

ON THE VERTEBRATE FAUNA OF THE AZORES¹

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This communication was prompted by a small collection of vertebrates from the Azores, obtained by Dr. and Mrs. P. Brinck and Dr. and Mrs. Erik Dahl in the course of the Swedish Zoological Expedition to the Azores in February to April, 1957. Although the material is not extensive, it is felt that the results may be worth publishing, as the vertebrate fauna of the Azores is comparatively poorly known. A brief review of the avifauna is also presented for comparison with other vertebrate groups, although no birds were collected by the members of the Expedition.

PISCES

Carassius (Cyprinus) auratus L.

One specimen taken in the lake in the Caldeira, Faial, on 10 April.

C. auratus is the only abundant and widespread fresh-water fish of the Azorean waters. Godman (1870) states that this species was introduced «some years ago», whilst Barrois (1896) considers that «la date d'importation se perd dans la nuit des temps». De Guerne (1888) was unable to find large specimens in the Caldeira of Faial and is of the opinion that *C. auratus* is only barely able to survive in these surroundings. Apparently the individuals of this population attain sexual maturity at a comparatively small size.

All the authors quoted above take it for granted that *C. auratus* was intentionally introduced by man, although opinions diverge about the probable date of introduction. Only Vicente (1955) is of a different opinion about the probable means of introduction. He believes that eggs of *C. auratus* were carried to the Azores on the feet of freshwater birds, such as Anatidae. Although it is true that the Azorean islands are visited by a variety of migratory birds (cf. de Chavigny & Mayaud 1932: 429-436), this seems to be an unnecessary hypothesis. In all probability, *C. auratus* was introduced intentionally by the Portuguese in olden times,

1) Report No. 22 from the Lund University Expedition in 1957 to the Azores and Madeira.

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Barrois (1896: 51) mentions that *Argulus foliaceus* L. «a été capturé par Chaves sur un Cyprin doré», and in a tabular summary (p. 110) he lists this branchiure parasite from Lagoa Grande and Lagoa Azul on S. Miguel. According to Chaves (1911: 14) this species was introduced with *Cyprinus carpio* L. in 1890.

Barrois (op. cit.: 55-57) presents some information concerning the attempts of introducing various fresh-water species to the Azores in the last three decades of the 19th century. Most of these attempts failed completely. The species involved were *Salmo trutta* L. (*S. t. trutta* L., *S. t. lacustris* L., *S. t. fario* L.), *Salmo alpinus* L., *Salmo irideus* Gibb. and *Cyprinus carpio* L. Later, in 1867, a *Leuciscus*-species, called *L. macrolepidotus* Steind., was imported from Portugal. According to Maclado (1937, quoted from Bertin 1946: 88), *Perca flavescens* Mitch. and *Micropterus salmoides* Lacép., have also been introduced to S. Miguel. These two forms are of Nearctic origin, as is also *Salmo irideus*. The *Salmo* spp. mentioned above were imported from Great Britain, France, Germany and Italy, whilst *Cyprinus carpio* came from Germany exclusively. As mentioned above, a *Leuciscus* species was imported from Portugal; according to Maclado (loc. cit.), *L. macrolepidotus* is a synonym of *L. rutilus* L.

Most of these attempts of introducing fresh-water fish to the Azorean waters were unsuccessful. Judging from the information in Cordeiro (s. à.: 10-12), only «trout» (*Salmo trutta* & *irideus*) and «Black Bass» (*Perca flavescens*) are now sufficiently abundant to provide reasonable opportunities of fishing, whilst locally also *Perca fluviatilis* L. occurs in good numbers.

It seems entirely reasonable that the frequent transports of live fish have greatly facilitated the dispersal of various fresh-water invertebrates to the Azores. In this connexion it is of importance that the fish populations imported to the Azores have had widely different areas of origin. Both Old and New World species have had a good possibility of travelling to the Azores with the fresh-water fish. This is a factor to be kept in mind in all discussions of Azorean zoogeography. As we shall see later, also transports by birds may have played a role, and again both Old and New World organisms may have utilized this means of dispersal.

AMPHIBIA

Rana esculenta L.

Collected in Lagoa da Pau Pique, one young specimen, on 7th March; in Lagoa do Canário, one larva, on the same day; at Lagoa Empadadores one

metamorphosed specimen, on the same day; in Lagoa das Furnas, two small metamorphosed specimens and one larva, on 10th March; in a «tanque» near Lagoa do Congro, two larvae, on 16th March; in Fonte at Casas Telhadas, SW of Ribeira Grande, two larvae, on 18th March; all these localities are situated on the island of S. Miguel. Finally one egg was collected 1 km W of Praia on S. Maria. Only probability argues in favour of the identification of the egg. The determinations of the larvae have kindly been checked by Dr. H. Kauri, Lund.

R. esculenta is said by Godman (1870) and Barrois (1896) to be widely spread over the Azorean archipelago, and later authors agree. Bertin (1946: 90) states that the species was probably introduced in the 16th century «en vue de la lutte antimalarienne», but other authors have different opinions on the probable date of introduction. Barrois (1896: 57) states that the species was introduced to S. Miguel «vers 1820». We can therefore do nothing beyond assuming that also *R. esculenta* was deliberately introduced to the Azores by man.

Breeding appears to have started very early indeed, as large larvae and newly metamorphosed specimens were taken in the first half of March. It should be remembered that the Azores have an extremely mild and maritime type of climate, so that the critical temperature for spawning of *R. esculenta* is reached practically throughout winter (cf. Kauri 1959: 41).

The frog of the Azores was called by some authors *R. ridibunda* Pall. De Guerne (1888: 24) and Barrois (1896) call it *R. esculenta perezii* Seoane. Regarding the *R. esculenta*-*R. ridibunda* complex the reader is referred to Kauri (*op. cit.*); according to this authority the traits supposed to characterize *ssp. perezii* are modificatory and not worth nomenclatorial recognition.

REPTILIA

Lacerta dugesii M. - Edw.

S. Pópulo, approx. $7\frac{1}{2}$ km E of Ponta Delgada, one specimen, on 1st March; *ibidem*, on a garden wall, one specimen, on 4th March; Fonte da Rocha, below Relva, on bare rock, one specimen, on 5th March; all these localities are situated on S. Miguel. Further, at Horta, Porto Pim, on Faial, one large and two small specimens were taken on 7th April.

L. dugesii was recorded from Graciosa already by Morelet (1860: 54), and Godman (1870: 43) mentions the species from the same island. However, neither of these authors collected it himself but merely quoted Drouet (*pers. comm.*, and 1861, respectively). Morelet says explicitly that *L. dugesii*

is restricted to Graciosa, which is the northernmost island of the central group of the Azores. Nobre (1930: 45), however, reports the species also from Ponta Delgada on S. Miguel.

Thus, as far as the present author knows, the record of *L. dugesii* on the island of Faial means an extension of the known range of the species. Whether this really means that the species has recently expanded and invaded Faial, or has previously been overlooked on this island, seems to be impossible to decide.

According to Cyrén (1934), the total range of *L. dugesii* includes Madeira and all the small islands round the main island, and also Great Salvage Island and the Azores. The record of *L. dugesii* from Tenerife is rejected, apparently on good grounds, by Cyrén (*op. cit.*: 43), but Bertin (1946: 105) lists it from the Canary Islands.

There seems to be no reasonable doubt that *L. dugesii* was accidentally or deliberately introduced to the Azores by man, as suggested already by Morelet (*loc. cit.*). Chaves (1911: 11) states that *L. dugesii* was introduced to the Azores in 1860 by «soldados que vieram d'Elvas para o castello de S. Braz».

Thus, *L. dugesii* is similar to *C. auratus* and *R. esculenta* with regard to its history on the Azores. However, whilst the latter two species were imported from Europe, the lizard must have come from Madeira. Also *L. dugesii* has been much slower to disperse between the Azorean islands than *C. auratus* and *R. esculenta*. This is probably due to the fact that man has not deliberately assisted its dispersal, at least not to the same degree as has been the case with the other two species. For sanitary and ornamental (and culinary?) reasons, the frog and the fish were brought along to every island, whilst there was no such active interest in the promotion of the spread of the lizard.

The extreme localization of *L. dugesii* within the Azorean archipelago is only one of several facts which make it highly improbable that the species originated on the Azores and spread from there to Madeira where it is widely distributed.

Cyrén (*op. cit.*: 40) is of the opinion that *L. dugesii* is most closely related to *L. muralis* Laur., particularly to ssp. *bocagii* Seoane from the Pyrenean peninsula and ssp. *vaucheri* Blgr. from south Portugal and Morocco. In an earlier paper, Cyrén (1924) points out the rather peculiar fact that the Madeiran population of *L. dugesii* is blocked from its close relatives of the *muralis* group in the north-western corner of the African con-

continent by *L. galloti* Dum. & Bibr., which is the only member of the genus *Lacerta* on the Canary Islands.

MAMMALIA

Erinaceus europaeus L.

A drowned specimen was found and closely examined in a garden pond in Ponta Delgada, S. Miguel, on 3 March.

This is the first record of the species from the Azorean islands. It is practically certain that it has been introduced by man, either intentionally or accidentally. As the subspecific status could not be ascertained, it is impossible to guess the area of origin of the Azorean population. The Pyrenean peninsula on the one hand and north-western Europe on the other are occupied by different subspecies (Ellerman & Morrison-Scott 1951: 19 et seq.).

Mus musculus L.

One specimen at Ribeira, S. Miguel, on 22 March. Recorded as found under stone in a field far from the nearest human habitation.

Very little seems to be recorded about the rodents of the Azores. Godman (1870: 17) lists «*Mus decumanus*, Pall.» = *Rattus norvegicus* Berk., «*Mus rattus*, Linn.» = *Rattus rattus* L. and *Mus musculus* L. These three species have followed in the track of European colonization all over the world, which has often had most serious consequences for the native fauna. Their presence on the Azores can cause no surprise.

According to Schwarz & Schwarz (1943: 65), the subspecies inhabiting the Azores is *M. musculus brevirostris* Waterh. In the Azorean population of this species a tendency to increased pigmentation is prominent, as in several other populations on these humid islands. Specimens showing this character were at one time described as an endemic subspecies under the name *azoricus* Schinz. According to Schwarz & Schwarz (*op. cit.*), differences between ssp. *brevirostris* and ssp. *domesticus* Ruddy (the two subspecies most likely to occur on the Azores), are slight, and they should be determined only when series are available. The difficulty of separating them is further increased by the tendency to melanism as mentioned above. Even though there is nothing in the specimen collected to prevent its being referred to *brevirostris*, previously known from the Azores, it has been considered best to use binominal nomenclature for it. According to Schwarz & Schwarz the range of ssp. *brevirostris* includes the Mediterra-

nean region, Spain, France, Macaronesia and part of America. To the latter area it has been introduced in recent times.

It may be of interest to give a brief review of other Azorean mammals. The fauna is exceedingly poor, and little exact information is available. Before man arrived in the first half of the 15th century (Chaves 1911), the Azorean archipelago may have had no mammals at all, possibly with the exception of the bat mentioned below. Frey (1943: 18) mentions the possibility that an old fauna of land vertebrates did in fact exist before man arrived. The evidence for this presumed fauna is meagre, however, and seems to consist merely of etymological considerations.

One of the mammals suggested to have existed on the Azores before man is *Oryctolagus cuniculus* L. This species was introduced a very long time ago, according to Chaves (1911: 16) in the first half of the 15th century, i. e. practically at the same time as the first Portuguese ships visited the islands. The resident population is referable to ssp. *huxleyi* Haeck., originally distributed over the Mediterranean region (Ellerman & Morrison-Scott 1951: 444). Godman (1870: 16) also lists «*Mustela furo*, Linn.» = *Mustela putorius furo* L., and «*Mustela vulgaris*, Linn.» = *Mustela nivalis* L. The latter species is represented by ssp. *numidica* Puch., which occurs in Morocco and Algeria (Ellerman & Morrison-Scott *op. cit.*: 237). This form is ranked by some authorities as a good species. All these mammals obviously were introduced by man, either accidentally or intentionally.

The only mammal, and indeed the only vertebrate other than birds, which may have travelled from Europe to the Azores without human assistance, is the bat listed by Nobre (1930: 44), quoting 19th century authorities, as *Vesperugo leisleri* Kuhl. According to Ellerman & Morrison-Scott (*op. cit.*: 159) the Azorean bat should be called *Nyctalus azureum* Thomas 1901. *Nyctalus (Vesperugo) leisleri* is restricted to the European continent, whilst the Madeiran representative of the genus is *N. verrucosus* Bowdich. The latter species is stated to be very close to *leisleri*, which seems to apply also to *azureum*. However, as taxonomy now stands, *Nyctalus azureum* is the only vertebrate species endemic on the Azorean islands. This fact may of course be used as an argument in favour of the opinion that this bat had arrived before man. But it should be remembered that time is only one factor in speciation, and that the degree of differentiation of the species in question is low. The evolution of slight morphological changes may have had time to occur in the course of the several hundred generations of bats which have lived on the islands since man first arrived

more than 500 years ago. Therefore we cannot exclude the possibility that the bat Azorean bat was introduced by man.

Chaves (1911: 11) quotes Drouet to the effect that «em 1857, o morcego do Norte da Europa foi introduzido nos Azores por colonos flamengos». This statement cannot apply to *N. azureum* and seems to be erroneous.

A V E S

Although no birds were collected in the course of the Expedition, some remarks on the Azorean avifauna are presented below for comparison with the other vertebrate groups. Only land and fresh-water species are of interest in this connection. For passerines, the taxonomy of Vaurie (1959) has been adopted, whilst for other groups that of de Chavigny & Mayaud (1932), who have given us the most recent survey of the avifauna, is retained without changes.

Among the 21 land and fresh-water species known to breed in the Azorean archipelago (Volsöe 1955: 131), probably three and possibly another two were introduced by man intentionally or accidentally. These are:

Alectoris rufa L. ssp. (with certainty introduced);

Carduelis carduelis parva Tschusi;

Carduelis chloris aurantiiventris Cab.

All three are widespread in southwestern Europe. As regards the following two species the means of dispersal to the Azores is more uncertain:

Serinus c. canaria L.;

Sturnus v. vulgaris L.

Sturnus vulgaris used to be considered as represented by a distinct subspecies, *S. v. granti* Hart., but the differences are considered by Vaurie (*op. cit.*: 127) to be too slight to warrant nomenclatorial recognition. The existence of a slight morphological difference from the continental population may be an indication of a relatively long history on the Azores, but cf. the discussion above under *Nyctalus azureum*. *Serinus c. canaria* differs from the other passerines in being endemic to the Macaronesian archipelago and must therefore have come to the Azores from Madeira or the Canary Islands. It seems very possible that it was brought as a cage bird. Also the two *Carduelis* species are commonly kept as pets, and the fact that the Azorean populations are identical with the forms inhabiting the Pyrenean peninsula and not with the N. W. European subspecies which are more highly migratory, seems to the present author to argue in favour of their having been brought directly by man.

It may be pointed out that *Sturnus vulgaris* is absent as a breeding bird on the Pyrenean peninsula where the genus is represented by *S. unicolor* Temm. *S. vulgaris*, however, is common in Spain and Portugal in winter (Bernis 1954: 71).

The remaining 16 species are as follows:

Gallinula chloropus correiana Murphy & Chapin;

Fulica atra L. ssp.;

Buteo buteo rothschildi Swann;

Coturnix coturnix conturbans Hart.;

Charadrius a. alexandrinus L.;

Scolopax r. rusticola L.;

Columba l. livia L., with a melanistic colour phase;

Columba palumbus azorica Hart.;

Asio o. otus L.;

Motacilla cinerea patriciae Vaurie;

Regulus regulus inermis Murphy & Chapin (Terceira, Pico, Faial,
S. Jorge, and Flores);

R. r. azoricus Seebohm (S. Miguel);

R. r. sanctae-mariae Vaurie (S. Maria);

Sylvia a. atricapilla L., with a melanistic colour phase;

Turdus merula azorensis Hart.;

Erithacus r. rubecula L.;

Fringilla coelebs moreletti Puch.;

Pyrrhula pyrrhula murina Godman.

Within these forms the degree of endemism is rather high. All the endemic forms are restricted to the Azores and do not occur on other sections of Macaronesia. The endemism was rated higher in olden days, but modern systematists have suppressed some subspecies and reduced some endemic «species» to subspecific rank.

It may be of interest to discuss the relations between these species and the corresponding continental populations, with special reference to their migratory habits. The migratory status of a population may be assumed to play an important role for its possibilities of dispersal over the open sea. Information about distribution has been obtained from Hartert (1910-1938) and Vaurie (1959), supplemented with certain other sources.

The first two species on the list of birds which have probably travelled to the Azores without human assistance are members of the order Ralliformes which is reputed for its unusual ability to colonize success-

fully even extremely remote oceanic islands. Both *Gallinula chloropus* and *Fulica atra* inhabit practically the whole of the European continent in their nominate forms. *Buteo buteo* also inhabits the whole of Europe, the nominate form extending up to Middle Scandinavia, to the north and east of which it is replaced by other subspecies. Like the two preceding forms, *B. b. buteo* is a migrant in part of its range, taking chiefly a southwesterly course and scarcely ever entering subtropical or tropical areas. Other subspecies have entirely different migratory habits. *Coturnix coturnix* is the only highly migratory member of the order Galliformes. *Charadrius alexandrinus* is a cosmopolite, but it is noteworthy that the Azorean population is similar to the Old World subspecies, not to the form inhabiting North America. It is a migratory bird, wintering as far north as the Pyrenean peninsula (Bernis 1954: 35). Also *Scolopax rusticola* in its nominate form inhabits most of the Old World temperate areas, though not the Pyrenean peninsula (Bernis *op. cit.*: 37), where it occurs only on migration and in winter. *Columba livia* is distributed along the west coast of Europe but can hardly be counted as a migrant. *Columba palumbus*, on the other hand, is as decided migrant in most of its range, having its chief winter quarters in west and southwest Europe. The same thing seems to apply to *Asio otus*. *Motacilla cinerea* is distributed all over Eurasia and has developed endemic races also on Madeira and the Canary Islands. It is migratory in part of its range. *Regulus regulus* is a partial migrant taking a southwesterly course and never travelling outside Europe. It is slightly surprising that it has been able to reach the Azores. It may perhaps have travelled at least part of the way on board a ship. It is the only vertebrate species to have split into several subspecies within the Azorean archipelago, which shows that it is not easily inclined to undertake long sea-crossings. *Sylvia atricapilla* migrates in part to the southeast, in part to the southwest. Part of the population winters in southern Europe, whilst part of it goes as far south as tropical Africa. It is more inclined to winter under temperate conditions than any of its congeners. *Turdus merula*, *Erithacus rubecula* and *Fringilla coelebs* are abundant in western Europe, they are partly migratory and always keep a southwesterly course and rarely leave the temperate zone. *Pyrrhula pyrrhula* is a partial migrant in northern Europe, a strict resident in southwestern Europe. Three distinct subspecies occur in Denmark to Belgium, the British Isles and the Pyrenean peninsula respectively, whilst the nominate form represents the species in Fenno-Scandia and eastern Europe. It is of interest that the Azorean

population is more similar to the northern nominate form than to the geographically closer subspecies of southwestern Europe (Volsøe 1955: 133). *P. p. murina* is, however, so strongly divergent from continental forms that it used to be kept as a distinct species. But the differences are concerned with plumage colour rather than with structure.

This brief review has revealed certain traits common to most species which have reached the Azores unaided by man. Their continental populations have migratory tendencies (exception: *Columba livia*), keep a south-westerly direction in the autumn migration (for *C. coturnix*, cf. Schifferli 1960) and are capable of surviving the winter under temperate conditions, i. e. they are not completely dependent on the tropics for the winter (border-line case: *Coturnix coturnix*, which is obviously scarce even in e.g. Spain in winter). The ability to survive at moderately low temperatures during winter is a prerequisite for successfully colonizing the Azores, as it would seem a dangerous life for most land-birds to be obliged to travel to and from these islands every winter. Very possibly, however, temperature as such plays a secondary role. It seems at least equally probable that the crucial thing is to be able to find food at comparatively cool temperatures.

These characteristics are borne out by the following comparisons, the form present on the Azores being listed in the left-hand column:

<i>Coturnix coturnix</i>	— <i>Perdix perdix</i> (nonmigratory)
<i>Asio otus</i>	— <i>Strix aluco</i> , <i>Tyto alba</i> (nonmigratory)
<i>Motacilla cinerea</i>	— <i>M. alba</i> (chiefly southeast bound)
	— <i>M. flava</i> (tropical winter-quarters)
<i>Regulus regulus</i>	— <i>R. ignicapillus</i> (lesser migratory tendencies)
	— <i>Parus spp.</i> (lesser migratory tendencies)
	— <i>Phylloscopus spp.</i> (chiefly tropical winter-quarters)
<i>Sylvia atricapilla</i>	— other <i>Sylvia spp.</i> (generally southeast bound and tropical winter-quarters)
<i>Erithacus rubecula</i>	— <i>Luscinia megarhynchos</i> , <i>Phoenicurus phoenicurus</i> (tropical winter-quarters)

A comparison such as the one suggested above, of course, should not be drawn too far. Naturally it is easy to find species which «ought to» have colonized the Azores as well as those listed above in the left-hand column: *Turdus philomelos*, *Prunella modularis*, *Accipiter nisus*, *Carduelis cannabina*, etc. The comparatively restricted variety of habitats and food sources may further limit the number of bird species on the Azores. Anyway, the comparisons attempted give an indication of what type of bird is most likely to reach remote islands of the general character of the Azores.

De Chavigny & Mayaud (1932) considered that the Azorean avifauna

had great affinities with Madeira, but Heim de Balsac (1936) and Volsøe (1955) rightly rejected this opinion. In point of fact, the Azorean avifauna has a north-central European character rather than a south European. This, as mentioned above, is probably caused by the stronger migratory tendencies in north-west European populations. The Azores have been colonized, it appears, by birds of north-west European origin, which have overshot the mark during the autumn migration and which have been capable of surviving the cool and humid winters of the Azores.

It may be repeated that the only vertebrates which have probably arrived in the Azores from Madeira are the lizard *Lacerta dugesii* and the bird *Serinus canaria*.

In the list of nonbreeding birds found in the Azores, de Chavigny & Mayaud (*op. cit.*) cite a relatively large number of American species, viz.:

<i>Egretta alba egretta</i> Gm.;	<i>Calidris fuscicollis</i> Vieill.;
<i>Botaurus lentiginosus</i> Mont.;	<i>Coccyzus erythrophthalmus</i> Wils.;
<i>Anas americana</i> L. («pas rare»);	<i>C. americanus</i> L.;
<i>Porphyrio alleni</i> Thomps.;	<i>Ceryle alcyon</i> L.;
<i>Charadrius vociferus</i> L.;	<i>Turdus mustelinus</i> Gm.

Considering the small amount of field ornithology that has been carried out in the Azores this list is quite impressive and goes to show that the influx of American birds to the islands must be considerable. One of the species, *Anas americana*, is said to be «not rare». Even if European birds make up the vast majority of the winter visitors to the Azores, the frequent occurrence of North American birds in the Azores should be kept in mind by those students of fresh-water invertebrates who consider dispersal by means of birds to be an important factor in distribution. If transport by birds is admitted to play a role, then the occurrence of a few American species of invertebrates may be explained as being due to ornithochor transport.

Finally, it may be pointed out that in spite of the comparatively frequent visits to the Azores by American birds, no such species has colonized the islands.

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