1 (8.94)	-	8.2
Postorbital width	16.8 - 19.4 (17.08)	-	17.6 - 19.8 (18.59)	-	17.1
Upper tooththrow length	9.2 - 10.4 (9.91)	9.0 - 9.8 (9.51)	9.6 - 12.5 (10.59)	9.2 - 11.2 (10.11)	11.1
Upper diastema length	11.6 - 12.9 (12.30)	11.8 - 13.2 (12.63)	11.8 - 13.4 (12.70)	11.2 - 15.4 (13.13)	11.9
Palatal length	23.4 - 24.8 (24.30)	-	25.0 - 27.8 (26.12)	-	27.0
Palatal width	6.0 - 7.0 (6.53)	-	6.1 - 7.5 (6.94)	-	7.2
Lower tooththrow length	9.6 - 10.2 (9.97)	8.9 - 9.8 (9.37)	9.8 - 11.5 (10.54)	9.2 - 11.0 (9.96)	10.2
Mandible length	32.4 - 34.7 (33.53)	-	33.6 - 38.1 (35.43)	-	33.7
N ^o specimens (N)	6	65	21	30	1

*This work, ** Sidorowicz (1971)

cludes the largest Iberian squirrels. Their general colour is greyish with white hairs in the underside of tail and head. No colour phases have been described for these populations (Valverde, 1967).

So, in spite of the considerable variation in the colour of the pelage, and the small sample analysed, the description given above for Portuguese specimens, including measurements, seems to confirm the recolonisation of Portugal by the subspecies *infuscatus*. It was suggested that *fuscater* (= *alpinus*) previously occurred in Medieval times in the north of the country (Telles-Antunes, 1985). The subspecies *fuscater* is the only Iberian form which does not live extensively in pine woods, occurring as well in broadleaf woods of oak, *Quercus* sp, beech, *Fagus* sp. and sweet chestnut, *Castanea* sp. (e.g. Valverde, 1967; Purroy and Rey, 1974) which were very abundant in the north of Portugal in the past.

The recent spreading of Spanish *infuscatus* into Portugal is most certainly related either to high population numbers in north-western Spain and to reforestation in the north of Portugal by the Ministry of Agriculture which offer large and continuous areas of pine woods.

Etymology. The recent common name for Portuguese red squirrel is 'esquilo' and the Spanish name is 'ardilla comdn'. The name 'esquilo' derived from the latin name *sciurus* which in turn comes from the greek 'skiouros'.

CONSERVATION

Red squirrels are very attractive animals and greatly liked by the public. There have been several attempts during the last 150 years to reintroduce this species into Portugal, apparently without any scientific objectives (Seabra, 1900; Trouessart, 1906; Baeta-Neves, 1956; Valverde, 1967;

Rosário, 1993; R.Matos, pers.com.). The first three unsuccessful attempts were carried out, between 150 and 160 years ago, i.e. long before the recent recolonisation of northern Portugal. The first attempt was carried out at Sintra (central Portugal), during the second half of the 19th century, with central European specimens. In the second attempt, red squirrels, presumably from England but identified as *S.v.alpinus* by Gama (1957), were introduced on two occasions into Belas (central Portugal) between 1872 and 1900. It is known that a population survived there for over thirty years. The third attempt was carried out at Fornos de Algodres (northern Portugal), probably using Belgian specimens, sixty years ago. None of these specimens or their descendants have been captured or seen during the past 50 years.

The most recent introductions of red squirrels to Portugal have been carried out in parks, in or near urban areas. The first in 1993, was carried out in the Ecological Park of Monsanto, bordering the city of Lisbon (central Portugal), and involved between 12 and 15 animals from near Madrid (Spain) (Rosário, 1993). Madrid was specifically chosen because it is within the range of the subspecies *infuscatus*. In 1994, squirrels were introduced to the Botanical Garden of Coimbra (northern Portugal); they also came from near Madrid. At present, both founding populations seem to have increased in size.

The introduction of red squirrels into parks should not be considered as part of a strategy for conserving the species in Portugal, although the introductions have involved animals of the native subspecies and can provide valuable ecological knowledge through the study of apparently increasing small populations. However we believe that the focus of the conservation effort should be the design and implementation of management strategies that consider the natural populations of the species (see Gurnell and Pepper, 1993; Gurnell and Lurz, 1997). In particu-

lar this should appraise reforestation and forest management policies. Red squirrels can benefit by considering the age structure and tree species composition of forests, by planting mixtures of tree species and by creating or maintaining links between isolated forests (e.g. Gurnell and Pepper, 1991; Lurz *et al.*, 1995; Lurz and Garson, 1997; Wauters, 1997). In short, the future of the red squirrels in Portugal depends on the maintenance of self-sustainable populations, and more in-depth research on their biology, ecology and practical conservation. The first important conservation step was made in 1991 when the red squirrel was classified as a Rare species and gained legal protection (SNPRCN, 1991).

FINAL CONSIDERATIONS

Historically, numbers of red squirrels have fluctuated and two important facts emerge from a consideration of the past history of red squirrels in Portugal:

i) there was a period of abundance from the Middle Ages to the 16th century, probably with peaks and troughs between these times, which was followed by decline and extinction. Loss of habitat is believed to be the main reason for this.

ii) there has been a recent expansion of the red squirrel into the north of the country, from north-western Spain, probably as a result of large areas of pine woods becoming available through afforestation.

S.vulgaris was confirmed at several sites in Portugal at about the same time, but we don't know when the first squirrels arrived. Importantly, the red squirrel is still not an abundant species in Portugal and its further spread is hampered by a lack of suitable habitat, especially to the south. For these reasons the red squirrel is considered a threatened species (Rare) in Portugal (SNPRCN, 1991).

Short-term solutions for the conservation of the species should involve monitoring the

populations, studying their general ecology and modelling their spatial dynamics at a landscape scale (perhaps as joint-research projects with European colleagues). Hunting should also be controlled and forests managed for red squirrels both within the range of the species and in areas where they may return. Long-term solutions must consider the development of forest habitat over large and continuous areas. Last, it has come to our notice that there have been requests from people in the Iberian Peninsula to obtain grey squirrels from Britain (unpubl.). It is clear from the experiences in Britain and Italy that grey squirrels will replace the native red squirrels wherever they are introduced; on no account should they be translocated to anywhere else in Europe (see Gurnell, 1996; Wauters *et al.*, 1997).

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