Jaime Albino Ramos (J. A. R.)

Photographs: Mário Nelson and the author

The Priolo

(*Pyrrhula murina*)

and the natural cloud forest

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CHAPTER 1 - INTRODUTION

1. **History**

The exuberant vegetation and unusual forms of animals found on the islands of the archipelago of the Azores (36-39°N, 25-31°W), have attracted the attention of naturalists since their discovery in the period 1431 to 1452. The royal historian, Gaspar Fructuoso (Fructuoso, 1926) and, in particular, the naturalist Colnel Afonso Chaves, were the first to refer to and describe, in simple terms, the Azorean flora and fauna. Travellers such as Bullar and Bullar (1849) also wrote of the beauty of the landscapes of San Miguel and, particularly, of the luxurious vegetation of the Vale das Furnas. However, the majority of the vegetation was only described in detail in the second half of the 20th Century by Professor Palhinha (1961).

In the 19th Century, a bird with black head, wings and tail, and with greyish-brown plumage, attracted the attention of farmers, collectors and naturalists. The farmers saw their orange orchards, then the dominant crop of the southern coast of the island of São Miguel, being attacked by birds that rapidly devoured the fruit trees' flowers. A reward was given for each head presented to the Agricultural Services (Agricultor Micaelense, 1843 and 1848; Chaves, 1923). Collectors searching for specimens for museums were attracted to this enigmatic bird. In the second half of the 19th Century and the early 20th Century specimens were captured for American, English, Austrian and German museums (Hartert and Ogilvie-Grant, 1905; Murphy and Chapin, 1929). In 1903 an Austrian collector captured 53 birds in 60 days (Bannerman and Bannerman, 1966).

The naturalists gathered the first information on the distribution, habits and classification of the species. They also collected specimens for museums. Godman (1866), who first classified the species correctly, discovered that although the birds invaded the orchards during flowering, they were predominantly birds of the mountainous areas.

All these sightings were made in the region of the Vale das Furnas and, more importantly, birds were only found in the east of the island of San Miguel. At the end of the 19th Century the orange orchards were decimated by disease and the birds became more difficult to observe in the Vale das Furnas (Hartert and Ogilvie-Grant, 1905; Chavigny and Mayaud, 1932). In 1923, Mr Botelho saw and captured a bird in Lomba do Carro. There are no other records of sightings in mountainous regions after this time, but the birds were regularly observed by the Forestry Service workers during the afforestation of the Serra da Tronqueira with Japanese Red Cedar *Cryptomeria*

japonica (Guarda Carlos Arruda, Mr Salvador and others, personal communication). In the 1960's and 70's sightings were made of birds feeding on the flowers of peach and pear trees by the streams above Lombas da Povoação and Nordeste (Chaves, 1964; Açores, 1970; Mª. Mendonça and others, personal communication). In November 1971 a bird was captured at Furnas (Correio dos Açores, 1971). The famous English ornithologists, the Bannermans, failed to observe any during two visits to São Miguel in 1965 and 1966.

What were these enigmatic birds found only in the mountainous east of the island of São Miguel? Why were they restricted to that part of the island?

2. **Description**

The Priolo, or Azorean Bullfinch, (see photos below) is a passerine of the genus *Pyrrhula*. This genus has a predominantly Asiatic distribution. The only European representative is the species *Pyrrhula pyrrhula*. In Europe, generally speaking, the size of the birds and the light tones of the plumage increase from east to west and from north to south, allowing six sub-species to be distinguished. In Eastern and Northern Europe all the species show marked sexual dimorphism: the chest of the males is red and that of the females is grey.

Relative to the birds of Eastern Europe, those of the Azores, *Pyrrhula murina*, exhibit three fundamental differences **(1)** They are bigger. The wings of the male and female Priolos measure 87 to 93 mm and 85 to 92 mm long, respectively. In Spain the corresponding measurements are from 79 to 84 mm and 76 to 81 mm (Noval, 1971), and in Great Britain from 79 to 86 mm and 78 to 86 mm (Newton, 1966). The Priolo weighs around 30 g, whereas the Bullfinch of Spain weighs around 25 to 26 g. **(2)** The coverts under the wings and the upper part of the tail are brownish and not white. **(3)** In terms of plumage, little sexual dimorphism is evident. The male Priolo does not have the red chest of its European relatives. Other than a few chest feathers tinged with light red that are found mostly on adults, the plumage of the males is practically identical to that of the females. Moreover, this differentiation is only evident if the birds are examined in the hand.

Given these differences, Goodwin (1984) and Knox (1988) proposed that the Priolo should be classified as a separate species. In addition to the morphological differences, analyses of feathers made by Dr. Robert Dawson in Nottingham, England, revealed consistent genetic differences between the birds of the Azores and of Continental Europe.

3. **The first observations**

Since the beginning of this century the rarity of the Priolo has caused concern. In 1961 the Dutch ornithologist, Van Vegten, observed a bird in Japanese Red Cedar whilst travelling between Salto do Cavalo and Planalto dos Graminhais (Vincent, 1968). In 1968 Vincent stated in the Red Book of Vertebrates that the Priolo was probably on the brink of extinction (Vincent, 1968).

At the end of the 1970's, the French ornithologist, Gerard Le Grand, working at the University of the Azores, estimated the population at 30 or 40 pairs and confirmed that the Priolo was restricted to endemic vegetation around Pico da Vara (Le Grand, 1982).

The first thorough study was made by Dr. Colin Bibby and Trevor Charlton of the British conservation association, the "Royal Society for the Protection of Birds". These ornithologists explored the area along a vast network of pathways through the endemic vegetation from Furnas to Ponta da Madrugada, allowing them to assess the distribution of the species. They found that the birds were confined to the endemic vegetation, although one individual had been observed at Salto do Cavalo. The birds were not found in the dense plantations of Japanese Red Cedar. By counting the numbers of birds seen from observation points during ten minutes, and noting whether or not they occur within a radius of 30 metres, the population was estimated to be around 100 pairs (Bibby e Charlton, 1991; Bibby, Charlton e Ramos, 1992).

4. The objective of this book

The observations of Le Grand, Bibby and Charlton revealed a strong association between the presence of Priolos and endemic vegetation. What explains that association? Given that the endemic vegetation has gradually been replaced by invasive exotic plants, what influence have they on the Priolo? Furthermore, the historical records of this birds distribution show it to be highly restricted. Why is this?

In order to find the answers to these and other questions regarding Priolos, a study of the habitat and feeding of these birds was made between 1991 and 1993. The main objective of this book is to describe the Priolo and its habitat to those interested. Therefore, it introduces the annual cycle of this bird and presents a simple description of its habitat and feeding through the year. Finally, it tries to explain the distribution and size of this population, analysing the difficulties of preserving this singular bird.

5. Annual cycle

Birds were captured with Japanese mist-nets and examined (brood patch, moulting, fat index), measured (bill, head, wing, tail, tarsus) and ringed with an individual combination of coloured rings. 72 Priolos were processed in this way. The occurrence of a brood patch in females (who lose feathers on the chest, which is highly vascularized) established that the reproductive season occurs from the middle of June to the end of August. The first juveniles (easily identifiable by the brown head, instead of black as in adults) appear flying with their parents in the middle of July.

At the end of September and during October all the adults captured were moulting. From October the juveniles resemble the parents, though at times it is still possible to see some brown feathers on the head.

Two nests were found in July (see picture below) in young Japanese Red Cedar, approximately three metres above the ground. As with their European relatives, the nest of the Priolo has two obvious layers: an exterior layer of twigs (of Lilly-of-the – valley tree *Clethra arborea* and Azorean Heather *Erica azorica* in the nests found) and an interior layer of roots, very fine twigs and some moss.

CHAPTER 2 - DISTRIBUTION AND HABITAT

1. **The natural cloud forest**

The early observations of the Priolo revealed a fundamental detail of their ecology: the birds are confined to endemic vegetation at high altitude. What are the characteristics of this vegetation?

It is a cloud forest (*Laurissilva*) which is a remnant of the great forests that covered southern Europe during the Tertiary Period, and most of which disappeared thousands of years ago. Consequently, it is a museum forest with a high level of endemisms (plants that occur nowhere else in the world). Eight of the eleven species of trees that occur in this forest are found only on the Azores. Some plants also occur on the archipelagos of Madeira and the Canaries, whose forests are also considered to be museum forests of the Tertiary period.

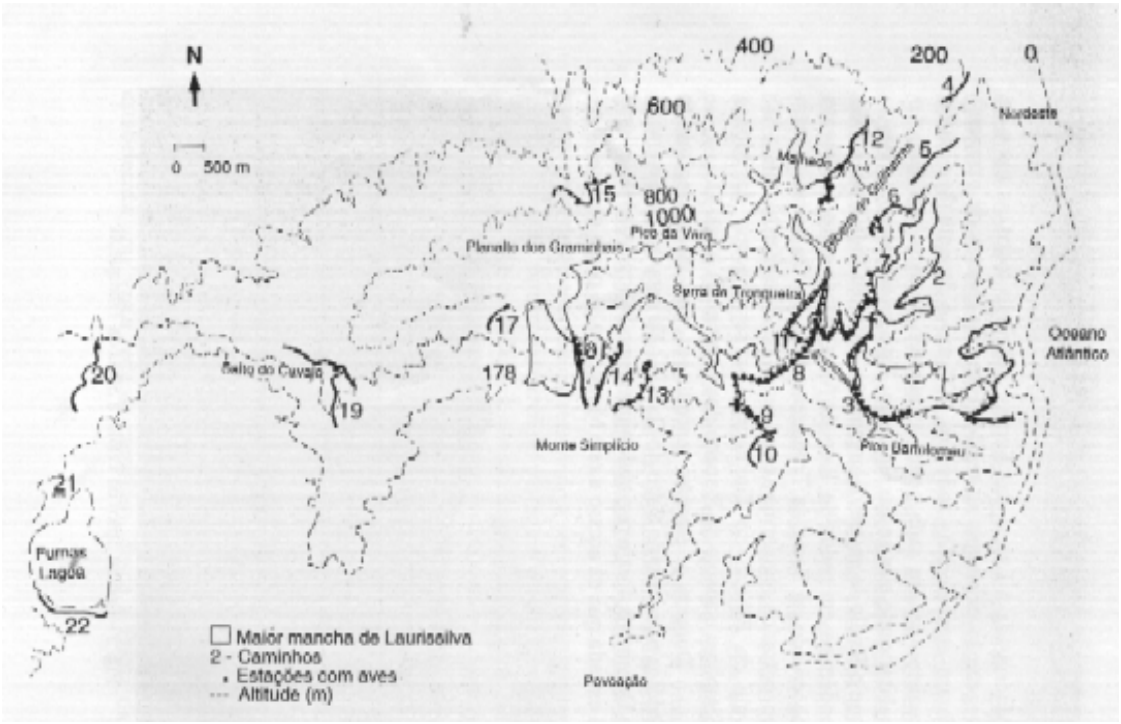
The natural azorean cloud forest is very dense, with up to 150 trees per 100m^2 on São Miguel, and has a high level of botanic biodiversity. The sub-shrub layer is generally very dense with large ferns and shrubs, some of which are endemic. As examples of trees we have Azorean Holly (*Ilex perado* spp *azorica*), Azorean Cedar (*Juniperus brevifolia*), Azorean Heather (*Erica azorica*), Azorean Laurel or Sweet Bay (*Laurus azorica*), Azorean Blueberry (*Vaccinium cylindraceum*) and Azorean Plum (*Prunus lusitanica* spp *azorica*). As examples of large ferns we have Tree Fern (*Culcita macrocarpa*) and Rooting Chain Fern (*Woodwardia radicans)*. As examples of shrubs there are Cape Myrtle (*Myrsine africana*) and Azorean Laurustinus (*Viburnum tinus* spp *subcordatum*). Also, various herbaceous plants are found in open areas (clearings, brook-sides and landslides): Azorean Hawkbit (*Leontodon filii)*, Azorean Woodrush (*Luzula purpureo-splendens*), Azorean Daisy (*Bellis azorica*) and the Azorean Lettuce (*Lactuca watsoniana*), among others. Viewed as a whole, the forest is a mosaic of several types of endemic communities (Haggar, 1988). Sjogren (1984) provides a descriptive summary of the main plants of the Azores.

The reduction in area of the natural forest is due both to the increase in area of pasture and Japanese Red Cedar plantations, and to the invasion of exotic plants. On the island of São Miguel, the Australian Cheesewood (*Pittosporum undulatum*) dominates the vegetation below 400 metres and the Yellow Ginger-Lilly (*Hedychium gardnerianum*) and the Lilly-of-the-Valley Tree (*Clethra arborea*) are invading the remaining areas of natural forest. Some endemic plants, including the Azorean Plum, are at risk of disappearing and in certain areas the Lilly-of-the-Valley Tree and/or the Yellow Ginger-Lilly and already replacing large parts of the endemic plant community.

2. **Distribution and utilization of habitats**

In order to investigate the distribution of the species, a vast network of pathways was established from Ponta da Madrugada to Lagoa das Furnas, covering all types of vegetation found in the area. Stations (point counts) were marked every 200 metres and at each point the number of birds and the habitat they were seen in were recorded for a period of 8 minutes. This census revealed that the Priolo is largely restricted to endemic vegetation around the Pico da Vara, and is most easily observed in the Serra da Tronqueira (see photograph below).

The birds were regularly found around Pico Bartolomeu, in the valley of Ribeira do Guilherme, in the mountains above Monte Simplício,and below Planalto dos Graminhais (see map below).



Distribution of the Priolo: The map shows the 22 pathways used during this study and the stations where the occurrence of Priolos was recorded. The presence of birds was associated with the largest patches of Laurissilva.

During the breeding season no Priolos were recorded in the region of Salto do Cavalo. However, from September to December juveniles were recorded at Salto do Cavalo and along the road leading to this view point. There were no sightings in this area after January.

In summary, the distribution of the Priolo appears to be divided into two areas: **(1)** a zone with the highest population density in the natural forest around Pico da Vara and Pico Bartolomeu where breeding occurs and **(2)** a zone with lower population density in the natural forest around Salto do Cavalo, which may only be used during the juvenile dispersal phase at the end of summer.

Using this method, the population density was found to be 0.58 birds/ha in 1991 and 0.46 birds/ha in 1992, which represents populations of approximately 336 and 267 individuals respectively. Using the capture-recapture method, populations were estimated at 350 and 423 in 1991, and 216 and 204 individuals in 1992. These estimates are slightly higher than those made by Bibby and Charlton (1991).

In the zone of high population density, Tronqueira and Bartolomeu, the habitats of the Priolo were studied in detail. Pathways with stations every 200 metres (totalling 125 stations) were surveyed three times a month. The habitats in which the Priolo were found are illustrated in the photographs that follow. Only the natural forest is used throughout the year, with 70 to 90% of sightings recorded in the period from January to April.

Other habitats are important at certain times of year, namely in summer when the herbaceous plants that the Priolos feed upon grow in clearings, brook-sides and landslides in areas adjacent to the natural forest. The most commonly used of these areas are those bordering the natural forest (within 200 metres) and which contain clearings. The areas of dense Australian Cheesewood and Japanese Red Cedar trees are not used, neither are pastures as the vegetation cover is too limited for the Priolo.

3. **Movements**

Data from ringed Priolos provided information on the bird's mobility. The Priolo is a very sedentary bird: several individuals were captured in the same location throughout 24 months. Furthermore, birds that were ringed in Ribeira do Guilherme were never seen at Bartolomeu, Malhada or in the mountains above Monte Simplício.

The Priolo does, however, make several very local movements as new plants fruit or produce seed. These movements are more pronounced in Summer (80 to 750 metres) than in Winter (30 to 200 metres) because the birds have to cross dense areas of forest to reach clearings where the herbaceous plants on which they feed grow.

Movements of around 3 Km were recorded at the end of April/May. At this time the Priolos travel along the brooks to lower altitudes where the herbaceous plants produce seeds earlier.

CHAPTER 3 - FEEDING

1. **Diet**

In order to understand why the Priolo is restricted to the natural forest, particularly at the end of the Winter and in early Spring, it is necessary to reduce the scale of the study of feeding habitats.

Although a cautious bird, the Priolo, as with other birds, can be seen feeding, primarily at dawn and in the evening. With practise the birds become relatively easy to locate by their characteristic call (similar to a whistle), by the marks they leave on the plants, and even by their tendency to use the same plants day after day.

In addition to direct observations of feeding, faeces were collected and the food fragments they contained were identified.

The diet of the Priolo is based on several types of vegetation and varies monthly according to which plants are flowering and producing seeds. The photographs below show the most important foods through the year. In all, the Priolos feed on 38 different plants. Of these, only 13 are important in the diet. From May to August the birds feed on seeds of herbaceous plants (namely *Polygonum capitatum*, *Prunella vulgaris*, *Hypericum humifusum* and Azorean Hawkbit), from August to December on fruit seeds (Azorean Blueberry, Blackberry and *Leycesteria formosa*), from November to March seeds of Lilly-of-the-Valley Tree and fern sori (*Woodwardia radicans* and *Culcita macrocarpa*), and, in March and April the flower buds of Azorean Holly. Between May and July, invertebrates (Hemiptera) emerging on leaves of Azorean Laurel are also

taken. From March to May when herbaceous plant seeds are no longer available, the birds eat young ferns, fronds (Common Fern *Pteridium aquilinum* and Royal Fern *Osmunda regalis*) and the vegetative tips of mosses (*Polythrichum sp.*). The fronds and mosses are not preferred foods because as soon as the Royal Fern produces sporangia the birds concentrate on these and ignore the fronds and the moss tips.

The birds' food resources come from various types of habitat. In Summer, from open areas: land slides, pathways, clearings and brooksides. In Autumn and Spring, mainly from the natural forest. It is because the Priolo makes use of the tree-bush layer (Lilly-of-the-Valley Tree, Azorean Laurel, Azorean Blueberry) and the sub-shrub layer (ferns) that it requires the various mosaics typical of the natural Azorean forest.

In general, the diet of the Priolo is similar to other Bullfinches of Continental Europe, (Newton, 1964, 1967; Noval, 1971). The Priolo is, however, the only Bullfinch known to regularly feed on ferns. The Royal Fern and the Common Fern are equally common in other parts of Europe, but there are no records of them being taken by Bullfinches. Other differences between the diet of the Priolo and continental Bullfinches are due to the differences in the local plant communities.

One of the most important aspects of feeding in the Priolo is the importance of introduced plants, namely *Polygonum capitatum, Leycesteria formosa* and Lilly-of-the-Valley Tree. The first is very important during the breeding season, the second during the moult and the dispersal of juveniles, and the third during Winter.

In August/September and April endemic plants predominate in the diet. In the first period the birds ingest the seeds of the Azorean Hawkbit and Azorean Blueberry, in the second period the birds consume buds of the Azorean Holly and fern sori typical of the Laurissilva, *Woodwardia radicans* and *Culcita macrocarpa.*

The period from the end of March to the beginning of May is very important given that the Priolo feeds almost exclusively on Azorean Holly. At first sight, this seems unusual in that the seeds of Lilly-of-the-Valley Tree are still present and seeds are more nutricious than flower buds. In order to understand why this is so, it is necessary to focus on the feeding behaviour of the Priolo.

Polygonum capitatum (seeds, May to July)

Azorean Woodrush, *Luzula purpureo-splendens* (seeds, June and July)

Prunella vulgaris (seeds, July and August)

Azorean Hawkbit, *Leondonton filii* (seeds, August and September)

Azorean Blueberry, *Vaccinium cylindraceum* (seeds, August to October)

Blackberry, *Rubus* sp. (seeds, September to December)

Leycesteria formosa (seeds, September to December)

Lilly-of-the-Valley Tree, *Clethra arborea* (seeds, November to March)

Rooting Chain Fern, *Woodwardia radicans* (fern, November to February)

Tree Fern, *Culcita macrocarpa* (fern, January to April)

Azorean Holly, *Ilex perado* spp *azorica* (flower buds, March and April)

2. **Feeding behaviour**

The Priolo feeds directly on the vegetation and so is very rarely on the ground. Besides this, it does not search through fallen leaves and twigs for food as the Common Chaffinch (*Fringilla coelebs moreletii*) does. Consequently, as soon as the seeds fall they are inaccessible to the Priolo.

Despite feeding on many plants, the Priolo can be considered a selective forager. In Autumn it prefers fruit seeds (Azorean Blueberry, Blackberries and *Leycesteria formosa*) and the seeds of Lilly-of-the-Valley Tree. The latter is rejected if fruits are

available. Seeds of the Yellow Ginger-lilly and the Australian Cheesewood are ignored, and the birds cannot extract the seeds from the Japanese Red Cedar cones due to the conical shape of its beak.

With regard to ferns, only the species mentioned above which have large sori (2 to 4 mm wide) are taken. In Winter there are also sori of *Polystichum* sp., measuring 1 mm, but these are never taken.

The buds of the Azorean Holly are only taken when they reach approximately 2.6 to 3.8 mm in width. The Azorean Laurel, Australian Cheesewood and the Laurustinus also produce flower buds, but these are ignored by the birds. All these feeding behaviours were observed directly and confirmed by experiments on captive birds.

From January, the only foods available to the Priolo are Lilly-of-the-Valley Tree seeds and fern sori. An apparent abundance of these foods in the middle of winter does not necessarily signify that there is plentiful food available to the Priolo. By March a large amount of the fruit and high quality (largest) sori have already been consumed. The birds must now choose between the fruit and poorer quality (smaller) sori that remain. The feeding behaviour of the Priolo showed a preference for the largest fruit of Lilly-of-the-Valley Tree and the largest sori. After intense periods of feeding on Lilly-of-the-Valley Tree and ferns, the fruits and sori remaining were significantly smaller.

At the beginning of April practically all the sporangia have opened and released the spores on which the birds feed, but marking of Lilly-of-the-Valley Tree in September showed that around 30% of seeds produced were still available in April. However, direct observations and trials with captive birds demonstrated that at this time the Priolos prefer Azorean Holly with large flowers (2.7 a 4.4 mm) to the seeds of *Lilly*-of-the-Valley Tree. These seeds are ignored from early April, whilst almost the total annual production of Azorean Holly buds is consumed by the birds.

CHAPTER 4 - CONSERVATION

1. **Explanations for the distribution of the Priolo**

The Azorean Holly is practically the only food available to the Priolo during April. Therefore, the current distribution of this bird is likely to be related to the presence of the Azorean Holly.

In order to evaluate this hypothesis, the density of trees was measured at Tronqueira and Bartolomeu where the Priolos occur throughout the year, and at Salto do Cavalo where the birds were only seen from September to December. The density of Azorean Holly was found to be lower at Salto do Cavalo (2 to 5 trees per 100 m^2), compared to densities at Tronqueira and Bartolomeu (10 to 20 trees per 100 m^2)). Furthermore, the density of ferns that produce sori which are taken by the Priolo is also lower at Salto do Cavalo (4 to 6 per 100m^2), compared to Tronqueira and Bartolomeu (20 to 106 per 100 m/2).

It is likely that the natural forest at Salto do Cavalo was more highly perturbed during the past by grazing and/or the extraction of clods for greenhouses. The birds were regularly found around this area until at least the start of the last century, as they would feed on the orange flowers in the Furnas region at the end of Winter. The orchards near to the forest provided an artificial concentration of food that the birds could exploit. The Bullfinch of England has also been seen to periodically invade orchards in Winter (Newton, 1964).

2. **Explanations for the population size**

This is a complex question and there may be several factors involved. The results obtained suggest that the areas of pasture and patches of Australian Cheesewood, Japanese Red Cedar and Yellow Ginger-Lilly do not provide a sufficient food source for this species and, furthermore, at the end of Winter (March - April) the quantity of food in the Laurissilva is low. Clearly the size of this population is dependent on the area of natural forest available. However, it is necessary to take into account the "quality" of the forest. The existence of moderately developed forest, which has a sub-shrub layer of ferns and sufficient numbers of Azorean Holly, is fundamental. For forest to be colonized by Priolos throughout the year, it must provide food throughout the annual cycle. In some areas this is not currently possible because of damage caused by exotic plants.

The most important issue relates to the negative impact of Lilly-of-the-Valley Tree on the flower production of Azorean Holly. In areas with a high density of Lilly-of-the-

Valley Tree, the resulting shading of the Azorean Holly leads to reduced flower production. Consequently, whilst Lilly-of-the-Valley Tree is an important food during Winter, a high density of this exotic plant can have drastic consequences on the Spring feeding of the Priolo.

3. **Conservation of the Priolo and its habitat**

Areas where the Priolo is practically absent, and those where it still occurs, are being rapidly invaded by Lilly-of-the-Valley Tree, the Australian Cheesewood and the Yellow Ginger-Lilly. The forest is suffering a rapid transformation, and the majority of the invading exotic plants affect this species in a negative way.

In order to protect the Priolo over the long term, it is necessary to protect and manage the endemic could forest in the eastern part of the island of São Miguel. The expansion of exotic plants must be controlled, or the endemic plant communities risk deterioration on a large scale. Furthermore, it is essential to recuperate and expand the area of natural forest through planting. It is particularly important to increase the population of plants that produce flower buds taken by the Priolo: the Azorean Holly and the Azorean Plum.

The Priolo and its habitat constitute a natural azorean patrimony with worldwide importance and require effective management measures for their preservation.

REFERENCES

- Açores (1970). O Priôlo, ave dada como extinta, continua a viver na nossa ilha! *Açores.* Nº 7526, 2 p.
- Agricultor Micaelense (1843, Setembro, e 1848, Novembro). Pássaros daninhos, 1 p.
- Bannerman, D. e Bannerman, D. (1966). *Birds of the Atlantic Islands. A history of the birds of the Azores*. Oliver e Boyd: Edinburgh.
- Bibby, C. J. e Charlton, T. D. (1991). *Observations on the São Miguel bullfinch*. *Açoreana* **7**: 297 - 304.
- Bibby, C. J., Charlton, T. D. e Ramos, J. (1992). Studies of West Paleartic birds - Azores bullfinch. *British Birds* **85**: 677 - 680.

- Bullar, H. e Bullar, J. (1849). *Um Inverno nos Açores e um Verão no Vale das Furnas.* Instituto Cultural de Ponta Delgada: Ponta Delgada.
- Chaves, F. A. (1923). O Priôlo, a ave mais interessante da ilha de San Miguel. *Os Açores* **1 (7)**: 1-16.
- Chaves, A. (1964). O Priôlo, por que será esta ave exclusiva de San Miguel? *Açores*: Ponta Delgada.
- Correio dos Açores (1971). A *avis rara* passava o Outono nas Furnas. *Correio dos Açores.* Nº 15081, 2 p.
- Chavigny, D. e Mayaud, N. (1932). Sur l'avifaune des Açores. *Alauda* **4**: 133 - 159, 304 - 348, 416 - 441.
- Fructuoso, G. (1926). *Saudades da Terra. Livro IV. Ilha de San Miguel.* Tip. do Diário dos Açores: Ponta Delgada.
- Godman, F. du C. (1886). Notes on the birds of the Azores. *Ibis* **5**: 88 - 119.
- Goodwin, D. (1985). The bullfinches. *Aviculture magazine* **91**: 143 - 12.
- Haggar, J. P. (1988). The physiognomy and status of cloud forest of Pico Island, the Azores. *Biological conservation* **46**: 7 - 22.
- Hartert, E. e Ogilvie-Grant, W. (1905). On the birds of the Azores. *Novitates Zoologicae* **12**: 80 -128.
- Le Grand, G. (1982). Priôlo, a ave mais interessante de San Miguel. *Açoreana* **6**: 195 - 211.
- Knox, A. (1989). Proposed Changes to the Voous list. *British Birds* **82**: 119 - 120.
- Murphy, R. C. e Chapin, J. P. (1929). A collection of birds from the Azores. *American Museum Novitates* **384**: 1 - 23.
- Newton, I. (1967). The feeding ecology of the bullfinch (*Pyrrhula pyrrhula* L.) in Southern England. *Journal of Animal Ecology* **36**: 721 - 744.
- Noval, A. (1971). Movimientos estacionales y distribuicion del Camachuelo comum, *Pyrrhula pyrrhula iberiae,* en el norte de España. *Ardeola* (**vol. especial)**: 491 - 507.
- Palhinha, R. T. (1966). *Catálogo das plantas vasculares dos Açores.* Sociedade de estudos açorianos Afonso Chaves: Lisboa.
- Sjogren, E. (1984). *Açores - Flores.* Direcção Regional do Turismo: Horta.
- Van Vegten, J. A. (1968). The Azores bullfinch not extinct. *Ardea* **56**: 194.
- Vincent, J. (1968). *Red data book (Aves).* I.U.C.N.: Moeges, Geneve.