NIVERSITY OF KANSAS
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MISCELLANEOUS
PUBLICATION
No. 82

Bats of Portugal: Zoogeography and Systematics

By

Jorge M. Palmeirim

LAWRENCE

March 15, 1990

THE UNIVERSITY OF KANSAS, MUSEUM OF NATURAL HISTORY PUBLICATIONS

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Bats of Portugal: Zoogeography and Systematics

BY

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MISCELLANEOUS PUBLICATIONS

Editors: Robert M. Mengel and Richard F. Johnston
Managing Editor: Joseph T. Collins
Design and Typesetting: Kate A. Shaw and Joseph T. Collins

Miscellaneous Publication No. 82
Pp. 1–53; 39 figures; 24 tables; 1 appendix
Published March 15, 1990
ISBN: 0–89338–034–2

DYCHE HALL
THE UNIVERSITY OF KANSAS
LAWRENCE, KANSAS 66045-2454, USA

PRINTED BY
UNIVERSITY OF KANSAS PRINTING SERVICE
LAWRENCE, KANSAS

CONTENTS

INTRODUCTION

The scientific study of Portuguese bats is a little more than a century old. Bocage (1863) compiled the first list of bats from Portugal, Oliveira (1895) and Oliveira and Vieira (1896) added a few species to that list, and Seabra continued their work, publishing a series of papers updating the knowledge of the composition and distribution of the Portuguese bat fauna (Seabra, 1900, 1905, 1910, 1911, 1922, 1924). During the same period Nobre (1903, 1904) and Ayres (1914) reported the chiropterans deposited in the museum collections of Porto and Coimbra respectively; and finally Themido (1928) listed a total of 20 bat species from Portugal and added a considerable number of new localities. Since then a few papers have been dedicated to the Portuguese bat fauna (e.g. Almaça, 1964, 1966; Palmeirim, 1978; Palmeirim *et al.*, 1979), but the last complete overview was that of Seabra (1910). The goals of this paper are to: 1) compile all available published information, 2) summarize the considerable number of new distributional records, 3) discuss the patterns of bat distribution both within Iberia and in the context of the western Palearctic, 4) analyze the taxonomic status of the species present, and 5) provide morphological descriptions and keys to allow the identification of all the bat species known from Iberia. This paper does not concern the chiropteran faunas of the Portuguese archipelagos of Madeira and Azores; for convenience "Portugal" is used throughout this paper to refer to continental Portugal.

Portugal is not a natural biogeographical unit and therefore I have incorporated much complementary information available from Spain; the two countries together constitute a meaningful biogeographic unit—the Iberian Peninsula (Fig. 1). The level of scientific knowledge of the chiropteran fauna of Spain is similar to that of Portugal. Cabrera's (1914) monograph includes the last overview of the entire Spanish bat fauna. Bauer (1956) studied Iberian samples of 15 species and Tupinier (1975) wrote a comprehensive thesis on half of the Spanish chiropteran species, while Balcells (1964a, 1967) published surveys of bat distributions in northern and eastern Spain.

Many endemic subspecies have been described from the Iberian Peninsula, but none are recognized in the present review. In some cases this should not be interpreted as a denial of the occurrence of geographic variation, but rather as my opinion of the appropriateness of using a subspecific name to designate the Iberian populations. This problem is discussed in the text for each species.

ACKNOWLEDGMENTS

I am grateful to Prof. Carlos Almaça, Carlos Magalhães, and Prof. Germano Sacarrão for providing guidance in the early phases of this project. I am also indebted to many people who contributed to this work, mostly by helping me in the field or bringing specimens. In particular my friends Fátima Bacellar, Deodália Dias, and M. João Ramos shared much of the field and lab work; with them even the most exhausting field days left good memories. The staff of the "Serviço Nacional de Caça e Pesca" and "Parque Nacional da Peneda-Gerês" provided valuable assistance. Drs. J. Castroviejo, M. M. Gama, J. E. Hill, F. Petter, and J. A. Valverde kindly granted me access to the collections in their care. Dr. Karl F. Koopman and an anonymous reviewer provided useful suggestions to improve the text. I am most grateful to my advisor, Prof. Robert S. Hoffmann, for his liberal guidance, generously providing help and advice whenever needed, and for critically reading the various versions of this paper. Finally I want to thank my parents for their example, support and love; thanks for not complaining about all those rotten bats in your freezer . . . !

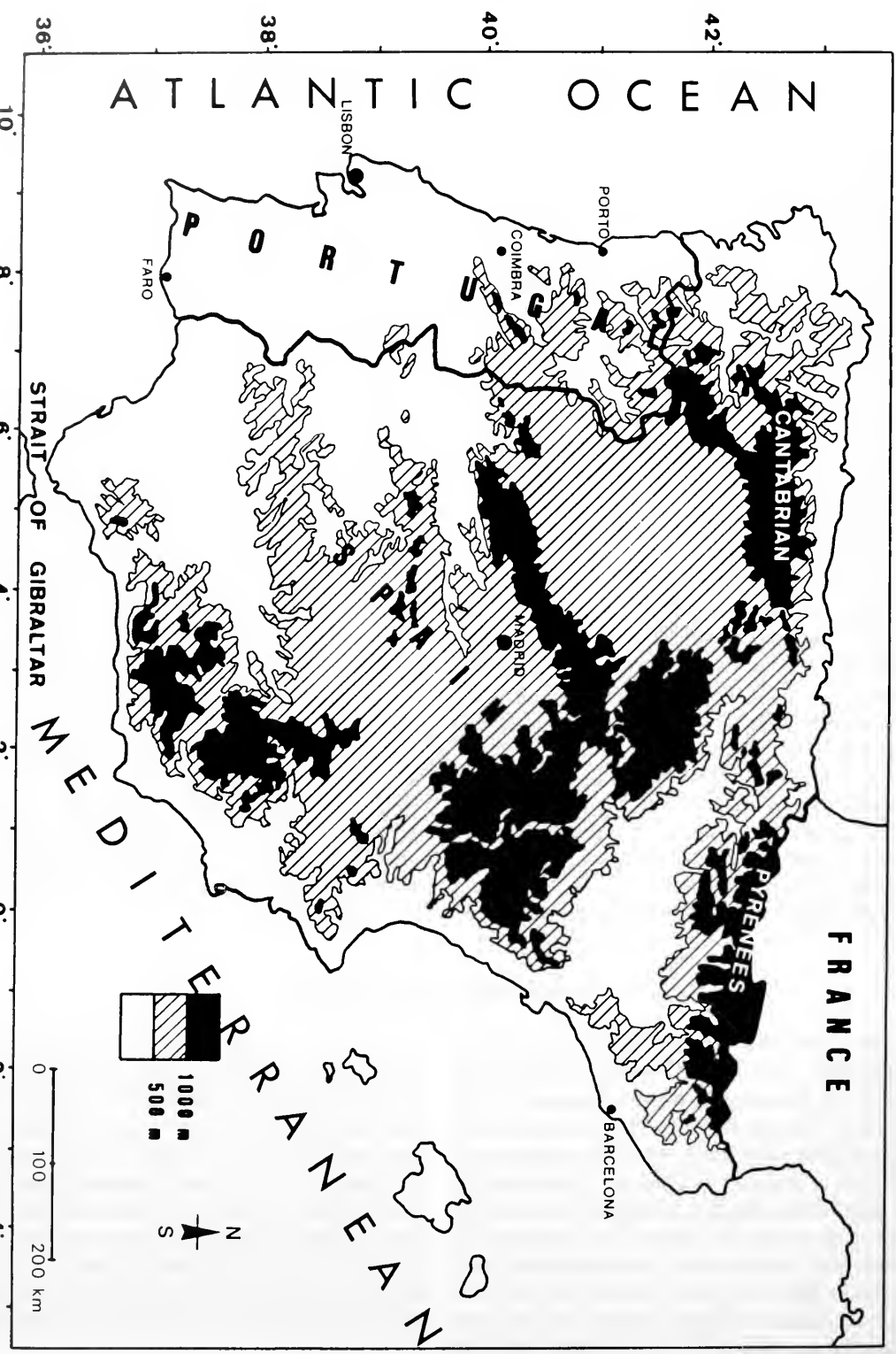

Fig. 1. Map of the Iberian Peninsula, showing altitudinal contours and major cities.

MATERIALS AND METHODS

Specimens were collected in their roosts or caught with mist nets from about one hundred localities throughout Portugal. Preserved specimens that have not yet been deposited in a museum collection are identified by the initials JP. In addition, the collections of the Museu Bocage (MB) in Lisbon and Museu Zoologico da Universidade de Coimbra (MZUC) in Coimbra were studied. A few specimens from Portugal were also found in the collections of the British Museum (Natural History) (BMNH) in London and Muséum National d'Histoire Naturelle (MNHNP) in Paris. Comparative specimens from other geographical areas were studied from the above collections, at the Museum of Natural History of the University of Kansas (KU) in Lawrence and the Estación Biológica de Doñana (EBD) in Seville. All measurements were made with calipers to the nearest 0.1 mm. Measurements given are shown in Fig. 2. Statistical analy-

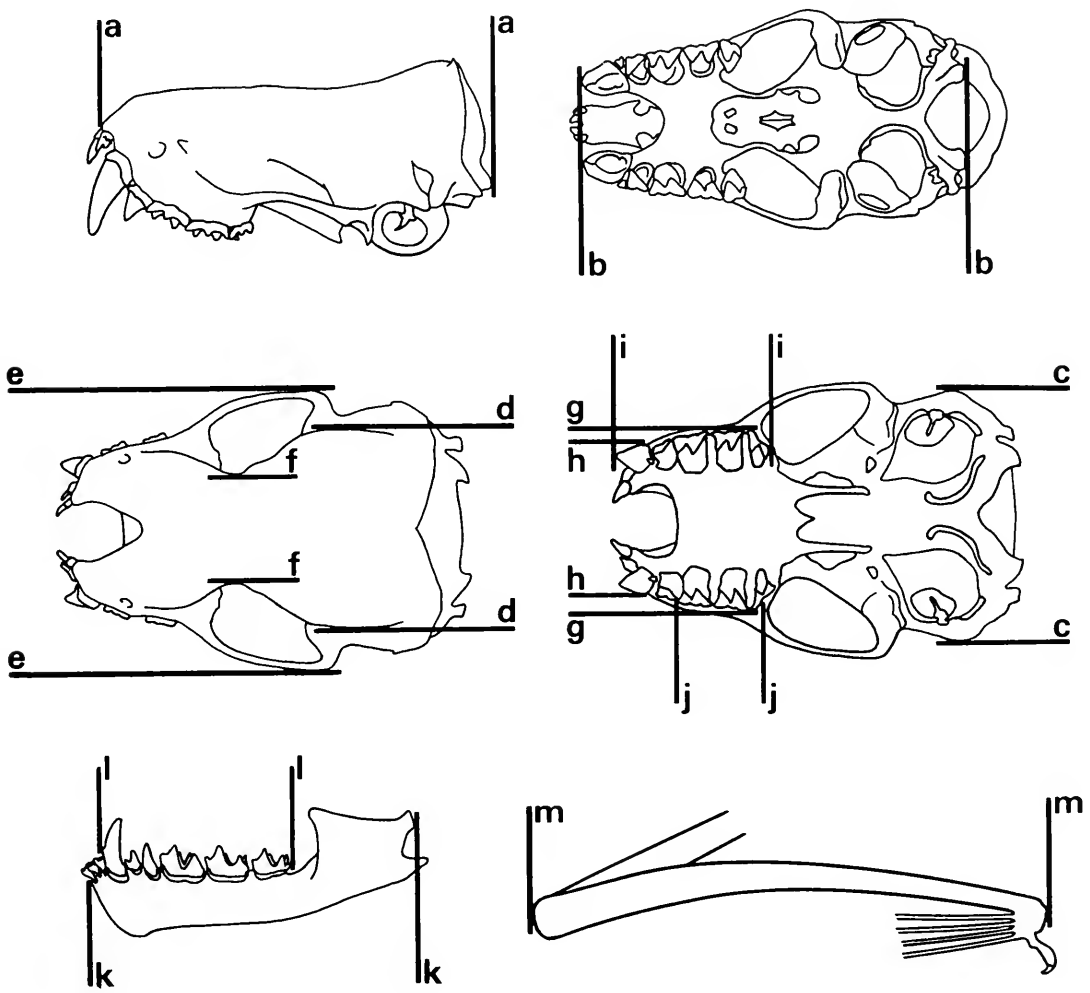

Fig. 2. Measurements used in this paper: (a–a) condylobasal length (not taken on rhinolophids), (b–b) condylocanine length (rhinolophids only), (c–c) mastoid breadth, (d–d) braincase breadth, (e–e) zygomatic breadth, (f–f) interorbital constriction breadth, (g–g) maxillary M–M breadth, (h–h) maxillary C–C breadth, (i–i) C–M^3 length, (j–j) labial M^1–M^3 length, (k–k) length of mandible, (l–l) C–M_3 length and (m–m) length of forearm. Skull drawings based on Lanza (1959).

sis involved the use of the BMDP 4M statistical package for principal components analysis and BMDP 2M for cluster analysis (Dixon, 1983); computations were done using a Honeywell 66/60 at The University of Kansas Computing Service. Distribution maps include all localities from which I have examined specimens and records found in the literature; the records in Palmeirim (1978) and Palmeirim *et al.* (1979, in press) are not included in the list of literature records, because they are listed as specimens examined.

KEY TO THE MICROCHIROPTERAN FAMILIES OF IBERIA

Based on External Characters.—

1. Tragus absent (Fig. 3); noseleaf present ....Rhinolophidae (p. 5)
1'. Tragus present (Fig. 3); noseleaf absent 2
2. Tail extending for at least ⅓ of its length beyond posterior edge of uropatagium..... .....Molossidae (p. 39)
2'. Tail almost entirely included in uropatagium 3
3. Second phalanx of third digit about 3 times as long as first phalanx (Fig. 4) ....Miniopteridae (p. 37)
3'. Second phalanx of third digit less than twice as long as first phalanx ....Vespertilionidae (p. 13)

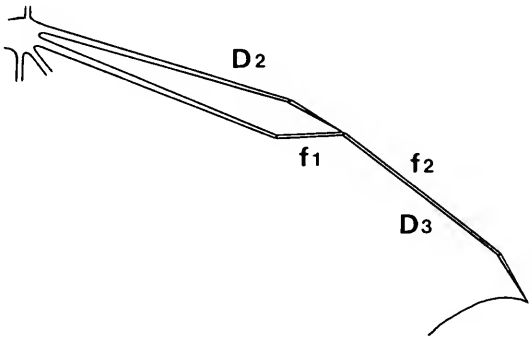

Fig. 4. Schematic representation of the second (D_2) and third (D_3) digits of *Miniopterus* showing the relative size of the first (f_1) and second (f_2) phalanges of D_3.

Based on Cranial Characters.—

1. Skull with conspicuous nasal inflation (Fig. 5); premaxillae unfused, often missing in cleaned skull.....Rhinolophidae (p. 5)
1'. Skull without nasal inflation; premaxillae fused to the skull 2
2. Only one pair of upper incisors ....Molossidae (p. 39)
2'. Two pairs of upper incisors 3
3. Dorsal profile of skull strongly curved, with a clear depression in the braincase (Fig. 5) ....Miniopteridae (p. 37)
3'. Dorsal profile of skull straight or curved, without any depression in the braincase..... .....Vespertilionidae (p. 13)

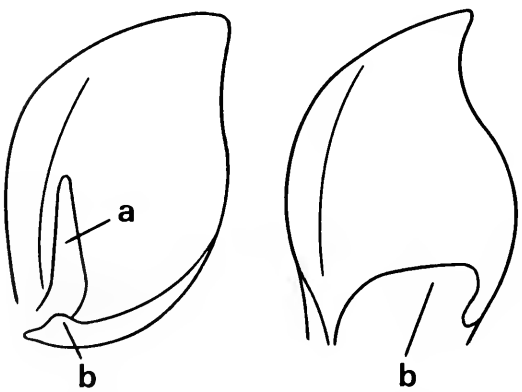

Fig. 3. Ear of a vespertilionid (left) and rhinolophid (right): (a) tragus, (b) antitragus. Note the absence of tragus and well developed antitragus on rhinolophids.

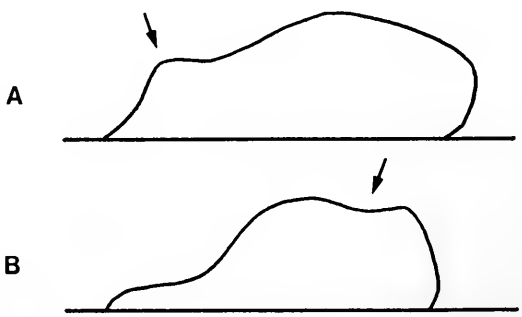

Fig. 5. Typical skull profiles of A) *Rhinolophus* and B) *Miniopterus*.

SPECIES ACCOUNTS

Family Rhinolophidae

An exclusively Old World family distributed throughout the Ethiopian, Oriental, and Australian regions, it is also present along the subtropical margin of the Palearctic and has a few representatives in temperate areas of this subregion. The family includes about 127 species and 10 genera; four species and one genus are known from Portugal.

The Rhinolophidae are the only bats in Europe with very complex and conspicuous noseleaf appendages (Fig. 6). The widely spaced ears are large, the antitragus is well developed, and the tragus absent (Fig. 3); a feature unique to this family among the Microchiroptera. Skulls of the members of this family can be separated from those of other European bat families by the presence of a conspicuously inflated rostrum (Fig. 5) and the absence of maxillary branches of the premaxillae. The slender palatal branches are fused medially and loosely attached to the skull; this fragile structure is very often lost in the process of cleaning the skull.

Genus *Rhinolophus*

This is a very large genus, widely distributed in the tropical and subtropical Old World, with a few species present in the Palearctic. Five species occur in Europe, four of which are known in Portugal: *R. ferrumequinum*, *R. hipposideros*, *R. euryale*, and *R. mehelyi*. *R. blasii* has not been found in Portugal, but a single individual was reported from Spain (Romero and Castroviejo, 1973). The presence of this species in the Iberian Peninsula still needs further corroboration. The dental formula is: I 1/2, C 1/1, P 2/3, M 3/3 = 32. For other characters, see the family account above.

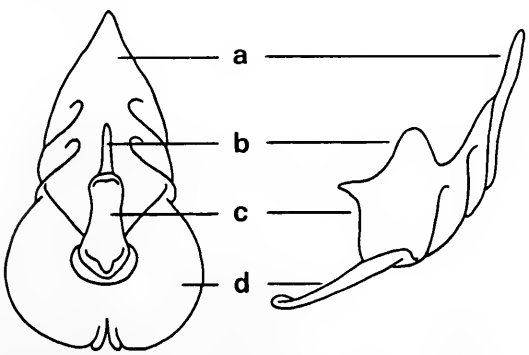

Fig. 6. Nasal appendages of *Rhinolophus*: A) lancet, B) connective process, C) sella, and D) horseshoe. Modified from Cabrera (1914).

KEY TO THE SPECIES OF *RHINOLOPHUS* KNOWN FROM IBERIA

Based on External Characters.—

1. Forearm shorter than 40 mm ..... *R. hipposideros* (p. 8)
1'. Forearm longer than 43 mm 2
2. First phalanx of fourth digit more than half as long as second phalanx ..... *R. blasii*
2'. First phalanx of fourth digit less than half as long as second phalanx 3
3. Forearm usually longer than 52 mm; connective process round and protruding about as much as sella (Fig. 7) ..... *R. ferrumequinum* (p. 6)
3'. Forearm usually shorter than 52 mm; connective process pointed and protruding much more than sella (Fig. 7) 4
4. Sides of lancet strongly curved inward (Fig. 7) ..... *R. mehelyi* (p. 11)
4'. Sides of lancet straight or slightly curved inward, but usually less so than in the previous species (Fig. 7) ..... *R. euryale* (p. 10)

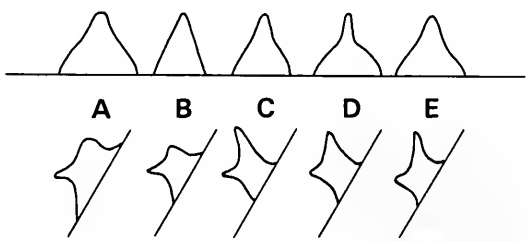

Fig. 7. Typical shapes of lancet (top) and connective process (bottom) of European *Rhinolophus*: A) *R. ferrumequinum*, B) *R. hipposideros*, C) *R. euryale*, D) *R. mehelyi*, and E) *R. blasii*.

Based on Cranial Characters.—

1. Condylocanine length under 14 mm; upper tooth row under 5.6 mm ..... *R. hipposideros* (p. 8)
1'. Condylocanine length over 16 mm; upper tooth row over 6 mm 2
2. Condylocanine length over 19 mm; upper tooth row over 8 mm ..... *R. ferrumequinum* (p. 6)
2'. Condylocanine length under 18.5 mm; upper tooth row under 7.5 mm 3
3. Crown area of first and third lower premolars approximately equal; clear depression in the braincase (Fig. 8) ..... *R. blasii*
3'. Crown area of first lower premolar smaller than that of the third lower premolar; braincase straight or slightly depressed (Fig. 8) 4
4. Condylocanine length over 16.8 mm; upper tooth row over 6.6 mm; mandible length over 12.5 mm; ratio of mastoid breadth/zygomatic breadth (MB/ZB) under 0.97 ..... *R. mehelyi* (p. 11)
4'. Condylocanine length under 16.8 mm; upper-tooth row under 6.6 mm; mandible length under 12.3 mm; ratio of mastoid breadth/zygomatic breadth over 0.97 ..... *R. euryale* (p. 10)

RHINOLOPHUS FERRUMEQUINUM (SCHREBER, 1774)

Distribution.—*R. ferrumequinum* ranges from the Magreb in North Africa (Anciaux de Faveaux, 1976) to southern Great Britain (Stebbings, 1977) and from Portugal eastward throughout the southern Palearctic to Japan (Imaizumi, 1970). According to Cabrera (1914) and Tupinier (1975) this species is present throughout the Iberian Peninsula. In Portugal *R. ferrumequinum* is common in the north and centrally, but has only been found marginally in the southernmost province (Algarve), despite relatively thorough exploration of its bat caves (Fig. 9). *R. ferrumequinum* roosts in caves, mines and large spaces in buildings.

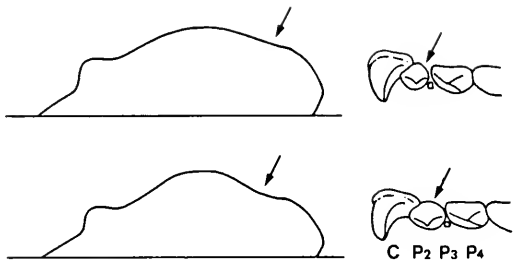

Fig. 8. Skull profiles and dorsal view of part of lower dentition of *Rhinolophus euryale* (top) and *R. blasii* (bottom). Arrows point to differences in the braincase profile and the relative size of P_2. Modified from Lanza (1959).

Morphology and Taxonomic Remarks.—*R. ferrumequinum* is the largest of the European species of the genus (Table 1). The hair is very light brown; darker tips give a rather dark appearance to the upper parts. The membranes are medium dark brown. The sides of the sella are strongly concave and meet in a round apex; the connective process is round and protrudes approximately as much as the sella (Fig. 7). The sides of the lancet are slightly concave (Fig. 7).

TABLE 1. Statistics of a sample of *Rhinolophus ferrumequinum* from Portugal. Measurements are in millimeters.

	$\bar{x}$	*SD*	range	*n*
Length of Forearm	54.57	1.30	52.3–58.2	26
Condylocanine Length	20.21	0.27	19.8–20.6	7
Zygomatic Breadth	11.87	0.20	11.6–12.2	7
Mastoid Breadth	10.45	0.16	10.3–10.7	6
C–M^3 Length	8.47	0.17	8.3–8.8	7
Maxillary C–C Breadth	6.56	0.21	6.4–6.9	5
Maxillary M–M Breadth	8.61	0.17	8.3–8.8	7
Length of Mandible	15.37	0.26	15.0–15.8	6
C–M_3 Length	9.05	0.23	8.8–9.3	4

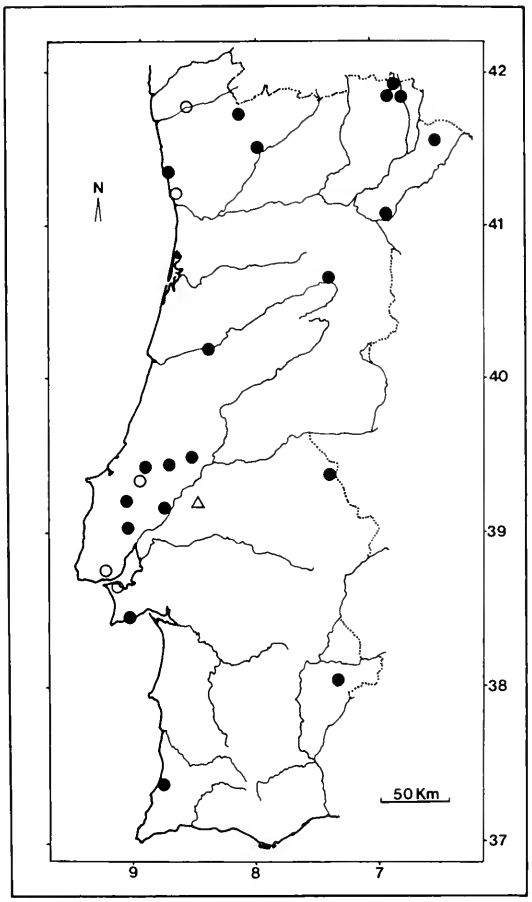

Fig. 9. Locality records of *Rhinolophus ferrumequinum* from Portugal. Closed circles—specimens examined; open circles—literature references; closed triangles—approximate location, specimens examined; open triangles—approximate location, literature references.

The skull is easily separable from all other European *Rhinolophus* by its large dimensions. Furthermore, it is the only species of *Rhinolophus* in Europe to have the large upper premolar in contact with the canine; this is possibly due to the reduction and labial displacement of the small premolar.

Cabrera (1904) described the subspecies *R. f. obscurus* from southeastern Spain and tentatively suggested that it would be found throughout the Mediterranean coast, while the rest of the peninsula was occupied by the nominate form. The name *obscurus* refers to the darker tone of this form, but Cabrera (1914) later recognized that there was no color difference between the Iberian specimens and the nominate form; the distinctiveness of the two forms has since been based on size differences, particularly in forearm length. Andersen (1905) suggested that all Iberian specimens belong to *obscurus* and this view was followed by many authors (e.g. Cabrera, 1914; Themido, 1928, 1931; Gama, 1957; Hayman and Hill, 1971). Felten *et al.* (1977) examined specimens from localities ranging from Iberia to Afghanistan; they grouped the specimens from Iberia, Sardinia, Corsica, and North Africa in the subspecies *obscurus*. However, the great majority of the Iberian specimens studied by Felten *et al.* (1977) are from the southern and central parts of the peninsula; the mean forearm length of a sample from northern Iberia that I measured is larger than their sample from "Iberia" and similar to the mean of their sample of French animals, which belong to the nominate subspecies (Fig. 10). If the distinctiveness of the form *obscurus* is recognized, then the larger specimens from northern Iberia should be assigned to *R. f. ferrumequinum*, whereas the smaller animals from the south should be included in *R. f. obscurus*. There are no distributional discontinuities, but it is not known how gradual the north–south size decrease is. In Europe there is also a clear east–west size gradient (Fig. 10), with the smallest animals in southern and central Iberia. Caubére *et al.* (1968) noticed this cline and demonstrated a slight size decrease from east to west in France. The gradual nature of geographic size changes in this species and the broad contact between *R. f. obscurus* and *R. f. ferrumequinum* in Iberia suggest to me that *obscurus* should not be considered a distinct subspecies. Furthermore, the size difference between the central and southern Iberian populations of *R. ferrumequinum* and those of France does not fulfill the 75% rule (Mayr *et al.*, 1953). A cluster analysis of the data in Felten *et al.* (1977) (Fig. 11) also failed to show the separability of *obscurus*. Considering the above, I support the view that Iberian *R. ferrumequinum* should all be assigned to the nominate form (e.g. Miller, 1912; Ellerman and Morrison-Scott, 1951; Bauer, 1956; Caubére *et al.*, 1968; Tupinier, 1975; Corbet, 1978).

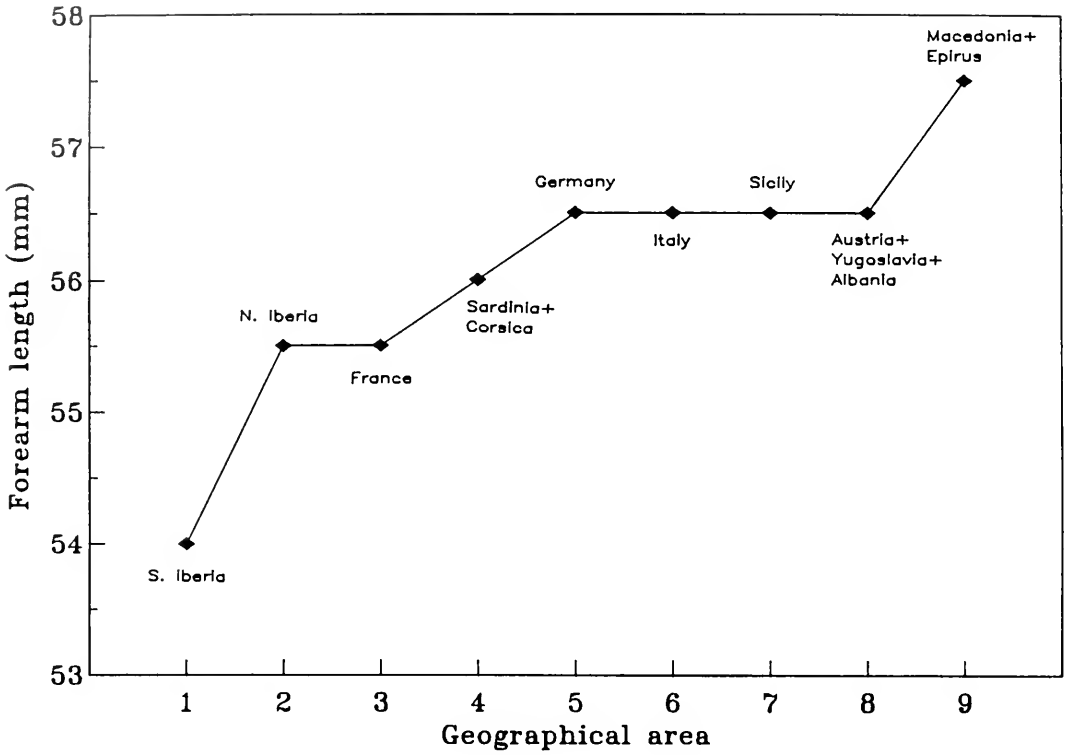

Fig. 10. Mean forearm length of European samples of *Rhinolophus ferrumequinum*. Note the gradual east-west size decrease. All but the Iberian data from Felten *et al.* (1977).

RHINOLOPHUS HIPPOSIDEROS (BECHSTEIN, 1800)

Distribution.—*R. hipposideros* is found from the Mediterranean Sea north to Ireland (Stebbings, 1977) and southern Poland (Kowalski and Ruprecht, 1981), south to Ethiopia (Hayman and Hill, 1971) and extends through southwestern Asia to Kashmir (Roberts, 1977). It is present throughout the Iberian Peninsula (Cabrera, 1914; Tupinier, 1975). In Portugal (Fig. 12) this is one of the bats most commonly found in caves and mine tunnels; during the summer it also roosts in buildings. It is usually found isolated or in small dispersed groups.

Morphology and Taxonomic Remarks.—*R. hipposideros* is the smallest of the European members of the genus (Table 2); size alone distin-

TABLE 2. Statistics of a sample of *Rhinolophus hipposideros* from Portugal.

	$\bar{x}$	*SD*	range	*n*
Length of Forearm	36.74	0.79	35.0–38.3	34
Condylocanine Length	13.56	0.14	13.4–13.8	42
Zygomatic Breadth	7.59	0.15	7.3–7.8	9
Mastoid Breadth	7.40	0.08	7.3–7.5	8
C–M^3 Length	5.33	0.10	5.2–5.4	10
Maxillary C–C Breadth	3.47	0.08	3.3–3.6	10
Maxillary M–M Breadth	5.44	0.17	5.2–5.7	10
Length of Mandible	9.71	0.28	9.2–10.1	9
C–M_3 Length	5.39	0.14	5.1–5.6	10

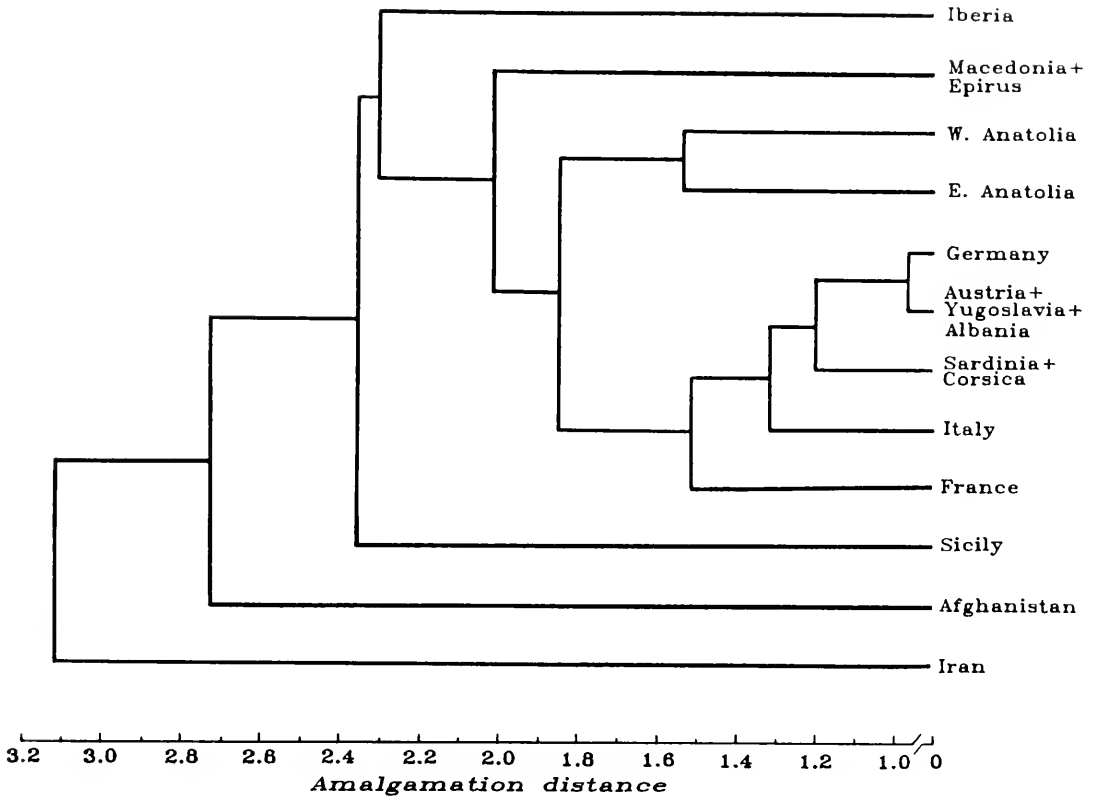

Fig. 11. Phenogram of twelve samples of *Rhinolophus ferrumequinum*. The natural logarithms of the averages of eight skull measurements and forearm length were first submitted to a principal components analysis. The first five components were then clustered by an algorithm using the square root of the sum of squares as a distance measure (Dixon, 1983). Principal component scores were used instead of the original measurements to avoid an overwhelming influence of size in the resulting phenogram. Data from Felten *et al.* (1977).

guishes it from the next smallest *R. euryale* (Table 3). The long hair is very pale grayish-brown, dorsally tipped with a much darker tone; the resultant overall color of the upper parts is rather dark. The membranes are darker than the dorsal fur. The sella is more protruding than that of other Iberian *Rhinolophus* (Fig. 7) and its sides are strongly convergent distally. The sides of the lancet are approximately straight (Fig. 7). The skull is easily identified by its small size. The

TABLE 3. Statistics of a sample of *Rhinolophus euryale* from Portugal.

	$\bar{x}$	*SD*	range	*n*
Length of Forearm	47.63	0.72	46.4–48.7	8
Condylocanine Length	16.31	0.09	16.2–16.5	9
Zygomatic Breadth	9.47	0.14	9.2–9.7	15
Mastoid Breadth	9.41	0.12	9.3–9.6	12
C–M^3 Length	6.26	0.08	6.2–6.4	14
Maxillary C–C Breadth	4.62	0.13	4.4–4.8	12
Maxillary M–M Breadth	6.61	0.15	6.3–6.8	15
Length of Mandible	11.78	0.20	11.5–12.2	15
C–M_3 Length	6.65	0.08	6.5–6.8	13

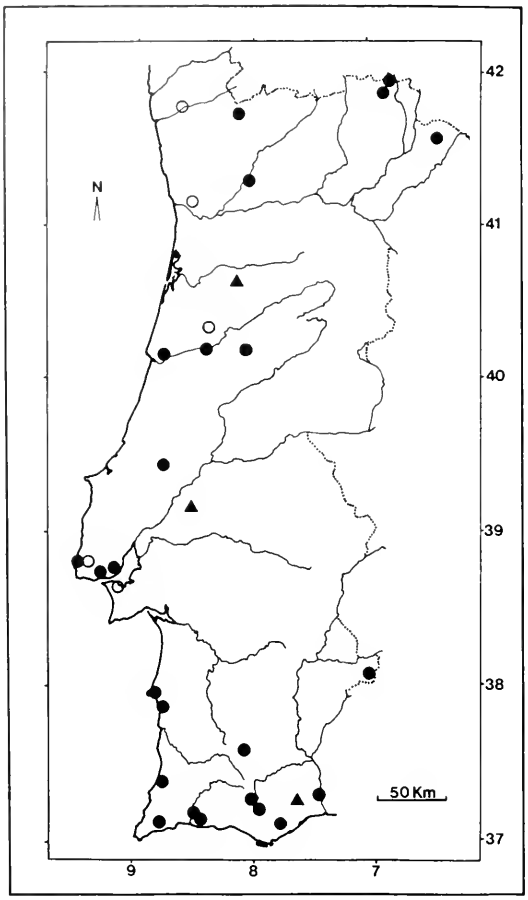

Fig. 12. Locality records of *Rhinolophus hipposideros* from Portugal. Symbols as in Fig. 9.

smaller upper premolar is located between the canine and the larger premolar, separating the latter two teeth.

Traditionally *R. hipposideros* in western Europe has been divided into three subspecies; *R. h. minimus* along the Mediterranean, *R. h. minutus* in the British Isles, and the nominate form in central Europe (Andersen, 1905, 1907; Miller, 1912; Ellerman and Morrison-Scott, 1951). Cabrera (1904) described *R. phasma* from central Spain distinguishing it from *R. hipposideros* by the shape of the ears and nasal appendages, but later (Cabrera, 1914) included this new species in *R. h. minimus*. Most authors referred Iberian populations to *R. h. minimus* (e.g. Seabra, 1922; Themido, 1928, 1931; Bauer, 1956; Gama, 1957; Tupinier, 1975). The various subspecies have been based mainly on size, particularly on the length of the forearm; the Mediterranean form *minimus* usually has a forearm shorter than 38 mm, whereas that of the nominate form in central Europe is usually over 39 mm (Miller, 1912). However, *R. hipposideros* shows great geographical size variation and Miller (1912) stated that the three recognized subspecies were not wholly satisfactory. Saint Girons and Caubère (1966) found that in France the forearm length of *R. hipposideros* decreases gradually from the NE to the SW; furthermore they showed that montane populations (Alps and Pyrenees) have longer forearms than those of the nearby lowlands. This suggests that *R. hipposideros* varies locally with climatic conditions and that the size similarities along the Mediterranean do not reflect a close evolutionary relationship among the populations of that area. Therefore, I believe that no subspecies of *R. hipposideros* should be distinguished within continental Europe. The separation of the form *minutus* from the British Isles also seems to be unjustifiable (Blackmore, 1964). Felten *et al.* (1977) studied specimens from most of the range of *R. hipposideros* including the Iberian Peninsula. They tentatively suggested partitioning the species into four groups, of which only the nominate subspecies was present in continental Europe; the subspecies *minimus* was restricted to the type locality (Eritrea) and Crete. Finally, Corbet (1978) recognizes the Asiatic form *midas* as a separate subspecies.

RHINOLOPHUS EURYALE BLASIUS, 1853

Distribution.—*R. euryale* is known from Portugal to eastern Iran (DeBlase, 1980), and from North Africa (Aellen and Strinati, 1970) and Palestine (DeBlase, 1972) northward to central France (Saint Girons, 1973) and the Caucasus (Bobrinskii *et al.*, 1965). Despite its Mediterranean character *R. euryale* has not yet been reported in southern Iberia. I have not found it in the southern third of Portugal, despite fairly intensive study of this area (Fig. 13). In the rest of the country the species is common, usually roosting in caves and mine tunnels.

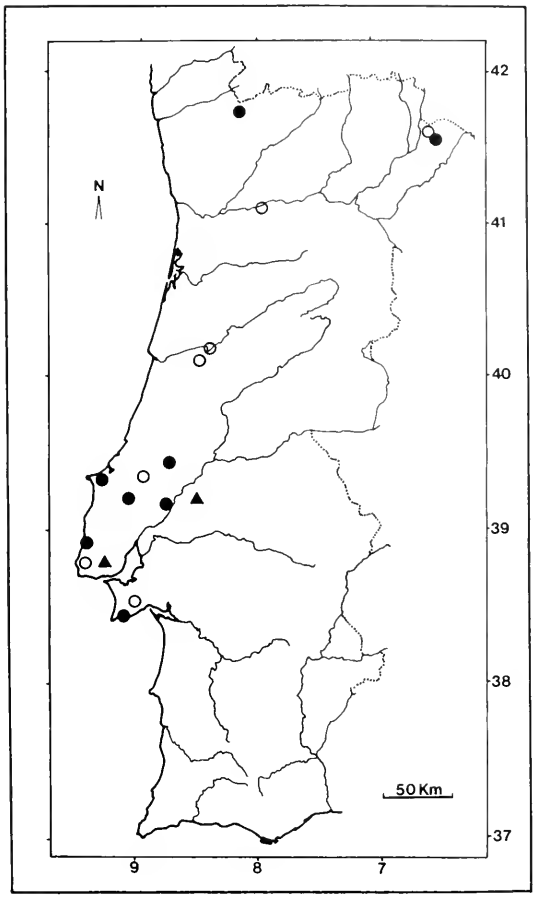

Fig. 13. Locality records of *Rhinolophus euryale* from Portugal. Symbols as in Fig. 9.

Morphology and Taxonomic Remarks.—*R. euryale* is a small bat, intermediate in size between *R. hipposideros* and *R. mehelyi* (Table 3). The hair is long and very light brown, dorsally tipped with darker brown. The patagium is brown and the ears yellowish-brown. Its size allows easy separation from the much smaller *R. hipposideros* and much larger *R. ferrumequinum*, but confusion with *R. mehelyi* is common. In both species the sides of the sellae are roughly parallel, meet in a blunt apex, and the pointed connective process clearly protrudes farther than the sella (Fig. 7). In *R. euryale* the sides of the lancet are straight or slightly concave, but usually much less curved inward than in *R. mehelyi* (Fig. 7). The skull and dentition are similar to those of *R. mehelyi*, but on average are smaller; the craniometric overlap between the two species varies geographically but in Portugal there is little overlap, which allows easy identification of most skulls. The braincase is slightly but consistently broader (measured at the level of the mastoid process) than that of *R. mehelyi*. The smaller upper premolar clearly separates the canine and the large premolar. Confusion with the similar *R. blasii* is also possible; this species has been reported from Spain (Romero and Castroviejo, 1973) and Morocco (Aellen, 1955) and therefore its presence in Portugal is possible.

Andersen and Matschie (1904) described the subspecies *cabrerae* from Iberia; however the study of specimens from Portugal corroborates the opinion (e.g. Miller, 1912; Cabrera, 1914; Tupinier, 1975) that this form is not separable from the nominate subspecies, which includes all European populations.

RHINOLOPHUS MEHELYI MATSCHIE, 1901

Distribution.—*R. mehelyi* seems to be associated with Mediterranean and sub-Mediterranean climates; it is present along both sides of the Mediterranean Sea and extends eastward to Iran (DeBlase, 1972), although this wide range seems to be discontinuous. Confusion between *R. mehelyi* and *R. euryale* has obscured the ranges of both species. In Portugal, *R. mehelyi* is most common in the south, but the species is also present in the central part of the country (Fig. 14). It is widespread in central and southern Iberia, but there are no records for the northern part of the peninsula, which has a more Atlantic climate. Tupinier (1975) tentatively identified as *R. mehelyi* specimens from various localities in the province of Santander in the Cantabrians. However, he based his identification on the shape of the lancet, a frequently misleading character (see below). His measurements and the MB/ZB ratio (see key p. 6) strongly suggest that they are actually *R. euryale*; therefore the presence of *R. mehelyi* in northern Iberia remains unconfirmed. I have found this species exclusively in caves and mine tunnels.

Morphology and Taxonomic Remarks.—*R. mehelyi* is a bat of medium size, averaging a bit larger than *R. euryale*, but clearly smaller than *R.*

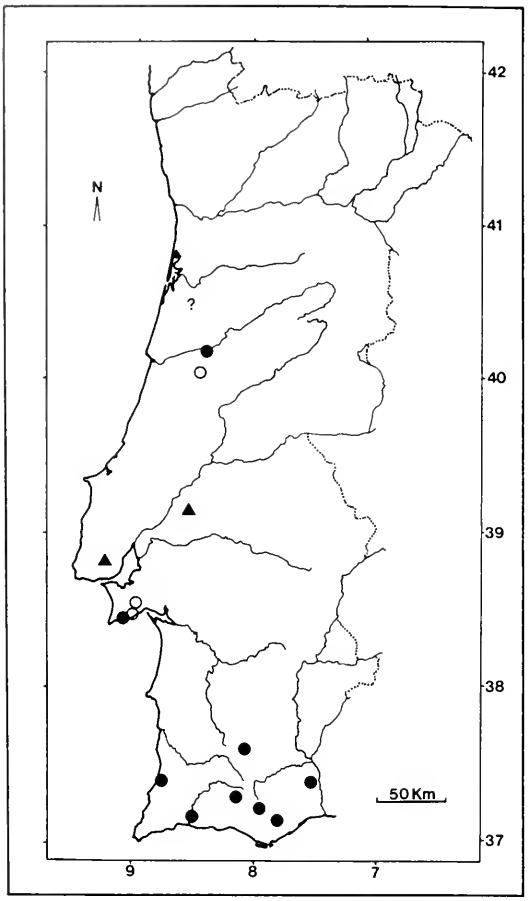

Fig. 14. Locality records of *Rhinolophus mehelyi* from Portugal. Symbols as in Fig. 9.

ferrumequinum (Table 4). Morphologically *R. mehelyi* is very similar to *R. euryale* and confusion between the two species is common. The fur is similar to that of *R. euryale*, but usually paler. In both species the sella has parallel or inwardly curved edges and a blunt apex and the connective process is pointed and protrudes clearly beyond the sella (Fig. 7). In *R. mehelyi* the sides of the lancet are strongly curved inward, more so than in *R. euryale* (Fig. 7). The shape of the lancet is the most widely used character in distinguishing *R. euryale* from *R. mehelyi*, but should be used with care; within-species variation includes specimens with intermediate lancet-shapes and this has caused considerable confusion in the literature (see account of *R. euryale* and Palmeirim *et al.*, 1979). DeBlase (1972) makes a thorough comparison between the two species. The small upper premolar is located between the canine and the large premolar, separating these teeth.

Cabrera (1904) described *R. carpetanus* based on Spanish specimens; later (1914) he considered this form to be a subspecies of *R. mehelyi*, distinguishable from the nominate subspecies by its larger size. This form was subsequently recognized by many authors (e.g. Seabra, 1924; Themido, 1928, 1931; Gama, 1957). However, comparing measurements given in the literature (e.g. Miller, 1912; Dulić, 1961; Baker *et al.*, 1974; Felten *et al.*, 1977; DeBlase, 1980) from various parts of the range of *R. mehelyi* and from Portugal, I found no reason to retain Cabrera's subspecies; this follows the opinion of Ellerman and Morrison-Scott (1951), Corbet (1978) and various other authors who consider *R. mehelyi* to be monotypic.

Strinati and Aellen (1958) advocated *R. carpetanus* as the species name based on the fact that

Table 4. Statistics of a sample of *Rhinolophus mehelyi* from Portugal.

	$\bar{x}$	*SD*	range	*n*
Length of Forearm	49.57	1.54	45.7–52.1	23
Condylocanine Length	17.34	0.34	16.9–18.5	21
Zygomatic Breadth	10.47	0.18	10.1–10.8	27
Mastoid Breadth	9.82	0.14	9.6–10.1	26
C–M^3 Length	6.99	0.13	6.7–7.2	28
Maxillary C–C Breadth	5.19	0.12	4.9–5.4	28
Maxillary M–M Breadth	7.47	0.13	7.3–7.7	27
Length of Mandible	12.88	0.19	12.6–13.4	27
C–M_3 Length	7.35	0.16	6.9–7.6	27

the description of *mehelyi* by Matschie (1901) is ambiguous and may refer to *R. euryale*, whereas Cabrera (1904) unequivocally described *R. carpetanus*. However, the interests of taxonomic stability are served by maintaining the name *mehelyi*, because it has been used consistently since Miller (1912) (e.g. Corbet, 1978).

Family Vespertilionidae

Bats of this family are present throughout the temperate and tropical regions of both the New and Old Worlds. About 300 species and 34 genera are included; 18 species of six genera are known from Portugal. In this paper *Miniopterus* is not included in the Vespertilionidae (see discussion under Miniopteridae).

In Europe members of this family can only be confused with the Miniopteridae, but the vespertilionids have a baculum, a scapula with an outwardly curved coracoid, and lack the vestigial anteriormost upper premolar recently found in *Miniopterus* (Mein and Tupinier, 1977).

Key to the Genera of Vespertilionidae Present in Iberia

Based on External Characters.—

1. Ear bases joined over top of head; nostrils opening upward 2
1'. Ear bases widely separated; nostrils opening forward 3
2. Ear as long, or almost as long, as forearm (longer than 28 mm); no post-calcarial lobe. ..... *Plecotus* (p. 35)
2'. Ear much shorter than forearm (shorter than 20 mm); small post-calcarial lobe present .... *Barbastella* (p. 34)
3. No post-calcarial lobe; pointed tragus (Fig. 15) ..... *Myotis* (p. 14)
3'. Post-calcarial lobe present; tragus with rounded tip (Fig. 15) 4
4. Tragus mushroom-shaped, wider than high (Fig. 15) ..... *Nyctalus* (p. 25)
4'. Tragus elongate, higher than wide (Fig. 15). 5
5. Forearm shorter than 38 mm .... *Pipistrellus* (p. 28)

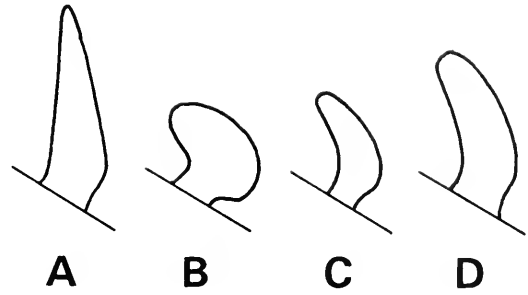

Fig. 15. Typical shape of the tragus of A) *Myotis*, B) *Nyctalus*, C) *Pipistrellus*, and D) *Eptesicus*.

5'. Forearm longer than 45 mm .... *Eptesicus* (p. 23)

Based on Cranial Characters.—

1. Three pairs of upper premolars .... *Myotis* (p. 14)
1'. One or two pairs of upper premolars 2
2. One pair of upper premolars (but see *P. savii*) ..... *Eptesicus* (p. 23)
2'. Two pairs of upper premolars 3
3. Three pairs of lower premolars; maximal diameter of tympanic bulla twice as large as the distance between them ..... *Plecotus* (p. 35)
3'. Two pairs of lower premolars; tympanic bulla not as large as above 4
4. Condylobasal length over 14.8 mm .... *Nyctalus* (p. 25)
4'. Condylobasal length less than 14.5 mm 5
5. Tapered rostrum (Fig. 16) .... *Barbastella* (p. 34)
5'. Rostrum not tapered (Fig. 16) .... *Pipistrellus* (p. 28)

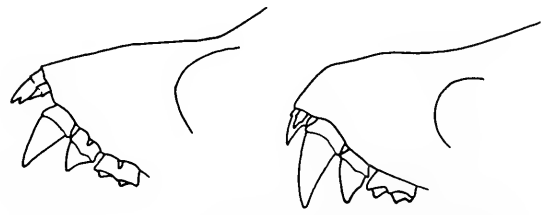

Fig. 16. Side view of the anterior part of the skulls of *Barbastella* (left) and *Pipistrellus* (right). Note the tapered rostrum of *Barbastella*. Modified from Gaisler *et al.* (1957).

Genus *Myotis*

This very large group includes about 90 species and is the most widespread of all bat genera; seven species are known in Portugal: *M. myotis, M. blythii, M. bechsteinii, M. nattereri, M. emarginatus, M. daubentonii*, and *M. mystacinus*. *M. nathalinae* may also occur (see discussion under *M. daubentonii*). These species traditionally have been divided into three subgenera: *Myotis, Leuconoe*, and *Selysius* (Lanza, 1959).

The size range of the species in Portugal is large, but all are lightly built. The muzzle is fairly narrow and the ears quite slender. The well-developed tragus (at least half as high as the external ear) is lanceolate and quite pointed (Fig. 15), which distinguishes this genus from other European bats. *Myotis* has the greatest number of teeth known in the Chiroptera, being the only European genus with three well-developed upper premolars: I 2/3, C 1/1, P 3/3, M 3/3 = 38.

KEY TO THE SPECIES OF *MYOTIS* KNOWN FROM IBERIA

Based on External Characters.—

1. Forearm longer than 50 mm 2
1'. Forearm shorter than 46 mm 3
2. Ear longer than 24 mm; tail (measured from anus) usually shorter than forearm ....*M. myotis* (p. 16)
2'. Ear shorter than 26 mm; tail (measured from anus) usually longer than forearm ....*M. blythii* (p. 17)
3. Ear longer than half the length of forearm (more than 22 mm) .....*M. bechsteinii* (p. 23)
3'. Ear shorter than half the length of forearm (less than 20 mm) 4
4. Calcar bordering about ½ of the uropatagium; foot shorter than ½ the length of tibia 5
4'. Calcar bordering about ⅔ of uropatagium; foot usually about as long as ½ the length of tibia 8
5. Uropatagium bordered by a fringe of stiff hairs, about 1 mm long; no pronounced notch on the outer edge of ear ....*M. nattereri* (p. 22)
5'. No stiff hairs bordering uropatagium; clear notch on outer edge of ear 6
6. Very pronounced notch on the distal half of outer edge of ear (Fig. 17); ears and patagium brown; forearm longer than 36 mm ....*M. emarginatus* (p. 20)
6'. Notch on the proximal half of outer edge of ear, although less pronounced than in previous species (Fig. 17); ears and patagium almost black; forearm usually less than 36 mm 7

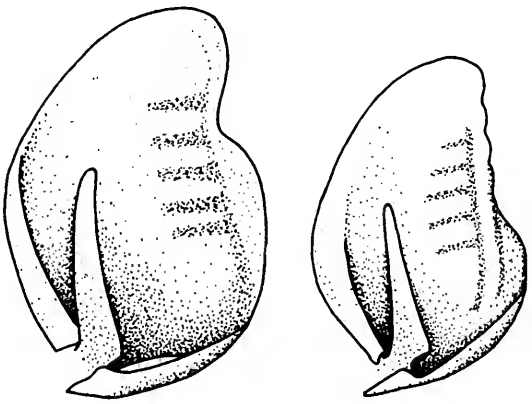

Fig. 17. Ears of *Myotis emarginatus* (left) and *M. mystacinus* (right). Note the differences in depth and location of the notch. Modified from Gaisler *et al.* (1957).

7. Penis with a pronounced distal swelling (Fig. 18); maximal diameter of penis about 2 mm .....*M. brandtii*
7'. Penis without a pronounced distal swelling (Fig. 18); maximal diameter of penis about 1 mm .....*M. mystacinus* (p. 20)
8. Leg covered dorsally with thin, but dense hair .....*M. capaccinii*
8'. Leg not covered with hair dorsally ....*M. daubentonii* (p. 18)

Fig. 18. Penis of *Myotis mystacinus* (left) and *Myotis brandtii* (right). Modified from Hanák (1970).

Based on Cranial Characters.—

1. Condylobasal length over 19 mm 2
1'. Condylobasal length under 18 mm 3
2. Labial length of upper molar row over 5 mm; condylobasal length over 21.5 mm ..... *M. myotis* (p. 16)
2'. Labial length of upper molar row under 5 mm; condylobasal length under 21.6 mm ..... *M. blythii* (p. 17)
3. Condylobasal length over 16 mm; upper tooth row (C–M^3) longer than 6.6 mm ..... *M. bechsteinii* (p. 23)
3'. Condylobasal length under 16 mm; upper tooth row (C–M^3) shorter than 6.8 mm 4
4. Condylobasal length 14 mm or more; zygomatic width over 9 mm; upper tooth row (C–M^3) 5.4 mm or more 5
4'. Condylobasal length usually 14 mm or less; zygomatic width usually under 9.2 mm; upper tooth row (C–M^3) 5.5 mm or less 7
5. Pronounced protoconules on M^1 and M^2 (Fig. 19); braincase much wider than ½ the greatest length of skull ..... *M. capaccinii*

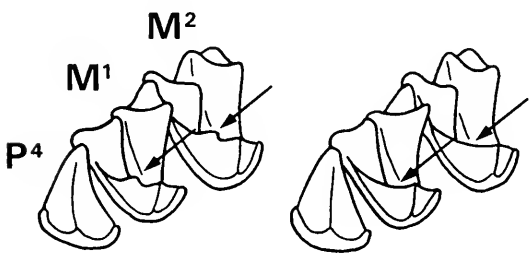

Fig. 19. Low oblique view of the lingual side of upper teeth of *Myotis* with (left) and without (right) protoconules on M^1 and M^2.

5'. Protoconules on M^1 and M^2 (Fig. 19) vestigial or absent; braincase at most slightly wider than ½ the greatest length of skull 6
6. Upper incisors strongly divergent distally (Fig. 20); first upper premolar much larger than second; condylobasal length over 14.8 mm ..... *M. emarginatus* (p. 20)
6'. Upper incisors not strongly divergent distally (Fig. 20); first upper premolar not much larger than second; condylobasal length under 14.9 mm ..... *M. nattereri* (p. 22)
7. Braincase wider than ½ the greatest length of skull; well-developed protoconules on M^1 and M^2 (Fig. 19); interorbital constriction usually over 3.9 mm ..... *M. daubentonii* (p. 18)
7'. Braincase width equal to or less than ½ the greatest length of skull; protoconules on M^1 and M^2 (Fig. 19) absent to moderately developed; interorbital constriction usually under 3.9 mm 8
8. No protoconules on upper molars (Fig. 19); first upper premolar about twice as high as second (Fig. 21) ..... *M. mystacinus* (p. 20)
8'. Protoconules on upper molars (Fig. 19) often present; first upper premolar slightly higher than second (Fig. 21) ..... *M. brandtii*

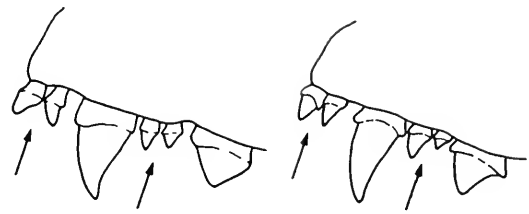

Fig. 20. Side view of the anterior part of the skulls of *Myotis nattereri* (left) and *M. emarginatus* (right). The arrows show differences in the dentition. Modified from Saint Girons (1973).

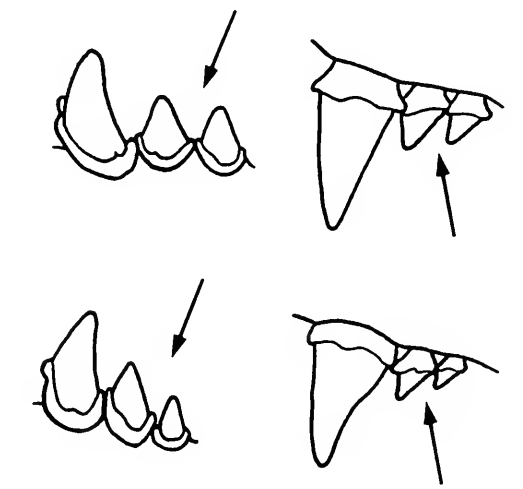

Fig. 21. Lateral view of lower (left) and upper (right) canines and first premolars of *Myotis brandtii* (top) and *M. mystacinus* (bottom). Note the differences in relative size of the premolars. Modified from Hanák (1970).

MYOTIS MYOTIS (BORKHAUSEN, 1797)

Distribution.—*M. myotis* ranges from the Azores Islands (Palmeirim, 1979) to the Ukraine (Bobrinskii *et al.*, 1965) and from the Mediterranean north to Great Britain (Phillips and Blackmore, 1970) and the Baltic Sea (Ruprecht, 1971). In the northern part of its range it seems to be rapidly declining in numbers (e.g. Braaksma, 1970). Outside Europe it is known only from Asia Minor (Çaglar, 1965); Syria, Lebanon, and Israel (Harrison and Lewis, 1961). The records of this species in North Africa and Central Asia actually refer to *M. blythii* (e.g. Corbet, 1978). Until recently *M. myotis* has been confused with *M. blythii*. Thus, older literature records are not reliable and have not been included in the distribution map. However, there are enough data to show that the species is common throughout most of the Iberian Peninsula. *M. myotis* is one of the common cavernicolous species in central and northern Portugal; but it is rare, in the south (Fig. 22). It has not been found in Algarve province in spite of the abundance of caves where the similar *M. blythii*, a more southerly species, is common. *M. myotis* is a very gregarious cave-dwelling species, but can also be found roosting in buildings, bridges, and even trees.

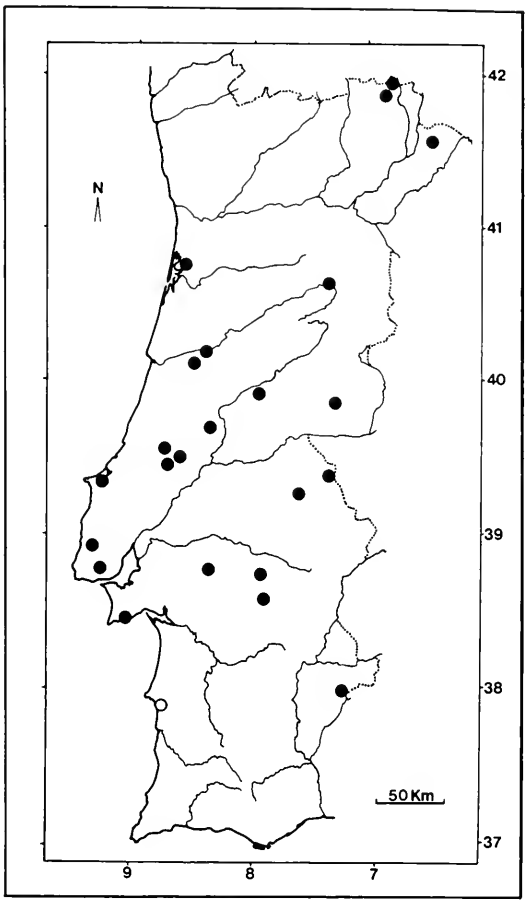

Fig. 22. Locality records of *Myotis myotis* from Portugal. Symbols as in Fig. 9.

Morphology and Taxonomic Remarks.—*M. myotis* is one of the largest European bats and the largest species of its genus (Table 5). The fur is grayish-brown dorsally, contrasting with whitish-gray underparts that often have a buffy tinge. The hair is clearly bicolored, the proximal half being dark slaty-gray and the distal part light brown or grayish-brown, becoming darker near the tips on the back. The ears and patagium are brown, varying in tone. The ears are long, but proportionally much shorter than in *M. bech-*

TABLE 5. Statistics of a sample of *Myotis myotis* from Portugal.

	$\bar{X}$	*SD*	range	*n*
Length of Forearm	61.25	1.81	58.0–65.5	23
Condylobasal Length	22.4	0.48	21.5–23.5	28
Zygomatic Breadth	14.87	0.31	14.0–15.3	32
Mastoid Breadth	10.97	0.17	10.5–11.2	25
Breadth of Braincase	10.09	0.18	9.8–10.5	35
C–M^3 Length	9.88	0.22	9.4–10.5	33
Maxillary C–C Breadth	6.01	0.14	5.7–6.3	24
Maxillary M–M Breadth	9.84	0.22	9.4–10.3	33
Length of Mandible	17.95	0.36	17.3–19.0	35
C–M_3 Length	10.61	0.24	9.9–11.1	31

steinii. The skull is large, but comparatively more slender and lightly built.

M. myotis is easily distinguishable from other large Iberian vespertilionids, except *M. blythii*, by its long ears, pointed tragus, light grey underparts, dental formula and curved dorsal profile of the skull. It is slightly larger than *M. blythii*, but all external measurements overlap to some extent. The tail of *M. myotis* is proportionally shorter than that of *M. blythii*, but its ears are comparatively longer. A combination of the ear, tail and forearm lengths allows a correct identification of most specimens, but sometimes it is necessary to examine the skull. Although the Iberian populations of *M. myotis* are morphometrically quite small, the condylobasal length, C–M^3 length, M^1–M^3 (labial) length (Tupinier, 1975) and M^2 length are greater than *M. blythii*. Bogan *et al.* (1978) suggested the use of the dentary length (=mandible length) to separate the two species, considering *M. blythii* to have a dentary shorter than 17.7 mm. Although these authors studied specimens from a vast geographic area this criterion is not valid in some regions, such as Iberia where *M. myotis* specimens with dentary lengths of less than 17.7 mm are common. Felten *et al.* (1977) suggested several indices to distinguish the skulls of these species. The baculum has also proved to be an excellent distinguishing character (Topál, 1958), in spite of its variability.

Schreber (1774) used the name *Vespertilio murinus* for this bat, a name employed by many Portuguese and other European authors (e. g. Nobre, 1904; Seabra, 1910) as well as Bocage (1863). However, *V. murinus* Linnaeus 1758 is a central European and Asian species that has never been recorded in Iberia.

The subspecies of *M. myotis* listed by Ellerman and Morrison-Scott (1951) either refer to *M. blythii* (*omari, ancilla,* and *risorius*) or seem to be distinct species (*luctuosus, chinensis*) (Corbet, 1978). Therefore *M. myotis* can be considered monotypic throughout most of its range, although Harrison and Lewis (1961) described a larger form from the Middle East, *M. m. macrocephalicus*.

MYOTIS BLYTHII (TOMES, 1857)

Distribution.—*M. blythii* ranges from Portugal to China and from northern Africa (Aellen and Strinati, 1970) and Iran (DeBlase, 1980) north to the Loire Valley (Beaucournu, 1965) and to the 52nd parallel in the USSR (Strelkov, 1972). The distribution of this species in Iberia has been unclear, because of its confusion with *M. myotis* and has only recently been recorded from Portugal (Palmeirim, 1978). *M. blythii* seems to occur all over the Iberian Peninsula, including the northern provinces of Spain, which have a marked Atlantic climate (Fig. 23). However it does not seem to be common in this region, because Tupinier (1975) was not able to find it in caves in Santander province. In central and northern Spain where it coexists with *M. myotis*, it is

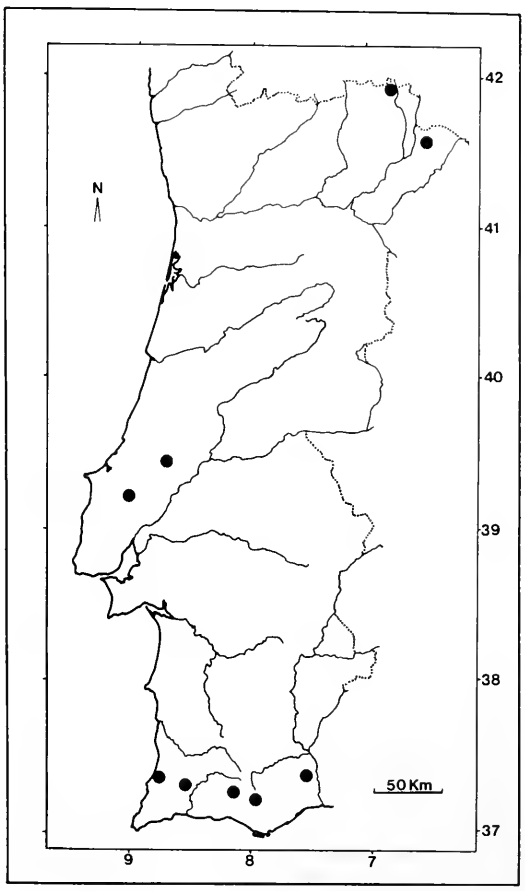

Fig. 23. Locality records of *Myotis blythii* from Portugal. Symbols as in Fig. 9.

not as common as it is in southern Portugal where *M. myotis* is not recorded. I believe that *M. blythii* is also common in southern Spain; the rarity of records for this region is probably due to scanty biological exploration of its caves and confusion with *M. myotis*. *M. blythii* roosts mainly in caves where it may form large colonies, often in association with *M. myotis*; this association has apparently increased the confusion between the two species.

Morphology and Taxonomic Remarks.—*M. blythii* is a large *Myotis*, often reaching the dimensions of the morphologically very similar *M. myotis* (Table 6). The hair is bicolored. Very light grayish underparts meet with the predominantly brown dorsal fur along a sharply defined line; the overall color is somewhat grayer than in *M. myotis*. The skull is similar to that of *M. myotis*, but averages somewhat wider. Differences between *M. blythii* and *M. myotis* are discussed under the latter species.

In 1885 Monticelli described *Vespertilio oxygnathus* (=*M. oxygnathus*) from Italy, separating it from *M. myotis*. Many authors (e.g. Cabrera, 1914) later claimed that this form was conspecific with *M. myotis*; others (e.g. Miller, 1900, 1912) defended the specific separation and more recently Topál (1958) tentatively considered *oxygnathus* a subspecies of *M. blythii*. Although this view was not adopted by many authors (e. g. Lanza, 1959; König and König, 1961), Topál (1971) found strong evidence for the conspecificity of the European (*oxygnathus*) and Asian (*blythii*) forms.

Strelkov (1972) studied geographic variation in *M. blythii* and recognized four subspecies: *blythii*, *oxygnathus*, *omari*, and *ancilla*. The latter two forms had been considered subspecies of *M. myotis* (Ellerman and Morrison-Scott, 1951), but *omari* was transferred to *M. blythii* by several authors (e.g. Aellen, 1959; Harrison and Lewis, 1961) and Corbet (1978) includes the Chinese *ancilla* in *M. blythii*.

Recently Felten *et al.* (1977) described a new subspecies from North Africa, *M. b. punicus*. However, in a multivariate study that included *M. blythii* from Morocco and Europe, Bogan *et al.* (1978) suggested that samples from Spain and Czechoslovakia are morphometrically closer to their Moroccan sample than to Italian and Greek samples. With the exception of some insular Mediterranean populations in which these animals have a slightly larger size than on the mainland, European *M. blythii* have all been included in *M. b. oxygnathus*. However it should be noted that the differences among all four subspecies are very small and the partitioning of geographic forms of *M. blythii* still does not seem satisfactory.

MYOTIS DAUBENTONII (KUHL, 1819)

Distribution.—*M. daubentonii* is present throughout most of Europe from the Mediterranean coast to central Scandinavia (Ryberg, 1947) and eastward through temperate Asia to Japan (Imaizumi, 1970). Specimens of *M. daubentonii* have been collected from most of Portugal (Fig. 24) and it seems to be present throughout the Iberian Peninsula. If the variant *nathalinae* proves to be a distinct species (see discussion below), then the range given above comprises the ranges of *M. daubentonii* and *M. nathalinae*;

TABLE 6. Statistics of a sample of *Myotis blythii* from Portugal.

	$\bar{x}$	*SD*	range	*n*
Length of Forearm	57.67	1.45	55.7–60.9	12
Condylobasal Length	20.35	0.43	19.6–21.0	19
Zygomatic Breadth	13.93	0.34	13.4–14.6	16
Breadth of Braincase	9.81	0.27	9.3–10.3	21
C–M^3 Length	8.87	0.22	8.5–9.2	21
Maxillary C–C Breadth	5.65	0.20	5.3–6.0	21
Maxillary M–M Breadth	8.93	0.25	8.4–9.4	20
Length of Mandible	16.17	0.40	15.3–16.9	21
C–M_3 Length	9.51	0.23	9.2–9.9	21

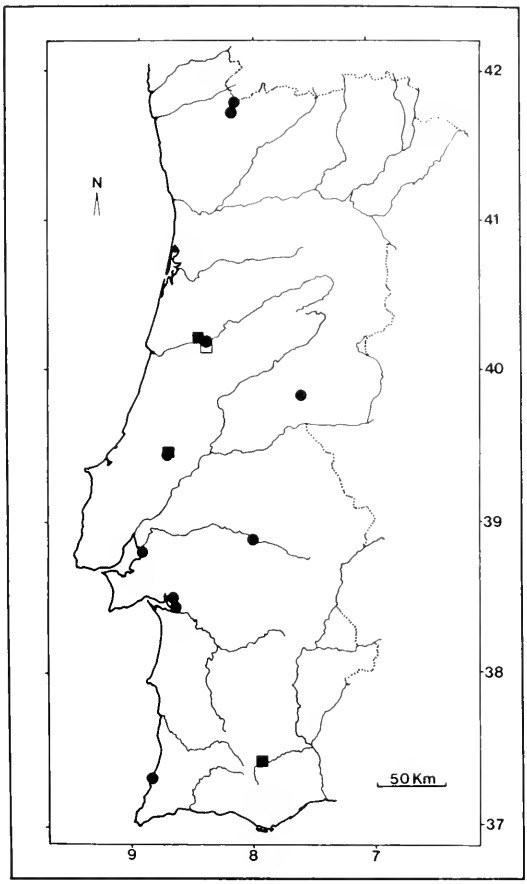

Fig. 24. Locality records of *Myotis daubentonii* from Portugal; closed circles. Locality records of *Myotis emarginatus* from Portugal; closed squares—specimens examined; open square—literature reference.

both variants have been identified throughout Portugal. *M. daubentonii* is closely associated with water; it roosts in hollow trees, bridges, buildings and crevices of rocks during the summer, and winters in caves and cellars (e.g. Kowalski and Ruprecht, 1981).

Morphology and Taxonomic Remarks.—*M. daubentonii* is almost as small as *M. mystacinus* and *M. brandtii* (Table 7). The upper parts are medium to dark brown with a variable gray tinge; the lighter underparts are gray or yellowish-gray. The bicolored hair is darker at the base; this contrast is particularly noticeable ventrally. The membranes are grayish-brown. The ears are proportionally the shortest in European members of the genus. The posterior border of the tragus is convex, whereas the longer tragus of *M. mystacinus* has a straight or even concave posterior border. The large foot is as long or longer than ½ the length of the tibia. The length of the calcar comprises about ⅔ of the margin of the uropatagium. The plagiopatagium is inserted well above the base of the toes. The skull is wider than in *M. mystacinus* and *M. brandtii* and the upper molars have well developed protoconules on the anterior edge (Fig. 19); less developed protoconules are also present in *M. brandtii*.

Tupinier (1977) described as new a small *Myotis* from southern Spain, *M. nathalinae*. According to this author the new species could be distinguished from *M. daubentonii* by its slightly smaller dimensions, color, the shape of the larger upper premolar and os penis. *M. nathalinae* has now been reported from Spain (Tupinier, 1977; Hutterer, 1978), France (Tupinier, 1977), Switzerland (Tupinier, 1977; Aellen, 1978), and Po-

TABLE 7. Statistics of a sample of *Myotis daubentonii* from Portugal.

	$\bar{x}$	*SD*	range	*n*
Length of Forearm	36.17	1.73	33.2–38.7	22
Condylobasal Length	13.66	0.35	13.1–14.2	18
Zygomatic Breadth	9.07	0.21	8.7–9.4	10
Mastoid Breadth	7.78	0.13	7.6–8.1	16
Breadth of Braincase	7.62	0.13	7.4–7.8	17
C–M^3 Length	5.31	0.12	5.1–5.5	18
Maxillary C–C Breadth	3.74	0.11	3.6–4.0	16
Maxillary M–M Breadth	5.69	0.17	5.5–6.1	17
Length of Mandible	10.28	0.27	9.9–10.8	19
C–M_3 Length	5.57	0.12	5.3–5.8	18

land (Bogdanowicz and Urbanczyk, 1981). In Portugal several specimens corresponding to the description and type specimen of *M. nathalinae* have been found along with typical *M. daubentonii*. However, specimens morphologically intermediate between *M. daubentonii* and *M. nathalinae* are also present in the samples examined and I was unable to separate consistently the two forms. Various multivariate statistical analyses based on skull measurements also failed to show the presence of two distinct groups. However, my samples were small and the results of the analyses may have been confounded by variance from factors such as age, sex, and origin. While not rejecting the possibility that *nathalinae* is a distinct species, I provisionally consider it as a variant of *M. daubentonii*. Ruprecht (1981) arrived at a similar conclusion when studying the relationship between *daubentonii* and *nathalinae* in Poland.

Table 8. Measurements of two *Myotis emarginatus* from Portugal. Statistics of the length of forearm of a sample of 10 females are: $\bar{x}$=40.9; *SD*=0.81; range=39.8–42.3.

	♀JP 169	♀JP 170
Length of Forearm	41.3	41.6
Condylobasal Length	15.6	15.4
Zygomatic Breadth	10.1	—
Mastoid Breadth	8.5	8.5
Breadth of Braincase	7.5	7.6
C–M^3 Length	6.6	6.5
Maxillary C–C Breadth	—	4.0
Maxillary M–M Breadth	6.5	6.4
Length of Mandible	12.1	12.1
C–M_3 Length	6.9	6.8

MYOTIS EMARGINATUS (GEOFFROY, 1806)

Distribution.—*M. emarginatus* is a fairly uncommon species throughout its range and distributional records are somewhat scattered. It is known from Portugal to eastern Afghanistan (Meyer-Oehme, 1965) and from northern Africa (Kowalski, 1979) north to the Netherlands, where it is very rare (Braaksma, 1970). The distribution of this species in the Iberian Peninsula is poorly known. It was recorded from Coimbra, Portugal by Themido (1928) and later in Spain by Balcells (1964b, 1965). Since then it has been found in a few other localities in Spain (Balcells, 1971; Tupinier, 1965, 1975; Gisbert and Melendro, 1978), all in the northern half of the peninsula. It is herein recorded in southern Portugal (Fig. 24); I believe that it also exists throughout southern Spain. *M. emarginatus* usually roosts in caves, often in association with members of the genus *Rhinolophus*. It is remarkably light tolerant and during the summer is found quite commonly in well-illuminated parts of caves.

Morphology and Taxonomic Remarks.—*M. emarginatus* is a *Myotis* of medium size, somewhat larger than *M. nattereri* (Table 8). The fur is peculiar among European bats, being woolly in texture. The hair is tricolored dorsally and bicolored ventrally. Overall the fur is rufous brown, lighter on the ventral surface; the ears and patagium are brown. The uropatagium is fringed with small, well-spaced hairs; very different from the more abundant and stiff hairs of *M. nattereri*. A pronounced distal notch on the outer edge of the ear (Fig. 17) distinguishes *M. emarginatus* from all other European species of *Myotis*. A notch is also present in *M. mystacinus* (Fig. 17) and *M. brandtii* but it is less accentuated and more proximal. The skull is similar to that of *M. nattereri*, but usually larger. In *M. emarginatus* the second upper premolar is much smaller than the first, while in *M. nattereri* they are of similar size (Fig. 20).

MYOTIS MYSTACINUS (KUHL, 1819)

Distribution.—The distribution of *M. mystacinus* is poorly known particularly in the Asian part of its range, because of confusion with other small *Myotis*—particularly *M. brandtii*. In Europe *M. mystacinus* is present from Sweden (Baagøe, 1973) south to the Iberian Peninsula and Greece (Gauckler and Kraus, 1970). *M. brandtii* seems to be more restricted, being known from Sweden (Baagøe, 1973) to northern Italy (Lanza, 1959; Hanák, 1970), and Yugoslavia (Hanák, 1965); the westernmost record on the

continent is from Chantilly, just north of Paris (Hanák, 1970), but it is also present in Great Britain (Stebbings, 1977). Corbet (1978) and Vernier (in Honacki *et al.*, 1982) show *M. brandtii* as being found "south to Spain and Greece," but this seems to be a misinterpretation of Gauckler and Kraus (1970). The latter authors examined specimens from northern Spain and they only suggested that *M. mystacinus* exists in westernmost Europe.

I do not know of any records of *M. brandtii* in Iberia and the distribution of *M. mystacinus* in the peninsula is poorly known. Gauckler and Kraus (1970) do not give the precise origin of the specimens they examined from northern Spain. Tupinier (1975) identified two mandibles from near Arredondo (Santander) as belonging to *M. mystacinus*. Dobson (1878) listed a specimen from the Luna River (Leon) and Cabrera (1914) mentioned three from El Escorial (Madrid), but these authors did not recognize *M. brandtii* and *M. mystacinus* as distinct species. Ayres (1914) reported it from Coimbra, but the forearm measurement given (40 mm) is too great for either *M. mystacinus* or *M. brandtii*. Seabra (1922) cited one male from Coimbra in the collection of the Lisbon Museum of Natural History (=Museu Bocage), but this specimen has disappeared (Palmeirim *et al.*, 1979). Although uncommon, *M. mystacinus* is probably quite widespread in central and northern Iberia (Fig. 25); its presence in the south is likely despite the northern character of this species' range, because *M. mystacinus* is known from various Mediterranean localities elsewhere in Europe.

Morphology and Taxonomic Remarks.—*M. mystacinus* is the smallest of the species of *Myotis* in Iberia (Table 9), its size being comparable to that of some *Pipistrellus*; it is easily distinguished from them by its pointed tragus, absence of post-calcarial lobe and dental formula. The long hair is very dark brown, but because the tips are much lighter, particularly on the ventral side, the overall color is a fairly light brown. Juveniles up to 12 months of age can be almost black (Stebbings, 1977). The ears and membranes are very dark and there is a pronounced notch on the outer edge of the ear, which is more proximal and less pronounced than that

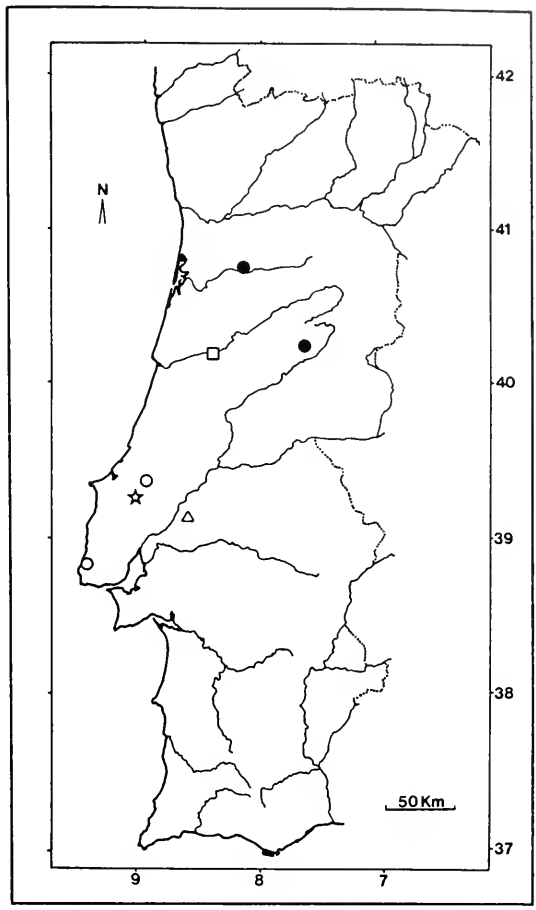

Fig. 25. Locality records of *Myotis nattereri* from Portugal. Symbols as in Fig. 9. Locality record of *Myotis mystacinus* from Portugal; open square—literature reference. Locality records of *Myotis bechsteinii* from Portugal; open star—literature reference; open triangle—approximate location, literature reference.

TABLE 9. Ranges of measurements of *Myotis mystacinus* from central Europe (from Gauckler and Kraus, 1970; Hanák, 1970; Ruprecht, 1974).

	range	*n*
Length of Forearm	31.0–37.0	184
Condylobasal Length	12.0–13.5	147
Zygomatic Breadth	7.3–9.0	109
Mastoid Breadth	5.1–7.7	69
C–M^3 Length	4.6–5.5	147
Length of Mandible	8.4–10.3	148
C–M_3 Length	5.0–5.7	135

of *M. emarginatus* (Fig. 17). The foot is shorter than ½ the length of the tibia. The calcar is only about ½ the length of the edge of the uropatagium. The plagiopatagium is inserted at the level of the base of the toes. The skull is more slender than that of *M. daubentonii* and there are no protoconules on the anterior edge of the upper premolars (Fig. 19).

Topál (1958) pointed out striking differences in the morphology of the baculum of the forms *mystacinus* and *brandtii*, suggesting that they were separate species. This view was confirmed by later studies (Hanák, 1965, 1970; Gauckler and Kraus, 1970); since then much work has been done to clarify the distribution of the two species and compare their morphology (e.g. Hanák, 1970, 1971; Baagøe, 1973; Ruprecht, 1974; Roer, 1975; Rybar, 1976; Fedorov, 1978; Tupinier and Aellen, 1978; Fairon, 1980; Strelkov and Buntova, 1982; Strelkov, 1983). Because the presence of *M. brandtii* in Iberia is possible, this species is included in the identification keys.

No specimens of *M. mystacinus* from Iberia were examined and morphometric data are very scarce in the literature; there is no suggestion that the Iberian populations differ from the nominate form.

MYOTIS NATTERERI (KUHL, 1818)

Distribution.—*M. nattereri* is widely-distributed, occurring from Portugal and Ireland (Stebbings, 1977) eastward through Europe and temperate Asia to Japan (Imaizumi, 1970); its latitudinal range is also quite wide, from Morocco (Brosset, 1963) and Israel (Harrison, 1964) to southern Scandinavia (Ryberg, 1947). The few records of *M. nattereri* from the Iberian Peninsula are scattered throughout a wide area. All the known localities in Portugal are in sub-Mediterranean and Atlantic areas (Fig. 25). Because of its somewhat northern character, this bat is probably rare or even absent along the southern coast of Iberia, which has a Mediterranean climate. *M. nattereri* usually hibernates singly or in small groups; in rock cracks, mines, cellars and caves (Brosset and Caubére, 1959; Lanza, 1959). In the summer it uses a greater variety of roosts. Although it usually forms fairly small groups, large colonies have been found (Balcells, 1956).

Morphology and Taxonomic Remarks.—This is a medium sized *Myotis* somewhat smaller than *M. emarginatus* (Table 10). The hair is bicolored throughout. The fur is brown or grayish-brown dorsally and whitish ventrally. The line of color separation along the sides of the body is clearly defined. The ears and membranes are brown. The tragus is proportionally longer than that of any other European *Myotis*, being higher than ½ of the pinnae. The unique fringe of stiff hairs, about one millimeter long, along the edge of the uropatagium distinguishes it from all other *Myotis* on the continent.

TABLE 10. Measurements of one specimen of *Myotis nattereri* from Portugal. Statistics of the length of forearm of a sample of 16 females are: $\bar{x}$=39.36; *SD*=0.72; range=38.4–40.7.

	♂MB 2801
Length of Forearm	38.0
Condylobasal Length	14.5
Zygomatic Breadth	9.4
Mastoid Breadth	7.7
Breadth of Braincase	7.5
C–M^3 Length	6.0
Maxillary C–C Breadth	4.0
Maxillary M–M Breadth	6.0
Length of Mandible	11.1
C–M_3 Length	6.2

Cabrera (1904) described *M. escalerai* from northeastern Spain, separating it from *M. nattereri* on the basis of a higher level of insertion of the plagiopatagium on the hindlimb. However, Miller (1912) suggested that this difference was an artifact of preservation in alcohol; Cabrera (1914) later recognized *escalerai* as a junior synonym of *nattereri*.

Specimens examined of *M. nattereri* from Portugal agree with the nominate form which occurs throughout Europe.

MYOTIS BECHSTEINII (KUHL, 1818)

Distribution.—*M. bechsteinii* ranges from Portugal and Britain through central and eastern Europe to northern Iran (DeBlase, 1980), and from Italy north to southern Sweden (Ryberg, 1947). It is a rare bat throughout its range except in certain areas of central Europe. As is typical with central European species, it has not been found in areas with a Mediterranean climate. *M. bechsteinii* is known from a few localities in central and northeastern Spain (Thomas, 1906; Cabrera, 1914; Balcells, 1965; Galan, 1970; Tupinier, 1975); in Portugal only two localities are known (Fig. 25) (Seabra, 1922; Niethammer, 1970). No information is available on the origin of two additional Portuguese samples of *M. bechsteinii* in the collection of the Museu Bocage (Palmeirim *et al.*, 1979). The known records and the climatic preferences of *M. bechsteinii* suggest that the species is widespread but rare in the northern half of Iberia; it is also likely to occur further south, especially at higher elevations. During the summer *M. bechsteinii* roosts mostly in hollow trees, but in the winter it seems to prefer caves (e.g. Lanza, 1959).

Morphology and Taxonomic Remarks.—*M. bechsteinii* is a fairly large *Myotis* (Table 11), although much smaller than *M. myotis* or *M. blythii*. It is well characterized by its conspicuously large ears, which are longer than ½ the length of the forearm; in Europe only *Plecotus* has proportionally longer ears. The upper parts are light brown and the underparts buffy gray. The ears and patagium are dark brown.

Thomas (1906) described the form *favonicus* from La Granja (Segovia) in central Spain as having smaller body and ear dimensions. Although the specimens examined from Portugal are in the lower morphometric range of the species, they overlap broadly with specimens from other geographical areas and subspecific distinction is unjustifiable; this is also the opinion of several earlier authors (e.g. Miller, 1912; Cabrera, 1914).

GENUS *EPTESICUS*

This genus includes over 30 species and is widespread on all continents except Antarctica. Two species occur in western Europe, *E. serotinus* and *E. nilssoni*, but only the first has been found in the Iberian Peninsula. A species of questionable validity, *E. sodalis*, may also occur in Portugal (see *E. serotinus*). This genus has often been included in *Vespertilio* (e.g. Lanza, 1959; Bobrinskii *et al.*, 1965) and the distinctness of the two groups is questionable (see also genus *Pipistrellus*).

In Europe this genus can be distinguished from all other vespertilionids by its dental formula, being the only one in the family lacking a small upper premolar (except some individuals of *P. savii*): I 2/3, C 1/1, P 1/2, M 3/3 = 32.

TABLE 11. Measurements of five *Myotis bechsteinii* from Portugal.

	♀MB 2701	♀MB 2798	♀MB 2798	♂MB 2798	♂MB 2798
Length of Forearm	40.7	—	40.1	41.0	40.2
Condylobasal Length	—	16.6	—	—	—
Zygomatic Breadth	10.5	10.6	—	—	—
Mastoid Breadth	8.4	8.5	—	—	—
Breadth of Braincase	8.1	8.1	—	—	—
C–M^3 Length	7.0	7.0	—	—	—
Maxillary C–C Breadth	4.1	4.4	—	—	—
Maxillary M–M Breadth	6.4	6.5	—	—	—
Length of Mandible	12.1	12.1	—	—	—
C–M_3 Length	6.8	6.9	—	—	—

Externally *Eptesicus* can be separated easily from *Myotis*, which does not have a post-calcarial lobe. The terminal tail vertebra is not included in the uropatagium which distinguishes it from *Nyctalus*. Finally, in Europe *Eptesicus* can be distinguished from the similar *Pipistrellus* by its larger size.

EPTESICUS SEROTINUS (SCHREBER, 1774)

Distribution.—*E. serotinus* has a vast distribution, from Portugal eastward to Korea (Gaisler, 1970a) and from North Africa (Harrison, 1963) to Denmark, where it seems to be expanding northward (Baagøe and Jensen, 1973). Several authors (e.g. Ellerman and Morrison-Scott, 1951) following Bobson (1878), included West Africa in the range of *E. serotinus*; but Hayman and Hill (1971) showed that Dobson's record was based on mislabeled specimens. *E. serotinus* occurs throughout Iberia where it is one of the most abundant bat species (Fig. 26). It is a very anthropogenic animal, often present in urban areas; it usually roosts in narrow cavities in buildings, rock crevices and trees.

Morphology and Taxonomic Remarks.—*E. serotinus* is one of the largest bat species in Europe (Table 12). The long, dense fur is variably brown, slightly lighter ventrally. The thick ears and flying membranes are blackish-brown. The tragus is more slender than in *Nyctalus*, but not pointed as in *Myotis*. The wing is broad and a short terminal portion of the tail is not included in the uropatagium. The heavily built skull has a straight dorsal profile and it is easily distinguishable from any other European bat of comparable size by its dental formula.

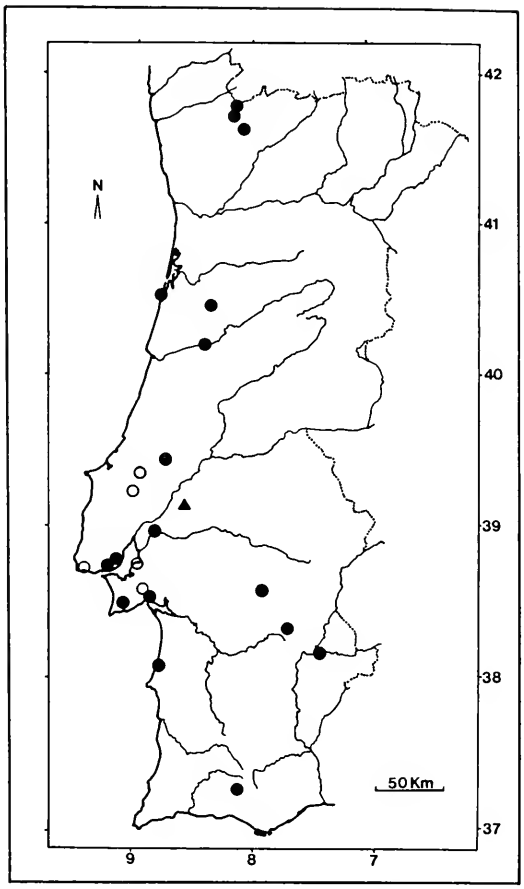

Fig. 26. Locality records of *Eptesicus serotinus* from Portugal. Symbols as in Fig. 9.

TABLE 12. Statistics of a sample of *Eptesicus serotinus* from Portugal.

	$\bar{x}$	*SD*	range	*n*
Length of Forearm	51.23	1.55	48.8–54.3	15
Condylobasal Length	20.90	0.74	19.8–22.0	10
Zygomatic Breadth	14.97	0.37	14.6–15.8	10
Mastoid Breadth	11.65	0.46	10.9–12.2	10
Breadth of Braincase	9.94	0.23	9.6–10.3	8
C–M^3 Length	8.20	0.34	7.6–8.6	10
Maxillary C–C Breadth	7.11	0.29	6.5–7.4	9
Maxillary M–M Breadth	9.10	0.23	8.9–9.6	10
Length of Mandible	16.17	0.67	15.0–17.2	10
C–M_3 Length	8.38	0.45	7.6–9.3	10

Cabrera (1904) identified three species and one insular subspecies of *Eptesicus* in Spain: *E. s. serotinus*, in central and western Iberia; *E. serotinus insularis*, a subspecies which he described from the Balearic Islands; *E. isabellinus*, a North African form considered to be present in extreme southern Spain; and *E. boscai*, a new species from eastern and central Iberia and separable from *E. serotinus* and *E. isabellinus* by the shape of its tragus. Cabrera (1908) later decided that *E. s. insularis* was indistinguishable from the nominate form and that *E. isabellinus* from southern Spain was assignable to *E. boscai*. Subsequently Cabrera (1914) stated that *E. boscai* was not separable from *E. serotinus* and considered the nominate form of this species to be the only one present in Iberia. This was also the opinion of Miller (1912) and Ellerman and Morrison-Scott (1951). However, Bauer (1956) and Harrison (1958), on the basis of small samples, considered *boscai* to be a valid subspecies of *E. serotinus* distinguishable from the nominate form by its paler color. Harrison (1958) suggested that *E. s. serotinus* was also present in northern Spain. Specimens I examined from Portugal suggest a color/latitude association; *E. serotinus* seems on average to be darker in the north than in the south. However, larger samples are needed to show a color gradient in a species with such high individual color variability. Specimens with the dark coloration characteristic of *E. s. serotinus* have been obtained throughout Portugal and I have found no evidence of latitudinal size differences. It seems therefore, that only the nominate form should be recognized in this country. However, only one specimen from Algarve (the southernmost Portuguese province) was examined and my conclusion may not apply there.

A skull (JP75) found in an owl pellet near Moura (Beja Dist.) in southeastern Portugal presents a taxonomic problem. Its small dimensions (condylobasal length=18.5 mm, zygomatic breadth=13.8 mm, C–M^3 length=7.2 mm and mandible length=14.3 mm) are similar to those of *E. sodalis* from central Europe and *E. serotinus isabellinus* from North Africa. *E. sodalis* is a species of questionable validity described by Barret-Hamilton (1910), based on one specimen from Rumania. A few specimens referable to *E. sodalis* were reported from Switzerland (Miller, 1912), Austria (Bauer, 1968) and Silesia (Felten, 1971). Some authors (e.g. Ellerman and Morrison-Scott, 1951) linked *sodalis* to the Asian form *bottae*, but Hanák and Gaisler (1971) showed that *sodalis* is actually much closer to *E. serotinus* than to *bottae*. Various authors (e.g. Lanza, 1959; Hanák and Gaisler, 1971) even suggested that *E. sodalis* may not be independent from *E. serotinus*, a view supported by Corbet (1978). In my opinion the small size of this skull places it with the form *isabellinus*. If *isabellinus* is simply a subspecies of *E. serotinus* as suggested by Harrison (1963), it is conceivable that specimens from extreme southern Iberia are intermediate in size between European populations (*E. s. serotinus*) and the smaller North African one (*E. s. isabellinus*). It is also possible that *E. isabellinus* is a separate species with a range including southern Iberia. A comparison of *Eptesicus* samples from Morocco and southern Spain should be helpful in clarifying this situation.

Genus *Nyctalus*

This is a small genus, widespread throughout the Palearctic; from the Azores Islands eastward to Japan. Three species live in continental Europe and all are found in Portugal: *N. noctula*, *N. lasiopterus*, and *N. leisleri*.

Nyctalus is morphologically similar to European *Pipistrellus*; they have been considered congeneric by some authors (e.g. Simpson, 1945). Species within this genus are heavily built and have narrow, pointed wings. The muzzle is broad, the ears fairly large and thick, and the tragus rounded. *Eptesicus* has only one premolar on the maxilla and has a slender tragus. The distinction between *Nyctalus* and *Pipistrellus* in Europe is very simple based on their size; the first is much larger than the second. *Barbastella* has the same dental formula, but is otherwise morphologically very different from *Nyctalus*. The dental formula of this genus is: I 2/3, C 1/1, P 2/2, M 3/3 = 34.

KEY TO THE SPECIES OF *NYCTALUS* KNOWN FROM IBERIA

Based on External Characters.—

1. Forearm over 60 mm ..*N. lasiopterus* (p. 26)
1'. Forearm under 57 mm 2
2. Forearm over 45 mm; hair uniformly colored .....*N. noctula* (p. 27)
2'. Forearm under 46 mm; hair bicolored .....*N. leisleri* (p. 28)

Based on Cranial Characters.—

1. Condylobasal length over 20 mm; length of upper toothrow (C–M^3) over 8 mm .....*N. lasiopterus* (p. 26)
1'. Condylobasal length under 20 mm; length of upper toothrow (C–M^3) under 8 mm 2
2. Condylobasal length over 17.3 mm; length of upper toothrow (C–M^3) over 6.6 mm .....*N. noctula* (p. 27)
2'. Condylobasal length under 16.2 mm; length of upper toothrow (C–M^3) under 6.5 mm .....*N. leisleri* (p. 28)

NYCTALUS LASIOPTERUS (SCHREBER, 1780)

Distribution.—This species is known from Portugal to Iran (Etemad, 1970) and the Ust-Urt plateau, east of the Caspian Sea (Borovskii and Vorontsov, 1970), and from North Africa (Palmeirim, 1982; Qumsiyeh and Schlitter, 1982; Spitzenberger, 1982) to central Poland (Ruprecht, 1970) and from the vicinity of Moscow (Bobrinskii *et al.*, 1965). It is not clear if the form *aviator* from Eastern Asia is conspecific with *lasiopterus*. This bat is one of the hardest to find in Iberia and in the rest of Europe; although it surely has been overlooked because of its similarity with *N. noctula*. It is known from two localities in Spain (Bauer, 1956; BMNH 21.2.2.1, see also Chapman *in* Valverde, 1960); it was only recently reported from Portugal (Palmeirim *et al.*, 1979) (Fig. 27).

Morphology and Taxonomic Remarks.—*N. lasiopterus* is a very robust species and the largest bat in Europe (Table 13). Overall it is medium-brown, with the hair uniform in color. The ears and flying membranes are thick and dark.

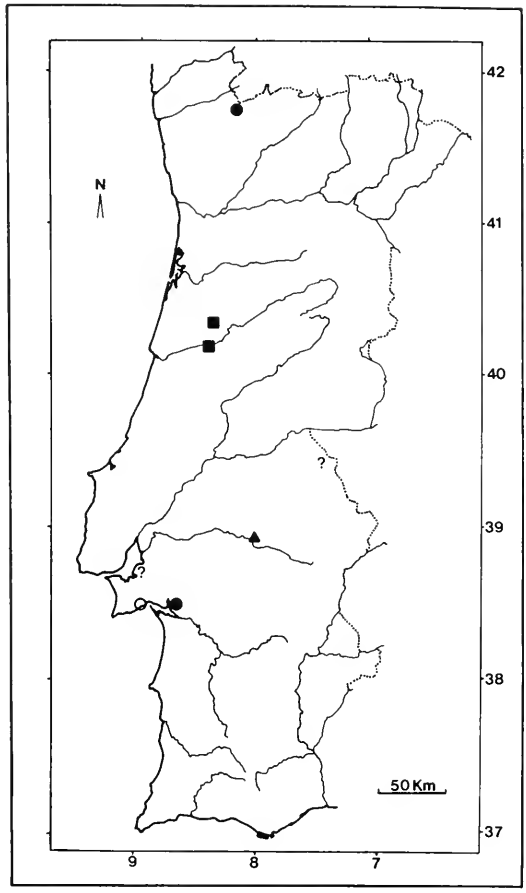

Fig. 27. Locality records of *Nyctalus leisleri* from Portugal. Symbols as in Fig. 9. Locality records of *Nyctalus lasiopterus* from Portugal; closed squares—specimens examined. Locality record of *Nyctalus noctula* from Portugal; closed triangle—specimen examined.

Although quite similar to the smaller *N. noctula*, it is easily distinguished because of its larger size and proportionally broader and more rounded pinnae (Fig. 28). The specific status of the two forms is now widely accepted, but was previously controversial (Heim de Balsac, 1932a 1932b; Rode, 1932a, 1932b). The name of this species has also been subject to considerable disagreement; the names *siculus* (Minà Palumbo, 1866) and *maximus* (Fatio, 1869) have been widely used. Lanza (1959) defended the use of *siculus* because it antedates *maximus* and because he thought *lasiopterus* was of uncertain

TABLE 13. Measurements of three *Nyctalus lasiopterus* from Iberia.

	♀MB 3115	♂MZUC Uncat.	♀BMNH * 21.2.2.1
Length of Forearm	63.0	66.0	68.1
Condylobasal Length	21.6	—	23.7
Zygomatic Breadth	15.0	—	—
Mastoid Breadth	13.9	—	14.7
C–M^3 Length	8.6	—	9.3
Maxillary C–C Breadth	8.5	—	9.2
Maxillary M–M Breadth	10.1	—	10.7
Length of Mandible	16.8	—	18.5
C–M_3 Length	9.6	—	10.0

*From Coto Doñana, SW Spain.

attribution. However, in recent years *lasiopterus* has been the name most commonly used for the species, apparently because it was used by Ellerman and Morrison-Scott (1951). Only the nominate subspecies exists in the western Palearctic; the form *aviator* (Thomas 1911) from Japan, Korea, and China may be a separate species (e.g. Corbet, 1978; Maeda, 1983).

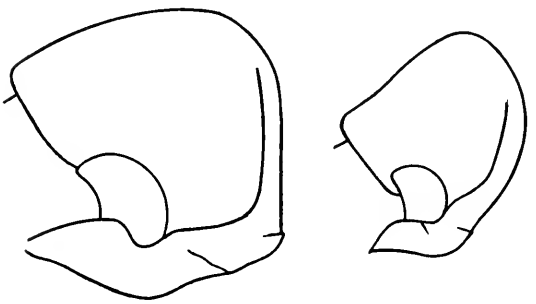

Fig. 28. Ears of *Nyctalus lasiopterus* (left) and *N. noctula* (right). Note the more rounded shape of the ear of *N. lasiopterus*. Modified from Lanza (1959).

NYCTALUS NOCTULA (SCHREBER, 1774)

Distribution.—*N. noctula* ranges from Portugal to Japan (Corbet, 1978) and from northern Africa (Palmeirim, 1982) to Scotland (Stebbings, 1977) and Scandinavia (Ryberg, 1947). The taxonomic status of the east Asian populations is not clear; the forms *velutinus* from China and *furvus* from Japan have been regarded as separate species by some authors (e.g. Imaizumi and Yoshiyuki, 1968). Although common in central Europe, this species is quite rare in Iberia, where it appears to be widespread. The inclusion of *N. noctula* in the Portuguese fauna by Seabra (1922) seems to have been based on a misidentification of specimens of *N. lasiopterus*, but a specimen from Pavia in the collection of Museu Bocage proves the existence of *N. noctula* in Portugal (Palmeirim *et al.*, 1979) (Fig. 27). *N. noctula* seems to prefer wooded areas, usually roosting in holes in trees and buildings (Lanza, 1959).

Morphology and Taxonomic Remarks.—*N. noctula* is a large, robust bat with narrow wings (Table 14). The dark yellowish-brown fur is quite uniform in color, but clearly glossier on the back than on the underparts. The hair is fine and slightly paler proximally. The membranes are very dark brown, almost black. The skull is wide and robust. *N. noctula* is easily told from *N. leisleri* by its larger dimensions and by the color of the hair which is much darker at the base than tip in *N. leisleri*. *N. lasiopterus* is even larger than *N. noctula* and has broader and more rounded ears (Fig. 28).

The only specimen known from Portugal is fairly small; in Mediterranean Europe *N. noctula* averages smaller than specimens from further north. Only the nominate subspecies is recognized in Europe (Ellerman and Morrison-Scott, 1951; Corbet, 1978), but several forms have been described from Asia, some of which may be specifically distinct (e.g. Imaizumi and Yoshiyuki, 1968).

TABLE 14. Measurements of one specimen of *Nyctalus noctula* from Portugal.

	MB 2785
Length of Forearm	52.0
Condylobasal Length	18.0
Mastoid Breadth	10.2
C–M^3 Length	7.0
Maxillary C–C Breadth	6.7
Maxillary M–M Breadth	8.4
Length of Mandible	14.0
C–M_3 Length	7.4

NYCTALUS LEISLERI (KUHL, 1818)

Distribution.—*N. leisleri* is an uncommon species in most areas, ranging from Portugal to Ireland, eastward to northwestern India (Gaisler, 1970a). It seems to be a characteristically central European species, not reaching Scandinavia, but is known from wooded montane areas in North Africa (Hanák and Gaisler, 1983). Insular forms (*verrucosus* from Madeira and *azoreum* from Azores) have been considered conspecific with *leisleri* by several authors (e.g. Corbet, 1978), but this taxonomic problem clearly needs further study. Seabra (1910, 1911) reported *N. leisleri* from two localities in Portugal. However, his contradictory statements make these records quite dubious; only his later record for Arrábida (Seabra, 1922) seems reliable. Specimens that he subsequently examined from this locality disappeared from the collection of the Museu Bocage (Palmeirim *et al.*, 1979). I have taken several specimens at two locations in northern and south-central Portugal (Fig. 27). *N. leisleri* was found recently in central Spain (Benzal, 1984). The range probably includes most of Iberia, but it seems to be present only in areas with suitable native forest or parkland. The range of this species might be shrinking due to the destruction of habitat, especially in the central and southern areas of the peninsula. *N. leisleri* usually roosts in tree holes, but may also use buildings (Lanza, 1959; Stebbings, 1977).

Morphology and Taxonomic Remarks.—Although *N. leisleri* is a relatively large bat, it is the smallest *Nyctalus* in continental Europe (Table 15). The back is dark brown and the underparts a bit lighter. The hair is clearly bicolored, the bases being darker than the tips. This character, plus its smaller size, separates it from *N. noctula*.

Asiatic *N. montanus* was previously considered a subspecies of *N. leisleri*, but was demonstrated to be a separate species (Gaisler *et al.*, 1968; Gaisler, 1970a; Neuhauser and DeBlase, 1974). Corbet (1978) recognized three subspecies, but the insular subspecies from Madeira (*verrucosus*) and the Azores (*azoreum*) may also be distinct species.

GENUS *PIPISTRELLUS*

The approximately 50 species of the genus *Pipistrellus* are distributed almost worldwide, but are absent from South America. All four species in the western European fauna have been found in Portugal: *P. pipistrellus*, *P. nathusii*, *P. kuhlii*, and *P. savii*.

These four species are among the smallest European bats. Morphologically they are similar to *Nyctalus*, *Vespertilio*, and *Eptesicus*. Relationships among these genera remain unclear. Small size readily distinguishes *Pipistrellus* from all other European bats except some small *Myotis*, which have a slender and more pointed tragus, lack a post-calcarial lobe and have three pairs of upper and lower premolars. *Barbastella* is also quite small and has the same dental formula as *Pipistrellus*, but its ears are almost fused at the base, whereas they are widely separated in *Pipistrellus*. The dental formula is usually: I 2/3, C 1/1, P 2/2, M 3/3 = 34. The anteriormost upper premolars however, are very small and their pres-

TABLE 15. Measurements of four *Nyctalus leisleri* from Portugal.

	♂JP 208	♂JP 210	♀JP 270	♂JP 286
Length of Forearm	41.0	43.1	41.6	42.2
Condylobasal Length	—	—	15.6	15.4
Zygomatic Breadth	—	—	10.5	10.5
Mastoid Breadth	—	—	9.5	9.6
Breadth of Braincase	—	—	8.5	8.6
C–M^3 Length	—	—	5.9	5.8
Maxillary C–C Breadth	—	—	5.6	—
Maxillary M–M Breadth	—	—	7.2	7.2
Length of Mandible	—	—	11.3	11.5
C–M_3 Length	—	—	6.2	6.0

ence is individually variable in *P. savii* (e.g. Miller, 1912; Lanza, 1959).

KEY TO THE SPECIES OF *PIPISTRELLUS* KNOWN FROM IBERIA

Based on External Characters.—

1. Tip of tail extending 2 mm or more beyond uropatagium ..... *P. savii* (p. 33)
1'. Tip of tail extending less than 2 mm beyond uropatagium 2
2. First upper incisor apparently unicuspid and twice as long as second (Fig. 29); first and second upper incisors positioned on same plane (characters observable on live animals) ..... *P. kuhlii* (p. 32)
2'. First upper incisor with two well-developed cusps and less than twice the length of second (Fig. 29); second upper incisor slightly posterior to first (characters observable on live animals) 3

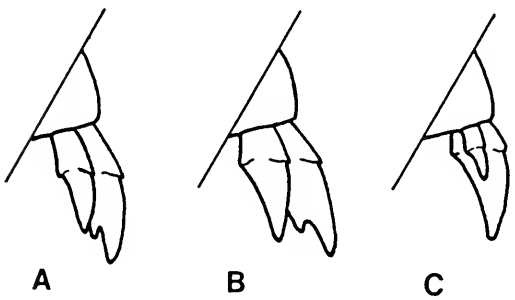

Fig. 29. Side view of the upper incisors of A) *Pipistrellus pipistrellus*, B) *P. nathusii*, and C) *P. kuhlii* showing relative differences in size and position between the teeth.

3. Thumb much shorter than the breadth of carpal joint (Fig. 30); fifth digit usually under 43 mm ..... *P. pipistrellus* (p. 30)
3'. Thumb almost as long as the breadth of carpal joint (Fig. 30); fifth digit usually about 46 mm ..... *P. nathusii* (p. 31)

Based on Cranial Characters.—

1. Anteriormost upper premolar vestigial or absent; dorsal profile of skull straight ..... *P. savii* (p. 33)

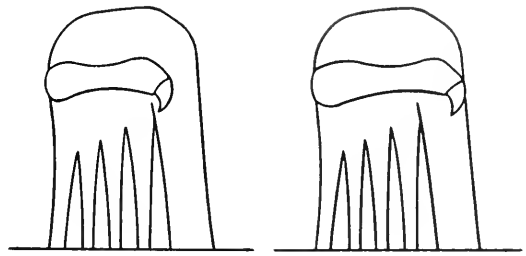

Fig. 30. Schematic representation of the carpal joints of *Pipistrellus pipistrellus* (left) and *P. nathusii* (right). Note the proportionally shorter thumb of *P. pipistrellus*.

1'. Anteriormost upper premolar small but well-developed; dorsal profile of skull concave ... 2
2. Second upper premolar and canine in contact or separated by a narrow gap; first upper incisor apparently unicuspid and twice as long as second (Fig. 29); first and second upper incisors positioned on same plane ..... *P. kuhlii* (p. 32)
2'. Second upper premolar and canine widely separated; first upper incisor with two well-developed cusps and less than twice the length of second (Fig. 29); first upper incisor slightly posterior to second 3
3. Clear gap between I_2 and I_3 (Fig. 31); second upper incisor usually higher than secondary cusp of first (Fig. 29); condylobasal length usually over 12 mm ..... *P. nathusii* (p. 31)
3'. No gap between I_2 and I_3 (Fig. 31); second upper incisor usually lower than secondary cusp of first (Fig. 29); condylobasal length usually under 12 mm ... *P. pipistrellus* (p. 30)

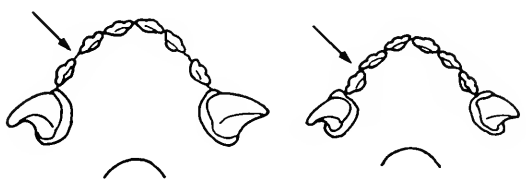

Fig. 31. Lower incisors and canines of *Pipistrellus nathusii* (left) and *P. pipistrellus* (right) showing the presence of a gap between I_2 and I_3 in *P. nathusii*. Modified from Hanák and Gaisler (1976).

PIPISTRELLUS PIPISTRELLUS (SCHREBER, 1774)

Distribution.—*P. pipistrellus* is present from Portugal to China (Neuhauser and DeBlase, 1974), and from North Africa (e.g. Hanák and Gaisler, 1983) to southern Norway and Sweden (Ryberg, 1947). Despite statements to the contrary in older works (e.g. Ellerman and Morrison-Scott, 1951; Lanza, 1959), this species seems to be absent from easternmost Asia and Japan (Wallin, 1969). *P. pipistrellus* occurs everywhere in Iberia and is the most common bat species from the peninsula (Fig. 32). It is very anthropogenic and usually roosts in trees and narrow cavities of human construction; it is often common in urban areas.

Morphology and Taxonomic Remarks.—*P. pipistrellus* is the smallest bat in the European fauna (Table 16). The overall color is variable reddish-brown. Juvenile animals are darker and grayish. The ears, face and patagium are very dark brown. Despite its small size, the skull is robust. There is a gap between the large upper premolar and the canine; the smaller upper premolar is partially visible laterally, while the lower incisors are crowded and the crowns slightly imbricated. A comparison of *P. pipistrellus* with the other species of this genus is given in the following descriptions of those species.

Cabrera (1904) described the subspecies *P. p. mediterraneus* from Spain, as being lighter and more reddish in color. However, after studying specimens from Britain and Poland with coloration similar to that of *mediterraneus*, he questioned this form's validity (Cabrera, 1914); Miller (1912) and Ellerman and Morrison-Scott (1951) included *mediterraneus* in the nominate

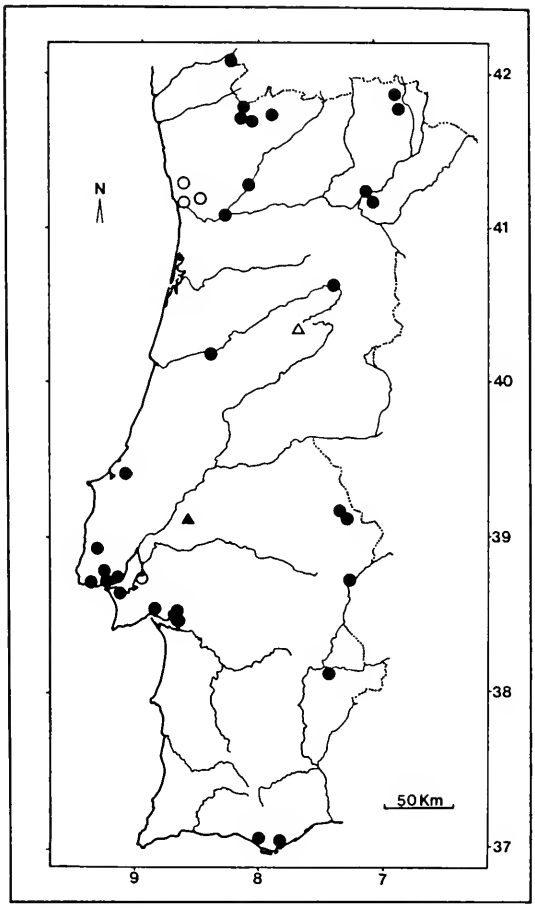

Fig. 32. Locality records of *Pipistrellus pipistrellus* from Portugal. Symbols as in Fig. 9.

TABLE 16. Statistics of a sample of *Pipistrellus pipistrellus* from Portugal.

	$\bar{x}$	*SD*	range	*n*
Length of Forearm	30.31	0.73	28.6–31.6	19
Condylobasal Length	11.22	0.26	10.6–11.6	14
Zygomatic Breadth	7.28	0.22	7.0–7.5	4
Mastoid Breadth	6.66	0.16	6.4–6.8	10
Breadth of Braincase	6.17	0.12	6.0–6.4	14
C–M^3 Length	4.11	0.09	4.0–4.3	16
Maxillary C–C Breadth	3.51	0.09	3.4–3.7	15
Maxillary M–M Breadth	4.84	0.16	4.6–5.1	14
Length of Mandible	8.16	0.17	7.8–8.4	14
C–M_3 Length	4.32	0.11	4.2–4.5	13

form. Nevertheless, Bauer (1956) and Harrison (1958) considered *mediterraneus* to be valid. The latter author suggested that *P. p. pipistrellus* is present in the Pyrenees and northern Iberia and *P. p. mediterraneus* in central and southern areas of the peninsula; a specimen from Porto (Portugal) was considered to be intermediate between the two forms. Color was the characteristic used to distinguish the two subspecies; the southern form is lighter than the nominate subspecies. Hanák (*in* Gaisler, 1970a) considered *mediterraneus* to be present in Turkey and added a new character to distinguish this subspecies; a whitish line along the posterior edge of the patagium. Gaisler (1970a) tentatively extended the range of *mediterraneus* to Afghanistan; he suggested that the two forms are genetically-fixed subspecies which evolved in different areas. More recently Tupinier (1975) recognized the presence of the two subspecies in Spain and reported two specimens of *mediterraneus* with the whitish line along the edge of the patagium.

The dark color of the specimens I have studied from northern Portugal is typical of the nominate form. However, some of these specimens have the white line considered characteristic of *mediterraneus*. This characteristic is, moreover, missing in many specimens from the south, which have the light color typical of *mediterraneus*. The specimens I have examined from Portugal suggest a north–south color gradient. The whitish line along the patagium is a variable character throughout the country; there may be latitudinal differences in frequency of occurrence of this character, but this is not conclusive from the series examined. The whitish patagial line also has been reported as frequent in geographical areas occupied by *P. p. pipistrellus* in other parts of Europe (e.g. Brosset, 1951). Measurements given by Miller (1912) from central and northern Europe are on average slightly larger than those from Italy and Greece. Portuguese specimens are indistinguishable in size from specimens from the latter two countries. They also average considerably smaller than the Afghanistan sample tentatively identified as *mediterraneus* by Gaisler (1970a). Two different hypotheses can explain this size/color pattern: (1) it results from the expansion of two genetically-fixed subspecies that evolved separately, as suggested by Gaisler (1970a); or (2) the pattern results simply from a climatically-induced cline. The second hypothesis seems more likely. In Great Britain, Stebbings (1973) showed a cline in the dimensions of *P. pipistrellus* correlated with climate and a trend towards lighter color with decreasing latitude is observable in other European vespertilionids. At this point I prefer not to distinguish two forms of *P. pipistrellus* in Portugal, while recognizing the need for further examination of this problem.

PIPISTRELLUS NATHUSII (KEYSERLING AND BLASIUS, 1839)

Distribution.—This species is found throughout most of Europe, from Iberia to the Urals and from the Mediterranean north to Leningrad (Hanák and Gaisler, 1976). It is one of the rarest of European bats, reaching its highest densities in the central and southern European part of the USSR (Hanák and Gaisler, 1976). I have not examined any specimens of *P. nathusii* from Portugal and all literature records for this country are questionable. Oliveira and Vieira (1896) listed two specimens in the National Museum in Lisbon. Seabra (1900) listed the same specimens and later (Seabra, 1910) added a new locality (Fig. 33). However in a subsequent paper, Seabra (1922) doubted the identification of all three specimens; none of these specimens can be found now in the National Museum (Palmeirim *et al.*, 1979). Ayres (1914) listed a sample of *P. nathusii* in the Zoological Museum of the University of Coimbra, but the measurements given are clearly outside the range of this species and I could not find these specimens when studying the collection. The presence of *P. nathusii* in Portugal needs to be confirmed. In Spain this species has been recorded only from near Madrid (Cabrera, 1914) and in Catalonia (Aguilar-Amat, 1924; *in* Tupinier, 1975). *P. nathusii* roosts mostly in narrow cavities in trees and buildings, usually near woods and ponds or rivers (Hanák and Gaisler, 1976).

Morphology and Taxonomic Remarks.—*P. nathusii* is slightly larger than *P. pipistrellus*, but is morphologically very similar to it (Table 17). The wing is broader than in *P. pipistrellus* and the

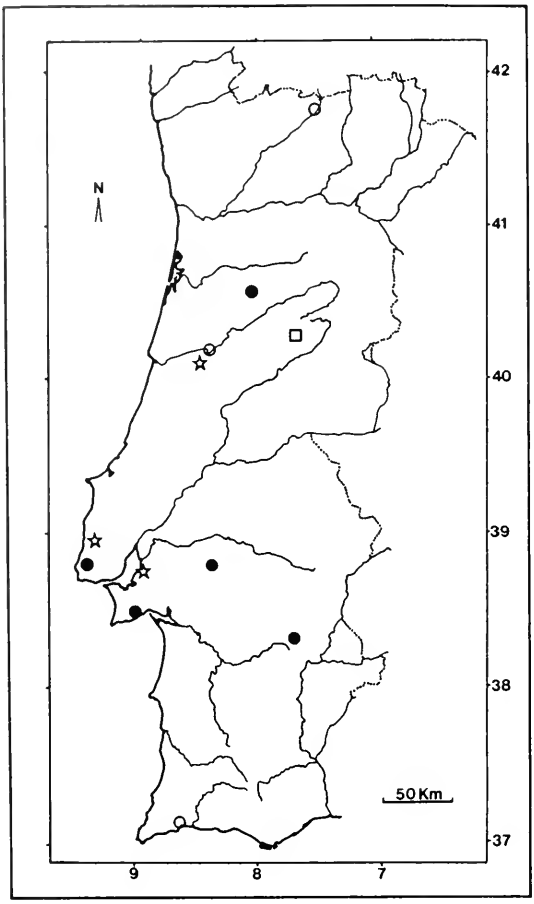

Fig. 33. Locality records of *Pipistrellus kuhlii* from Portugal. Symbols as in Fig. 9. Locality records of *Pipistrellus nathusii* from Portugal; open stars—literature references; Locality record of *Pipistrellus savii* from Portugal; open square—literature record.

TABLE 17. Range of measurements of *Pipistrellus nathusii* from Central Europe and Italy (from Hanák and Gaisler, 1976; Miller, 1912).

	range	*n*
Length of Forearm	32.4–35.2	19
Condylobasal Length	12.0–13.4	37
Zygomatic Breadth	7.6–8.4	22
Mastoid Breadth	6.9–7.7	15
Breadth of Braincase	6.8–7.4	20
C–M^3 Length	4.4–5.0	37
Length of Mandible	8.8–9.6	35
C–M_3 Length	4.3–5.0	36

fifth finger is usually at least 43 mm long. The thumb of *P. nathusii* is proportionally longer than that of *P. pipistrellus* (Fig. 30). These external characters are not always conclusive and dentition must be used to identify some specimens. The first upper premolar of *P. nathusii* is more visible laterally than that of the smaller species; in *P. pipistrellus* this tooth is located more lingually than in *P. nathusii*, where it is more in line with the other teeth (Fig. 29). In *P. nathusii* the outer upper incisor is higher than the secondary cusp of the inner incisor, while in *P. pipistrellus* it is usually lower (Fig. 29). Finally, the lower incisors of *P. nathusii* are not as crowded as those of *P. pipistrellus* and in the former species there is most often a distinct gap between I_2 and I_3 (Fig. 31). *P. nathusii* seems to be a very homogeneous species throughout its range (Hanák and Gaisler, 1976) and only the typical form is recognized (e.g. Miller, 1912; Ellerman and Morrison-Scott, 1951; Hanák and Gaisler, 1976; Corbet, 1978).

PIPISTRELLUS KUHLII (KUHL, 1819)

Distribution.—*Pipistrellus kuhlii* is one of the few bats in the Portuguese fauna that is not exclusively or almost exclusively palearctic in distribution. It ranges from South Africa (Roberts, 1951) north to the Loire Valley in central France (Brosset and Caubère, 1959) and from Portugal eastward to Pakistan (Roberts, 1977). It exists all over Portugal and, although most records are from the central part of the country, it is probably also common in the south (Fig. 33). *P. kuhlii* roosts in trees and narrow cavities in human constructions.

Morphology and Taxonomic Remarks.—*P. kuhlii* is very similar in size to *P. nathusii* (Table 18) and larger than *P. pipistrellus*. According to Brosset (1951), the coloration of *P. kuhlii* is quite variable, changing with age, but usually more yellowish than that of *P. pipistrellus*. In adult specimens the almost black base of the hair strongly contrasts with the tips as in *P. pipistrellus*. The membranes are very dark brown and the posterior part of the plagiopatagium is usually bordered with a well-defined, nearly white, line. This line also is often present in *P. pipistrellus* and *P. nathusii*, although in these species it is

TABLE 18. Measurements of three *Pipistrellus kuhlii* from Portugal.

	♀JP 304	♂JP 320	♀MB 7338
Length of Forearm	34.0	32.4	32.8
Condylobasal Length	12.9	—	—
Zygomatic Breadth	8.3	—	—
Mastoid Breadth	7.4	—	—
Breadth of Braincase	6.4	—	—
C–M^3 Length	5.2	—	5.1
Maxillary C–C Breadth	4.3	—	4.4
Maxillary M–M Breadth	5.7	—	—
Length of Mandible	9.6	—	—
C–M_3 Length	5.6	—	5.1

usually less well-defined. The upper incisors differ from those of the other European *Pipistrellus* in that the first upper incisor is at least twice as long as the second (Fig. 29). The small outermost upper incisors are situated in the same plane as the inner incisors; in all other European species of this genus the outermost incisors are slightly posterior to the innermost (Fig. 29). Weak development of the secondary cusp of the first upper incisor is also characteristic of *P. kuhlii*. In contrast to *P. pipistrellus* and *P. nathusii*, the gap between the second upper premolar and the canine is very small or absent and the first upper premolar is seldom visible laterally. The lower incisors are strongly imbricate. Portuguese specimens of *P. kuhlii* are not separable from the nominate form of this species.

PIPISTRELLUS SAVII (BONAPARTE, 1837)

Distribution.—*P. savii* ranges from the Cape Verde Islands (Cabrera, 1912) and Morocco (Strinati, 1952) north to Bavaria (Kahmann, 1958) and eastward to Japan (Imaizumi, 1970). It is a rare species throughout most of its range and only one record is known from Portugal (Fig. 33), a specimen from central Portugal originally identified as *Vesperugo borealis* (=*Eptesicus nilssoni*) by Seabra (1900, 1905, 1910); both Cabrera (1914) and Seabra (1922) referred this specimen to *P. savii*. The few known localities in Iberia are not sufficient to delineate the range of this species, which probably includes at least central and southern areas of the peninsula. Little is known about the biology of *P. savii*, but it seems to be similar to other European *Pipistrellus* (Lanza, 1959). Its tendency to live in montane regions has been noted by various authors (e.g. Cabrera, 1914; Lanza, 1959).

Morphology and Taxonomic Remarks.—*P. savii* is the largest member of its genus in Europe (Table 19). The fur is very dark brown or blackish with dorsally contrasting light tips. The coloration of this species is, however, remarkably variable (e.g. Miller, 1912; Harrison, 1958; Lanza 1959; Saint Girons, 1973). The ears and membranes are very dark. At least two millimeters of the terminal portion of the tail are not included in the uropatagium; in other European *Pipistrellus* the free part of the tail usually does not exceed one millimeter. The tragus is shorter and rounder than in other species of the genus in Europe. The skull is easily distinguished by its straight dorsal profile, unique among the *Pipistrellus* in this area. The second upper premolar is in contact with the canine; the first upper premolar is minute or absent.

TABLE 19. Range of measurements of *Pipistrellus savii* from Western Europe (from Bauer, 1956; Miller, 1912).

	range	*n*
Length of Forearm	31.0–37.3	7
Condylobasal Length	12.8–14.2	17
Zygomatic Breadth	8.4–9.2	16
Breadth of Braincase	6.6–7.2	14
C–M^3 Length	4.6–4.9	17
Length of Mandible	9.4–10.6	17
C–M_3 Length	5.0–5.6	17

Cabrera (1904) described *Vespertilio ochromixtus* from central Spain and the Balearic Islands. Later (Cabrera, 1914), he recognized that the specimens were assignable to *P. savii* and, comparing his Spanish sample with specimens from France, Italy, and the Cape Verde Islands, he concluded that they were not distinguishable even at the subspecific level. Miller (1912) and later Ellerman and Morrison-Scott (1951) also included *ochromixtus* as a synonym of *P. savii*.

However, Bauer (1956) identified three Spanish specimens as *P. savii ochromixtus*; according to him this subspecies was present in the Pyrenees, Iberia, and the Balearic Islands. The three specimens that Bauer (1956) examined are in fact large when compared to other European populations. However, the specimen from the Pyrenees described by Harrison (1949, 1958) is considerably smaller than any of Bauer's (1956) specimens and well within the range of variation of the nominate form. The same is true for both Miller's (1912) and Cabrera's (1914) specimens from Spain. Part of the variability might be attributable to differences in measuring techniques among the various authors, but it seems likely that the specimens examined by Bauer (1956) represent the upper size extreme of the Iberian populations. Due to great individual variability in *P. savii*, color characteristics are of little use when only small series are available. More specimens are needed to resolve the taxonomic status of *P. p. ochromixtus*.

Genus *Barbastella*

This genus occurs throughout the Palearctic and adjacent parts of the Oriental and perhaps Ethiopian regions. Only *B. barbastellus* occurs in western Europe.

These small bats have broad but relatively low, forward-facing ears, with the inner margins of their bases very close together. The bases of the ears of all other European bats are widely separated, with the exception of *Plecotus*, but in this genus the pinnae are much longer than in *Barbastella*. The dental formula is as in *Nyctalus* and *Pipistrellus*: I 2/3, C 1/1, P 2/3, M 3/3 = 34.

BARBASTELLA BARBASTELLUS (SCHREBER, 1774)

Distribution.—This uncommon species ranges from Portugal eastward to the Caspian Sea (Bobrinskii *et al.*, 1965) and from southern Scandinavia (Siivonen, 1976) to Macedonia (Dulić and Mikuska, 1966) and some Mediterranean islands (Kahmann, 1957). Panouse (1955) referred to *B. barbastellus* from the Atlas Mountains of Morocco; there are however, still questions about the distribution of this bat due to its confusion with the similar *B. leucomelas*. In Portugal *B. barbastellus* is herein reported for the first time and appears to be quite rare (Fig. 34). The few records from Spain are almost all from montane areas and corroborate the central European character of this species' distribution. However, the presence of *B. barbastellus* in the warm lowlands of Iberia is shown by new localities documented here and by Bauer's (1956) record from Oropesa (Castellon). This species seems to need relatively low temperatures to

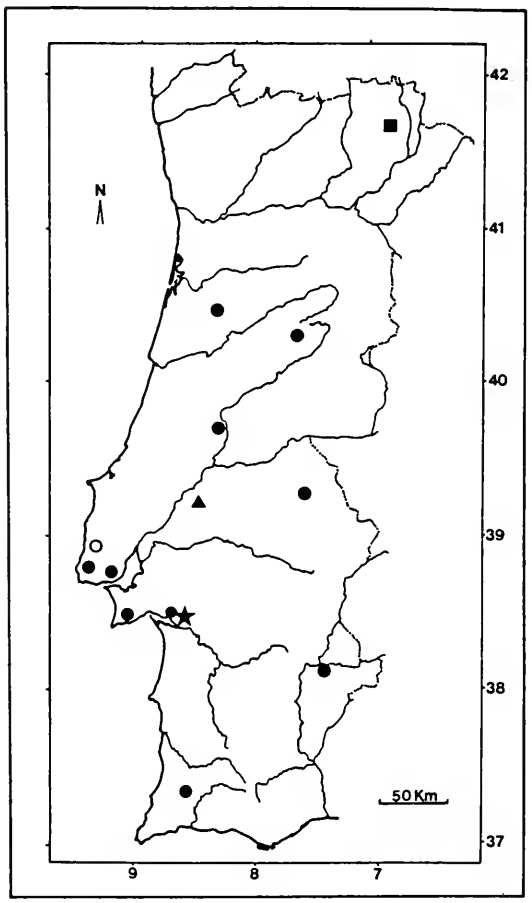

Fig. 34. Locality records of *Plecotus austriacus* from Portugal. Symbols as in Fig. 9. Locality record of *Plecotus auritus* from Portugal; closed square—specimens examined. Locality record of *Barbastella barbastellus* from Portugal; closed star—specimens examined.

hibernate (Gaisler, 1970c) and therefore it is unlikely that it can find caves suitable for hibernation in the lowlands of southern Iberia. In fact, there are no winter references outside the cooler montane areas and seasonal migratory movement between the lowlands and the mountains is likely. During the summer these bats roost in hollow trees and attics, but usually spend the winter in cool caves and cellars (Kowalski and Ruprecht, 1981).

Morphology and Taxonomic Remarks.—*B. barbastellus* is a medium-sized bat (Table 20) easily distinguishable from all other European species. General color is very dark brown, almost black dorsally. The hair on the upper parts of adult specimens has very pale tips giving this animal a frosted appearance. The ears and membranes are very dark brown. The ears are very broad and united at the base, just above the blunt muzzle. The outer side of the ear is densely covered with hair. The skull is easily recognized by the ventrally depressed short rostrum (Fig. 16) and has a particularly deep emargination reaching posterior to the level of the antorbital foramina.

TABLE 20. Measurements of three *Barbastella barbastellus* from Portugal.

	♀JP 268	♂JP 279	♀JP 280
Length of Forearm	38.6	38.3	37.2
Condylobasal Length	13.2	13.4	12.9
Mastoid Breadth	8.3	8.2	8.4
Breadth of Braincase	7.4	—	7.5
C–M^3 Length	4.7	4.6	4.5
Maxillary C–C Breadth	3.9	—	3.6
Maxillary M–M Breadth	5.5	5.6	5.5
Length of Mandible	9.2	9.2	9.9
C–M_3 Length	5.0	5.0	4.8

GENUS *PLECOTUS*

The five recognized species of this genus are widespread in the north temperate zone and a few contiguous tropical areas. The two Old World species, *P. auritus* and *P. austriacus*, have been found in Portugal.

The enormous ears joined across the forehead make this genus unmistakable among European bats. Although smaller, the ears of *Myotis bechsteinii* are also very large, but are widely separated at the base. The dental formula of this genus is also unique among the European vespertilionids although equal to the "apparent" formula of the Miniopteridae (see below): I 2/3, C 1/1, P 2/3, M 3/3 = 36.

KEY TO THE SPECIES OF *PLECOTUS* KNOWN FROM IBERIA

Based on External Characters.—

1. Overall color brown; bases of hair chocolate brown; tragus brown and translucent, lightly pigmented; thumb usually over 6.5 mm ..... *P. auritus* (p. 35)

1'. Overall color gray; bases of hair almost black; tragus gray and opaque, intensely pigmented; thumb usually under 6.5 mm ..... *P. austriacus* (p. 36)

Based on Cranial Characters.—

1. Angular process of the mandible pointed, with a pronounced median horn (Fig. 35); largest diameter of tympanic bulla usually over 4.5 mm ..... *P. austriacus* (p. 36)

1'. Angular process of the mandible blunt, median horn small or even absent (Fig. 35); largest diameter of tympanic bulla usually under 4.6 mm ..... *P. auritus* (p. 35)

PLECOTUS AURITUS (LINNAEUS, 1758)

Distribution.—*P. auritus* ranges from the Arctic Circle in Scandinavia (Ryberg, 1947) south to northern Portugal, central Italy (Lanza, 1960) and the Caucasus (Hanák, 1966) and eastward to Japan (Imaizumi, 1970). In Europe this species is usually absent from regions with a Mediterranean climate and most older records of "*P. auritus*" in Iberia were in fact *P. austriacus*. However, *P. auritus* has been demonstrated to occur in the Cantabrian mountains (Balcells, 1963, 1968) and in montane areas of central Spain (Paz, 1984). The distribution of this species in Iberia is here extended to northern Portugal where its presence was hitherto unconfirmed (Fig. 34). The only two known Portuguese speci-

mens were mist-netted at a mountain site over 1,000 meters in elevation. It is still not known whether *P. auritus* in Portugal is restricted to similar cold montane enclaves; its presence in the lowlands of northern Portugal is also possible. *P. auritus* usually spends the summer in buildings and tree cavities and winters in caves (e.g. Kowalski and Ruprecht, 1981; Saint Girons, 1973).

Morphology and Taxonomic Remarks.—*P. auritus* is a small bat (Table 21) averaging slightly smaller than *P. austriacus* (Table 22). The genus *Plecotus* has a very distinct morphology, but confusion between these two very similar species in Europe is possible; a thorough comparison with morphological descriptions of both species should be part of any identification (see key). The upper parts of *P. auritus* are grayish-brown, the under parts are light yellowish and partly translucent; the face is light brown. The dentition is less robust than that of *P. austriacus*, but the canines of *P. auritus* are comparatively less developed while the first upper premolars are proportionally larger than those of *P. austriacus*. The anular process of the mandible is blunt whereas that of *P. austriacus* is more pointed (Fig. 35). In the latter species a distinct "horn" is present medially on the dorsal side of the angular process; in *P. auritus* this is absent or reduced (Fig. 35). Various morphometric characters have been used to distinguish between the two species. However, most of these are not applicable to Portuguese specimens of *Plecotus*. In fact the only two known *P. auritus* from Portugal are unusually large, one of them (JP 165) exceeding the previously reported size range of this species. This suggests that in Portugal there is great morphometric overlap between the two species of *Plecotus*. The two morphometric characters used in the keys in this paper seem to be valid, but they should be used with great care. The size and shape of the baculum seem to be the most reliable characters to distinguish the two species throughout their range (Lanza, 1960). Several papers discuss the comparative morphology of the two European *Plecotus* and can be useful in the identification of difficult specimens (e.g. Bauer, 1960; Lanza, 1960; König and König, 1961; Balcells, 1963; Saint Girons, 1964; Ruprecht, 1965, 1969; Stebbings, 1967; Aellen, 1971; Hůrka, 1971), providing that one takes into consideration the peculiarities of the Portuguese populations.

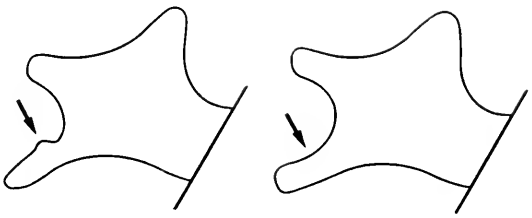

Fig. 35. Posterior part of the mandibles of *Plecotus austriacus* (left) and *P. auritus* (right) showing the differences in the shape of the angular process. A small horn can also be present in *P. auritus* and the shape of the terminal portion of the angular process is quite variable.

TABLE 21. Measurements of two *Plecotus auritus* from Portugal.

	♀JP 165	♀JP 166
Length of Forearm	40.8	40.1
Condylobasal Length	16.5	15.9
Zygomatic Breadth	9.2	9.1
Mastoid Breadth	9.4	9.3
Breadth of Braincase	—	—
C–M^3 Length	6.1	6.0
Maxillary C–C Breadth	4.2	4.2
Maxillary M–M Breadth	6.7	6.8
Length of Mandible	11.7	11.2
C–M_3 Length	6.4	6.4

I recognize only the nominate form in Europe. The form *P. auritus hispanicus* described by Bauer (1956) from Spain is actually a synonym of *P. austriacus*, which was later recognized as a distinct species (see below).

PLECOTUS AUSTRIACUS (FISCHER, 1829)

Distribution.—*P. austriacus* is found throughout Europe and northern Africa, from Cape Verde Islands (Dorst and Naurois, 1966) and Sudan (Kock, 1969) north to southern England (Corbet, 1964) and central Poland (Kowalski and Ruprecht, 1981) and eastward into Asia (Hanák, 1966). Because this species was only

TABLE 22. Statistics of a sample of *Plecotus austriacus* from Portugal.

	$\bar{x}$	*SD*	range	*n*
Length of Forearm	39.91	0.96	38.8–41.9	11
Condylobasal Length	16.14	0.46	15.2–16.6	8
Zygomatic Breadth	9.33	0.33	8.8–9.7	7
Mastoid Breadth	9.41	0.33	9.0–9.8	7
C–M^3 Length	5.91	0.28	5.4–6.2	9
Maxillary C–C Breadth	4.08	0.13	3.9–4.2	9
Maxillary M–M Breadth	6.47	0.29	6.1–6.7	6
Length of Mandible	11.22	0.28	10.8–11.6	9
C–M_3 Length	6.38	0.17	6.1–6.6	9

recently distinguished from the very similar *P. auritus*, the distribution of the two forms is still unclear in some parts of their range and especially in Asia. Because of this confusion only recent literature records of *Plecotus* were included in the distribution map. *P. austriacus* is common throughout central and southern Iberia, but I know of only one record from the Cantabrian Mountains where *P. auritus* also occurs (Balcells, 1968) (Fig. 34). There are no confirmed records from northern Portugal, but *P. austriacus* is very likely present there along with *P. auritus*. *Plecotus austriacus* occupies a wide variety of roosts, but most commonly uses buildings.

Morphology and Taxonomic Remarks.—*Plecotus austriacus* is on average slightly larger than *P. auritus* and is morphologically very similar to it (Table 22). The upper parts of *P. austriacus* are gray with a variable brownish tinge; the under parts are whitish-gray and the bases of the hair blackish. The tragus is gray and opaque; the face is dark gray. A description of skull characters is given in the previous section.

The confusion between *P. auritus* and *P. austriacus* was clarified by Topál's (1958) study of the morphology of the os penis of European bats, which showed strong evidence for the specific separation of the two forms. *P. auritus hispanicus* was described from Spain by Bauer (1956), but is referable to *P. austriacus*. Most Portuguese specimens do not differ from the subspecies *P. austriacus austriacus*. However the only specimen from Algarve, the southernmost Portuguese province, is craniometrically outside the range of this subspecies and its small dimensions are similar to those of North African specimens of *P. austriacus christiei* (=*aegyptius*) (e.g. Lanza, 1960; Gaisler *et al.*, 1972; Baker *et al.*, 1974). It is possible that populations of *P. austriacus* in extreme southern Iberia are intermediate in size between the two forms. Dulić (1980) also found small specimens of *P. austriacus* along the coast of Yugoslavia; she considered them to represent a distinct subspecies *P. a. kolombatovici* comparable in size to North African specimens.

FAMILY MINIOPTERIDAE

This Old World family is considered monogeneric and, according to most authors, has eight species of which only one exists in Europe. However, Maeda (1982) suggested a very different taxonomic arrangement of the family, recognizing 19 species of *Miniopterus* in Eurasia, Australia, and Melanesia.

The close relationship of *Miniopterus* with the Vespertilionidae has long been recognized. Following older authors (e.g. Dobson, 1875, 1878; Flower and Lydekker, 1891; Trouessart, 1898–1899), Miller (1907) classified *Miniopterus* within the Vespertilionidae and this view is maintained even in the latest reviews (e.g. Corbet and Hill, 1980; Honacki *et al.*, 1982). However, Mein and Tupinier (1977) pointed out the existence of a vestigial anterior upper premolar in *Miniopterus* and, on the basis of this and other differences from the Vespertilionidae, erected the family Miniopteridae. Chari and Gopalakrishna (1981) also suggested a reassessment of the taxo-

nomic status of *Miniopterus* based on embryological characters.

Genus *Miniopterus*

Distribution is as in the family (see above). Only one species, *Miniopterus schreibersii*, exists in Portugal. The dental formula is: I 2/3, C 1/1, P 3/3, M 3/3 = 38. The presence of the very small anteriormost upper premolar was noticed only recently (Mein and Tupinier, 1977); it is often absent in cleaned skulls.

MINIOPTERUS SCHREIBERSII (KUHL, 1819)

Distribution.—*Miniopterus schreibersii* is a predominantly tropical species that extends into the southern part of the Palearctic, from Portugal to Japan (Wallin, 1969; however, see Maeda, 1982). In Europe it shows clear Mediterranean preferences, extending northward to the Loire Valley in France (Caubère, 1952). It is very widespread in the Ethiopian, Oriental, and Australian regions. *M. schreibersii* exists all over the Iberian Peninsula where it is one of the most common cave bats (Fig. 36). It is very gregarious, forming large colonies, often mixed with other bat species such as *M. myotis* and *M. blythii*.

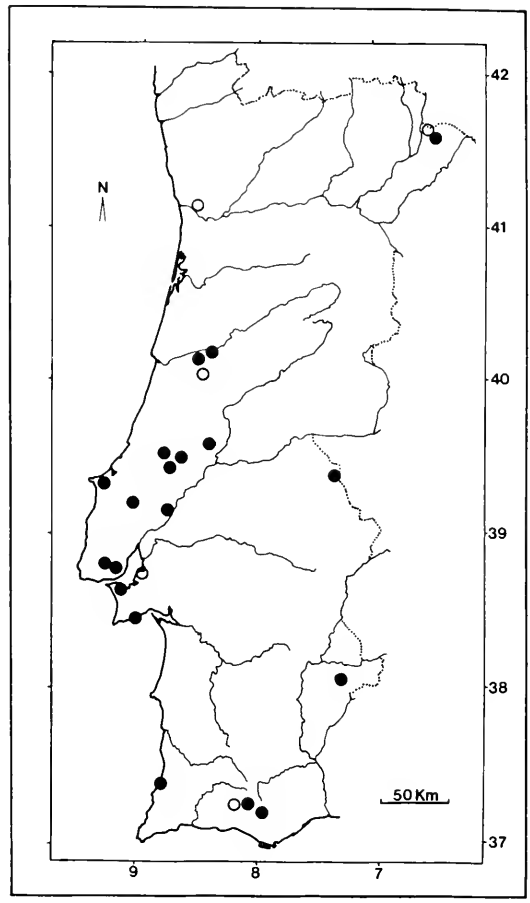

Fig. 36. Locality records of *Miniopterus schreibersii* from Portugal. Symbols as in Fig. 9.

Morphology and Taxonomic Remarks.—*M. schreibersii* is a species of medium size, easily separable from all other European bats (Table 23). The fur is grayish, silky and very dense. The underparts are slightly lighter than the back. The basal half of the hair is much darker than the terminal half. The long wings are a little darker than the fur. The ears are very short and

Table 23. Statistics of a sample of *Miniopterus schreibersii* from Portugal.

	$\bar{x}$	*SD*	range	*n*
Length of Forearm	45.47	0.97	43.2–47.4	26
Condylobasal Length	14.71	0.17	14.4–15.0	16
Zygomatic Breadth	8.58	0.12	8.3–8.8	12
Mastoid Breadth	8.78	0.09	8.6–8.9	16
Breadth of Braincase	8.01	0.09	7.9–8.2	16
C–M^3 Length	6.00	0.03	5.9–6.1	18
Maxillary C–C Breadth	4.6	0.07	4.5–4.7	18
Maxillary M–M Breadth	6.39	0.08	6.3–6.5	16
Length of Mandible	10.93	0.11	10.8–11.1	20
C–M_3 Length	6.27	0.07	6.2–6.4	20

have a characteristic square shape (Fig. 37). The brain case is very high, contrasting with the low, flattened rostrum. It is the only European bat in which the baculum is never present. As expected from such a widespread bat, many subspecies have been described. However, the European population of this bat is remarkably uniform and only the nominate subspecies exists on this continent.

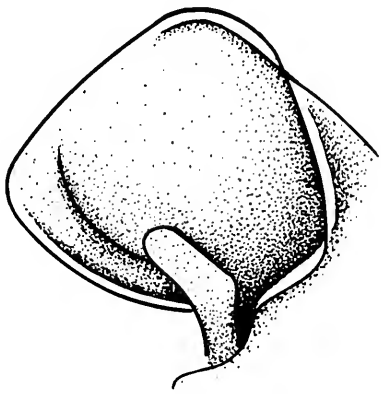

Fig. 37. Ear of *Miniopterus schreibersii* showing the characteristic square shape. Modified from Gaisler *et al.* (1957).

Family Molossidae

This is a widespread family occupying the Neotropical, Ethiopian, Oriental, and Australian regions; it extends into the southern parts of both the Nearctic and Palearctic subregions. The Molossidae is a large family (about 90 species and 11 genera), but only one species reaches Europe.

The family Molossidae is easily recognized by the tail which projects conspicuously beyond the relatively narrow uropatagium, a unique feature among European bats.

Genus *Tadarida*

Although it comprises only about 10 species, this genus has a vast distribution; occurring in the Americas, Europe, Africa, Asia, and Australia. Only one species, *T. teniotis* lives in Europe. Its dental formula in Europe is: I 1/3, C 1/1, P 2/2, M 3/3 = 32. This is the only bat genus in Europe with a single pair of upper incisors.

Tadarida teniotis (Rafinesque, 1814)

Distribution.—*T. teniotis* ranges from continental Portugal and Madeira eastward through southern Europe, northern Africa and southern Palearctic Asia to Japan (Aellen, 1966). Although rarely recorded due to the inaccessibility of its roosts, *T. teniotis* is probably a fairly common species throughout the Iberian Peninsula (Fig. 38). It has not been recorded in the southern part of Portugal, but it almost certainly exists there. This poorly known species most commonly

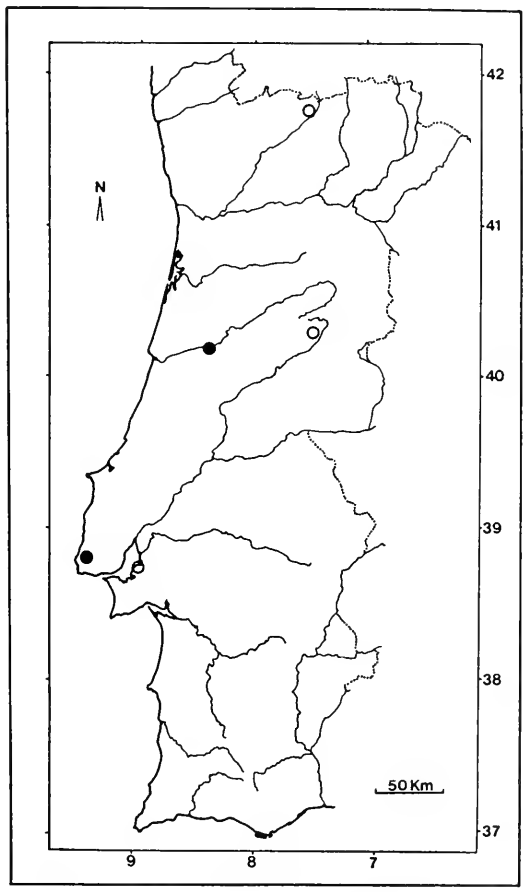

Fig. 38. Locality records of *Tadarida teniotis* from Portugal. Symbols as in Fig. 9.

roosts in rock crevices but can also be found in human constructions and caves.

Morphology and Taxonomic Remarks.—*T. teniotis*, the only molossid occurring in Europe, is one of the largest bats on the continent (Table 24). The fur is drab with the hair lighter toward the bases. The ears and patagium are quite dark. The wings are particularly long and narrow, the ears are large and rounded, the legs are short, the upper lip is characteristically large and wrinkled, and the distal half of the tail is free from the uropatagium. The skull is depressed and its dorsal profile straight and almost horizontal. The very small baculum may be absent in some adult specimens (Aellen, 1970).

The Portuguese specimens studied agree with the nominate subspecies which is the only one recognized in Europe.

TABLE 24. Measurements of four *Tadarida teniotis* from Portugal.

	♀BMNH * 98.2.2.6	♀BMNH * 98.2.2.7	♀MZUC Uncat.	♀MZUC Uncat.
Length of Forearm	60	61	57.3	58.1
Condylobasal Length	23.0	23.4	—	—
Zygomatic Breadth	14.0	14.2	—	—
Breadth of Braincase	11.2	11.6	—	—
C–M^3 Length	9.0	9.2	—	—
Length of Mandible	16.8	17.2	—	—
C–M_3 Length	9.6	9.6	—	—

*From Miller (1912)

ZOOGEOGRAPHIC COMMENTS

Longitudinal changes in bat community species composition within Europe (excluding the USSR) are minimal; of the 30 bat species present in eastern Europe (west of the USSR) only *Vespertilio murinus*, *Eptesicus nilssoni*, and possibly *Myotis brandtii* do not reach Iberia. There are however important latitudinal changes, not only in community diversity but also in the "distributional character" of the species present. The climatic character of the bat faunas of some European and North African regions was estimated, using an index varying from one ("ethiopian") to seven ("boreal") (Fig. 39). Finland, Norway, and Sweden form a distinct "atlantic-boreal" cluster. The next group, including both the "atlantic" and "mediterranean" European countries, displays a gradual change as would be expected given the lack of geographic barriers in this region. The low index value for Greece is partly explained by the presence of *Nycteris thebaica*, which was recorded only once, on the island of Corfu. The index value for the Magreb (Morocco, Algeria, and Tunisia) reflects the Mediterranean palearctic character of its bat fauna whereas that for Egypt shows a more Ethiopian character, despite sharing most of its bat species with Palearctic regions (Gaisler *et al.*, 1972). Portugal and Spain show a Mediterranean-Atlantic character.

The Iberian bat fauna includes mostly Palearctic species, which is the general situation throughout Europe. The only species present in Iberia with significant ranges outside the Palearctic are *Pipistrellus kuhlii* (widespread in Africa), *Miniopterus schreibersii* (also present in the Ethiopian, Oriental, and Australian regions) and probably *Rhinolophus blasii* (various Ethiopian forms have been included in this species). Almaça (1971) studied the composition of the Iberian herpetological and mammalian faunas (excluding bats and marine mammals) and concluded that they have a high degree of endemism. He attributed this mostly to the effectiveness of the Pyrenees Mountains and Strait of Gibraltar as geographic barriers. A very different pattern characterizes the Iberian bat fauna which does not include any endemics. The Pyrenees do not

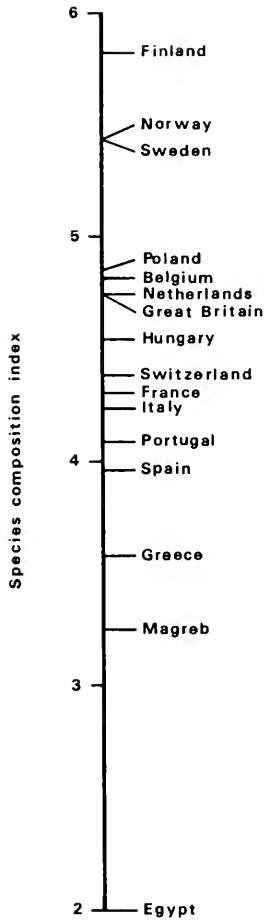

Fig. 39. Species composition index portraying the climatic character of western palearctic bat faunas. A rating varying between one (Ethiopian) and seven (Boreal) was assigned to each species present in the total area, according to their overall distributions. The position of each region on the scale above is determined by the average of the individual ratings of all the bat species in its fauna.

represent an important barrier for bats and the Strait of Gibraltar is too narrow to be a major obstacle to their movement. Also related to this lack of isolation is the high diversity of the chiropteran fauna of Iberia, which does not show any "peninsular effect" (Simpson, 1964); all the bat species known from western France are also present in the Iberian Peninsula. This analysis suggests that at the European level the composition of the Iberian bat fauna is determined by existing ecological conditions rather than historical or geographical factors.

The analysis of chiropteran distribution patterns within Iberia is considerably complicated by the relative lack of records for some species. However some patterns are suggested by the analysis of the existing data.

1. The most comprehensive of these patterns is shown by the species that seem to be present throughout all, or almost all, the Iberian Peninsula, including *R. ferrumequinum, R. hipposideros, M. blythii, M. daubentonii, M. emarginatus, M. nattereri, M. mystacinus, P. pipistrellus, P. kuhlii, P. nathusii, E. serotinus, N. noctula, N. leisleri, P. austriacus, M. schreibersii,* and *T. teniotis.* Some of these species, such as *N. leisleri,* and *N. noctula,* seem to be quite scattered in occurrence while others probably become rare or localized near the climatic limits of their distribution (e.g. *R. ferrumequinum, P. austriacus,* and *M. nattereri*).

2. The second most common pattern is that shown by southern species that do not reach northern Iberia. *M. capaccinii,* seems to be limited to the southern coast while others almost reach the Cantabrian region including *R. mehelyi, P. savii,* and *N. lasiopterus.*

3. Some species with a more northern character do not seem to reach southern Iberia; this is clear in the case of *P. auritus. M. bechsteinii* is known from further south in central Portugal and *R. euryale* and *M. myotis* seem to be absent or rare only along the southern coastal area, but their ranges are obscured by confusion with similar species. Some of these northern species are replaced in the south by morphologically similar species. *P. auritus* seems to be common in northern Iberia where *P. austriacus* has been reported only once; in contrast, in central and southern areas of the Peninsula *P. austriacus* is the common species and *P. auritus* has never been found in these regions. *M. myotis* is common in northern and central Iberia, but is absent or rare in the south; *M. blythii,* although present throughout the Peninsula, is particularly common in the south but rarer at higher latitudes. The species pair of *R. euryale* and *R. mehelyi* follows a similar pattern with *R. euryale* being common in the north and centrally, but absent or rare in the

south; *R. mehelyi* is abundant in the south, present centrally, but apparently absent in the Cantabrian region.

4. Finally, *B. barbastellus* probably has a seasonally variable distribution as discussed above.

The above discussion of distribution patterns within Iberia is largely based on data from Portugal whose bat fauna is better known than that of Spain. An obvious weakness is uncertainty concerning ranges of some species due to the scarcity of records or confusion between very similar species in the literature. As in other parts of Europe, much still needs to be done to clarify the distribution patterns of bats in the Iberian Peninsula.

SUMMARY

Of the 26 bat species recorded in the Iberian Peninsula, 24 have been found in Portugal (the exceptions are *Rhinolophus blasii* and *Myotis capaccinii*). Portuguese specimens of 21 of those species were examined in this study (exceptions are marked with an asterisk on the list below): *Rhinolophus ferrumequinum, R. hipposideros, R. euryale, R. mehelyi, Myotis myotis, M. blythii, M. daubentonii, M. emarginatus, M. mystacinus*, M. nattereri, M. bechsteinii, Eptesicus serotinus, Nyctalus lasiopterus, N. noctula, N. leisleri, Pipistrellus pipistrellus, P. nathusii*, P. kuhlii, P. savii*, Barbastella barbastellus, Plecotus auritus, P. austriacus, Miniopterus schreibersii*, and *Tadarida teniotis*.

B. barbastellus and *P. auritus* (*sensu stricto*) are reported for the first time in Portugal. Specimens corresponding to the description of *Myotis nathalinae* were also found, but are provisionally considered to be variants of *M. daubentonii*.

A species-by-species morphological comparison showed great similarity between the Portuguese and other European populations; no endemic Iberian subspecies are recognized. The Iberian bat fauna is dominated by exclusively Palearctic species and, in the context of the European fauna, shows a Mediterranean-Atlantic character. The data suggest the following distribution patterns within the Iberian Peninsula: (1) the most common pattern is that shown by species present throughout all or most of the Peninsula; (2) the second most common pattern comprises southern species that do not reach northern Iberia; (3) these are replaced in the north by morphologically similar species which do not reach southern Iberia; and (4) *Barbastella barbastellus* has a seasonal distribution, spending the winter in montane areas.

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APPENDIX I: SPECIMENS EXAMINED, AND OTHER RECORDS.

(Grouped by districts, from north to south.)

RHINOLOPHUS FERRUMEQUINUM

Bragança Dist.—Montezinho (41°56'N, 6°46'W), Bragança, caught and released; França (41°54'N, 6°44'W), Bragança, caught and released; Cova da Lua (41°53'N, 6°49'W), Bragança, caught and released; Minas de Sto. Adrião (41°30'N, 6°26'W), Miranda do Douro, 2 JP; Freixo de Espada à Cinta (41°2'N, 36°50'W), caught and released.

Braga Dist.—Caldas do Gerês (41°44'N, 8°9'W), Terras de Bouro, 1 JP; Cabeceiras de Basto (41°31'N, 7°59'W), 3JP.

Porto Dist.—Vila do Conde (41°21'N, 8°45'W), 1 MB.

Guarda Dist.—Celorico da Beira (40°38'N, 7°23'W), 1 JP.

Coimbra Dist.—Bordalo (40°12'N, 8°27'W), Coimbra, 3 MZUC; Coimbra (40°12'N, 8°25'W), 2 MB and 7 MZUC.

Santarém Dist.—Torres Novas (39°29'N, 8°32'W), 1 JP; Amiais de Baixo (39°27'N, 8°43'W), Alcanena, 3 JP and many more caught and released; Alcobertas (39°25'N, 8°54'W), Rio Maior, 2 MB; Cartaxo (39°9'N, 8°45'W), several caught and released.

Portalegre Dist.—S. Salvador da Aramenha (39°21'N, 7°22'W), Marvão, 1 JP.

Lisboa Dist.—Pragança (39°12'N, 9°3'W), Cadaval, 1 MB and several caught and released; Alenquer (39°3'N, 9°3'W), several caught and released.

Setúbal Dist.—Serra da Arrábida (38°30'N, 9°0'W), Setúbal, 1 JP.

Beja Dist.—Preguiça (38°2'N, 7°18'W), Moura, 8 JP.

Faro Dist.—Rogil (37°22'N, 8°48'W), Aljezur, 2 JP.

Unknown Origin.—5 MB and 39 MZUC.

Other Records.—Ponte de Lima (Braga, 1941); Matosinhos (Seabra, 1900); Coimbra (Ayres, 1914; Oliveira and Vieira, 1896; Seabra, 1900; Themido, 1928); Bordalo, Coimbra (Dulic and Felten, 1964; Felten *et al.*, 1977); Rio Maior (Niethammer, 1970); Ribatejo Prov. (Seabra, 1910); Ajuda, Lisboa (Seabra, 1900); Alfeite, Almada (Nobre, 1903; Seabra, 1900).

RHINOLOPHUS HIPPOSIDEROS

Bragança Dist.—Montezinho (41°56'N, 6°46'W), Bragança, several caught and released; Parâmio (41°54'N, 6°52'W), Bragança, several caught and released; Minas de Sto. Adrião (41°30'N, 6°26'W), Miranda do Douro, 1 JP.

Braga Dist.—Caldas do Gerês (41°44'N, 8°9'W), Terras de Bouro, 1 JP.

Porto Dist.—Amarante (41°16'N, 8°5'W), 1 MZUC.

Viseu Dist.—Serra do Caramulo, 4 MB.

Coimbra Dist.—Arganil (40°13'N, 8°3'W), 1 JP; Coimbra (40°12'N, 8°25'W), 3 MB; Maiorca (40°10'N, 8°45'W), Figueira da Foz, 2 MZUC.

Santarém Dist.—Amiais de Baixo (39°27'N, 8°43'W), Alcanena, several caught and released.

Lisboa Dist.—Colares (38°48'N, 9°27'W), Sintra, 2 MB; Barcarena (38°44'N, 9°17'W), Oeiras, 3 MB; Lisboa (38°43'N, 9°8'W), 1 MB.

Beja Dist.—Contenda (38°3'N, 7°2'W), Barrancos, 4 JP; Rosário (37°22'N, 8°48'W), Castro Verde, several caught and released.

Setúbal Dist.—Sines (37°57'N, 8°52'W), 1 MB; Porto Covo (37°51'N, 8°47'W), Sines, 1 JP.

Faro Dist.—Rogil (37°22'N, 8°48'W), Aljezur, several caught and released; Odeleite (37°17'N, 7°29'W), Castro Marim, 1 JP; Soidos (37°15'N, 8°1'W), Loulé, several caught and released; Querença (37°12'N, 7°59'W), Loulé, 2 JP; Mexilhoeira Grande (39°9'N, 8°30'W), Lagoa, several caught and released; Lagoa (37°8'N, 8°27'W), 1 JP; Moncarapacho (37°7'N, 7°47'W), Olhão, 2 JP; near Barão de S. João, Lagos or Vila do Bispo, 4 JP; Serra de Alcaria do Cume, Tavira, 1 JP.

Lisboa, Santarém or Portalegre Dists.—Ribatejo, 2 MB and 2 MZUC.

Unknown Origin.—10 MB and 5 MZUC.

Other Records.—Ponte de Lima (Braga, 1941); Valongo (Nobre, 1903); Serra do Caramulo (Seabra, 1900); Bussaco (Seabra, 1905); Coimbra (Ayres, 1914; Seabra, 1900; Themido, 1928); Maiorca, Figueira da Foz (Ayres, 1914; Oliveira and Vieira, 1896; Themido, 1928); Sintra (Miller, 1912); Lisboa (Seabra, 1900); Cacilhas, Almada (Nobre, 1903); Alfeite Almada (Seabra, 1900).

RHINOLOPHUS EURYALE

Braga Dist.—Gerês (41°44'N, 8°9'W), Terras de Bouro, 35 MZUC.

Bragança Dist.—Minas de Sto. Adrião (41°30'N, 6°26'W), Miranda do Douro, 1 JP.

Santarém Dist.—Amiais de Baixo (39°27'N, 8°43'W), Alcanena, several caught and released; Cartaxo (39°9'N, 8°45'W), several caught and released.

Leiria Dist.—Serra d'El-Rei (39°20'N, 9°15'W), Obidos, 1 JP.

Lisboa Dist.—Pragança (39°12'N, 9°3'W), Cadaval, 1 JP and 6 MB; Assafora (38°54'N, 9°25'W), Sintra, 5 JP and 7 MB; near Lisboa, 7 MB.

Setúbal Dist.—Sesimbra (38°26'N, 9°6'W), 1 MB.

Lisboa, Santarém, or Portalegre Dists.—Ribatejo, 1 MB.

Other Records.—Gerês (Felten *et al.*, 1977); Vimioso (Braga, 1941); Resende (Braga, 1941); Malhapão (Themido, 1928); Coimbra (Ayres, 1914; Themido, 1928); Condeixa (Oliveira and Vieira, 1896; Seabra, 1900); Rio Maior (Braga, 1941); Sintra (Miller, 1912); Azeitão, Setúbal (Nobre, 1903).

RHINOLOPHUS MEHELYI

Aveiro Dist.—Malhapão (?40°31'N, 8°33'W), ? Anadia, 1 MZUC.

Coimbra Dist.—Coimbra (40°12'N, 8°25'W), 2 MZUC.

Lisboa Dist.—Near Lisboa, 14 MB.

Setúbal Dist.—Sesimbra (38°26'N, 9°6'W), 62 MB.

Beja Dist.—Rosário (37°36'N, 8°5'W), Castro Verde, several caught and released.

Faro Dist.—Rogil (37°22'N, 8°48'W), Aljezur, 21 JP; Furnazinhas (37°21'N, 7°35'W), Castro Marim, 7 JP; Pena (37°15'N, 8°5'W), Loulé, several caught and released; Querença (37°12'N, 7°59'W), Loulé, several caught and released; Mexilhoeira Grande (37°9'N, 8°30'W), Lagoa, several caught and released; Moncarapacho (37°7'N, 7°47'W), Olhão, 4 JP.

Lisboa, Santarém or Portalegre Dists.—Ribatejo, 4 MB.

Unknown Origin.—1 MB.

Other Records.—Coimbra (Themido, 1928); near Coimbra (Seabra, 1924); Legação Penela (Lindberg, 1962); Ribatejo (Almaça, 1964, 1966); near Lisboa (Almaça, 1966); Azeitão, Setúbal (Almaça, 1964); Lapa dos Morcegos, Arrábida (Lindberg, 1962); Sesimbra (Almaça, 1966).

MYOTIS MYOTIS

Bragança Dist.—Montezinho (41°56'N, 6°46'W), Bragança, 1 JP; Cova da Lua (41°53'N, 6°49'W), Bragança, 1 caught and released; Minas de Sto. Adrião (41°30'N, 6°26'W), Miranda do Douro, several caught and released.

Aveiro Dist.—Salreu (40°44'N, 8°33'W), Estarreja, 1 caught and released.

Guarda Dist.—Celorico da Beira (40°38'N, 7°23'W), 1 JP.

Coimbra Dist.—Bordalo (40°12'N, 8°27'W), Coimbra, 1 MZUC; Coimbra (40°12'N, 8°25'W), 5 MZUC; Condeixa (40°7'N, 8°30'W), 1 MB.

Castelo Branco Dist.—Cavalo (39°56'N, 7°58'W), Oleiros, 1 JP; Rio Ponsul (39°51'N, 7°20'W), Castelo Branco/Idanha-a-Nova, 1 JP.

Santarém Dist.—Ceras (39°42'N, 8°22'W), Tomar, 2 JP; Almonda (39°30'N, 8°37'W), Torres Novas, 1 JP and 2 MB; Amiais de Baixo (39°27'N, 8°43'W), Alcanena, 1 JP and many more caught and released.

Leiria Dist.—Porto de Mós (39°31'N, 8°45'W), 7 JP; Serra d' El-Rei (39°20'N, 9°15'W), Óbidos, 2 JP.

Portalegre Dist.—S. Salvador da Aramenha (39°21'N, 7°22'W), Marvão, 8 JP; Crato (39°17'N, 7°39'W), 1 JP.

Lisboa Dist.—Mafra (38°56'N, 9°20'W), 1 MB; Belas (38°46'N, 9°16'W), Sintra, 3 MB and 1 MZUC.

Évora Dist.—Lavre (38°46'N, 8°22'W), Montemor-o-Novo, 1 JP; Arraiolos (38°44'N, 7°57'W), 1 JP; Évora (38°34'N, 7°54'W), 2 MB.

Setúbal Dist.—Serra da Arrábida (38°30'N, 9°0'W) Setúbal, 1 JP and 3 MB.

Unknown Origin.—10 MZUC.

Other Records.—(Some of these old records may refer to *M. blythii*, and are therefore not included in the distribution map.) Ponte de Lima (Braga, 1941); Vimioso (Braga, 1941); Serra do Marão (Braga, 1941); Leça da Palmeira, Matosinhos (Braga, 1941); Resende (Braga, 1941); Paredes (Braga, 1941); Mogofores, Anadia (Seabra, 1900); Serra da Estrela (Seabra, 1900); Bussaco (Seabra, 1905); Coimbra (Ayres, 1914; Oliveira and Vieira, 1896; Themido, 1928); Alhadas, Figueira da Foz (Oliveira and Vieira, 1896; Themido, 1928); Condeixa (Seabra, 1900); Mafra (Seabra, 1900); Sintra

(Miller, 1912; Seabra, 1900); Alcochete (Seabra, 1910); Lisboa (Seabra, 1910); Évora (Seabra, 1900); Azeitão, Setúbal (Nobre, 1903; Seabra, 1900); Porto Covo, Sines (Engels, 1972).

MYOTIS BLYTHII

Bragança Dist.—Montezinho (41°56'N, 6°46'W), Bragança, 1 caught and released; Minas de Sto. Adrião (41°30'N, 6°26'W), Miranda do Douro, 7 JP.
Santarém Dist.—Amiais de Baixo (39°27'N, 8°43'W), Alcanena, 2 JP.
Lisboa Dist.—Pragança (39°12'N, 9°3'W), Cadaval, 1 JP.
Faro Dist.—Rogil (37°22'N, 8°48'W), Aljezur, 2 JP; Furnazinhas (37°21'N, 7°35'W), Castro Marim, 11 JP; Monchique (37°19'N, 8°33'W), 2 MZUC; Salir (37°15'N, 8°5'W), Loulé, 2 JP; Querença (37°12'N, 7°59'W), Loulé, 2 JP.
Unknown Origin.—1 MB.

MYOTIS DAUBENTONII

Braga Dist.—Albergaria, Gerês (41°48'N, 8°9'W), Terras de Bouro, 4 JP; Caldas do Gerês (41°44'N, 8°9'W), Terras de Bouro, 1 JP.
Coimbra Dist.—Coimbra (40°12'N, 8°25'W), 2 MZUC.
Castelo Branco Dist.—Ocreza (39°50'N, 7°36'W), Castelo Branco, 5 JP.
Santarém Dist.—Amiais de Baixo (39°27'N, 8°43'W), Alcanena, 8 JP; Pancas (38°49'N, 8°56'W), Benavente, JP.
Évora Dist.—Pavia (38°54'N, 8°1'W), Mora, 1 MB.
Setúbal Dist.—Zambujal (38°32'N, 8°41'W), Alcácer do Sal, 11 JP; Pinheiro (38°28'N, 8°43'W), Alcácer do Sal, 1 JP.
Faro Dist.—Aljezur (37°21'N, 8°51'W), 7 JP.
Other Records.—Gerês (Seabra, 1922); Coimbra (Themido, 1928).

MYOTIS EMARGINATUS

Coimbra Dist.—Coimbra (40°12'N, 8°25'W), 3 MZUC; Bordalo (40°12'N, 8°27'W), Coimbra, 5 MZUC.
Santarém Dist.—Amiais de Baixo (39°27'N, 8°43'W), Alcanena, 3 JP and many caught and released.
Beja Dist.—Santa Cruz (37°26'N, 7°55'W), Almodovar, 1 JP.
Other Records.—Coimbra (Themido, 1928).

MYOTIS MYSTACINUS

Specimens examined.—None.
Other Records.—Coimbra (Ayres, 1914; Seabra, 1922).

MYOTIS NATTERERI

Viseu Dist.—Oliveira de Frades (40°44'N, 8°11'W), 1 MB.
Coimbra Dist.—Coimbra (40°12'N, 8°25'W), 14 MZUC.
Guarda Dist.—Alvoco da Serra (40°18'N, 7°40'W), Seia, 1 MB.
Unknown Origin.—16 MZUC.
Other Records.—Oliveira dos Frades (Seabra, 1900); Alvoco da Serra da Estrela, Seia (Nobre, 1904); Coimbra (Themido, 1928); Rio Maior (Niethammer, 1970); Colares, Sintra (Seabra, 1910).

MYOTIS BECHSTEINII

Unknown Origin.—5 MB.
Other Records.—Ribatejo Prov. (Seabra, 1922); Cercal, Cadaval (Niethammer, 1970).

EPTESICUS SEROTINUS

Braga Dist.—Albergaria, Gerês (41°48'N, 8°9'W), Terras de Bouro, 1 JP; Caldas do Gerês (41°44'N, 8°9'W), Terras de Bouro, 1 JP; Serra da Cabreira (41°39'N, 8°6'W), Vieira do Minho, 3 JP.
Aveiro Dist.—Costa Nova (40°37'N, 8°45'W), Ílhavo, 1 JP; Vale da Mó (40°26'N, 8°22'W), Anadia, 2 JP.
Coimbra Dist.—Botão (40°18'N, 8°24'W), Coimbra, 2 MZUC.
Santarém Dist.—Amiais de Baixo (39°27'N, 8°43'W), Alcanena, 1 JP; Benavente (38°59'N, 8°48'W), 1 MB.
Lisboa Dist.—Castelo de S. Jorge, Lisboa (38°43'N, 9°6'W), 1 JP; Lisboa (38°43'N, 9°8'W), 3 MB; Jardim Botânico, Lisboa (38°43'N, 9°9'W), 1 MB.
Évora Dist.—Évora (38°34'N, 7°54'W), 1 JP; Portel (38°18'N, 7°43'W), 1 JP.
Setúbal Dist.—Setúbal (38°32'N, 8°45'W), 1 JP; Cotovia (38°29'N, 9°7'W), Sesimbra, 1 JP; Lagoa de Santo André (38°5'N, 8°47'W), Santiago do Cacém, 1 JP.
Beja Dist.—mouth of the Ribeira de Ardila (41°44'N, 8°9'W), Moura, 1 JP.
Faro Dist.—Salir (37°15'N, 8°5'W), Loulé, 1 JP.
Lisboa, Santarém, or Portalegre Dists.—Ribatejo, 13 MB.

Unknown Origin.—1 MZUC.

Other Records.—Botão, Coimbra (Oliveira and Vieira, 1896; Themido, 1928); Coimbra (Themido, 1928); Rio Maior (Niethammer, 1970); Espinheira, Cercal (Niethammer, 1970); Alcochete (Nobre, 1903); Lisboa (Seabra, 1900); Cascais (Seabra, 1900); Palmela (Nobre, 1903; Seabra, 1900); Setúbal (Seabra, 1900).

NYCTALUS LASIOPTERUS

Coimbra Dist.—Bussaco (40°23'N, 8°22'W), 1 MB; Coimbra (40°12'N, 8°25'W), 2 MZUC.

NYCTALUS NOCTULA

Évora Dist.—Pavia (38°54'N, 8°1'W), Mora, 1 MB.

NYCTALUS LEISLERI

Braga Dist.—Albergaria, Gerês (41°48'N, 8°9'W), Terras de Bouro, 2 JP.

Setúbal Dist.—Zambujal (38°32'N, 8°41'W), Alcácer do Sal, 2 JP.

Other Records.—? Marvão (Seabra, 1911); ? Alcochete (Seabra, 1910, 1911); Arrábida (Seabra, 1910, 1911, 1922).

PIPISTRELLUS PIPISTRELLUS

Viana do Castelo Dist.—Melgaço (42°7'N, 8°16'W), 1 MB.

Bragança Dist.—Cova da Lua (41°53'N, 6°49'W), Bragança, 1 caught and released; Bragança (41°49'N, 6°47'W), 1 JP; Rio Sabor (41°13'N, 7°5'W), 1 JP; Torre de Moncorvo (41°10'N, 7°3'W), 4 MB.

Braga Dist.—Albergaria, Gerês (41°48'N, 8°9'W), Terras de Bouro, 3 JP; Caldas do Gerês (41°44'N, 8°9'W), Terras de Bouro, 3 JP.

Vila Real Dist.—Barragem do Alto Rabagão (41°44'N, 7°53'W), Montalegre, 1 JP; Fafião (41°42'N, 8°5'W), Montalegre, 4 JP.

Porto Dist.—Amarante (41°16'N, 8°5'W), 1 MZUC.

Guarda Dist.—Celorico da Beira (40°38'N, 7°23'W), 1 JP.

Coimbra Dist.—Coimbra (40°12'N, 8°25'W), 4 MZUC.

Leiria Dist.—Caldas da Rainha (39°24'N, 9°8'W), 1 MB.

Portalegre Dist.—Azinhal (39°11'N, 7°21'W), Portalegre, 1 JP; Arronches (39°7'N, 7°16'W), Portalegre, 1 JP.

Lisboa Dist.—Mafra (38°56'N, 9°20'W), 5 JP; Queluz (38°45'N, 9°15'W), Sintra, 2 MB; Lisboa (38°43'N, 9°8'W), 1 JP; Estoril (38°42'N, 9°24'W), Cascais, 1 JP; Estádio Nacional (38°42'N, 9°16'W), Oeiras, 1 MB.

Évora Dist.—Juromenha (38°44'N, 7°14'W), Alandroal, 1 JP.

Setúbal Dist.—Cacilhas (38°41'N, 9°9'W), Almada, 1 JP; Alfeite (38°39'N, 9°8'W), Almada, 1 MB; Setúbal (38°32'N, 8°54'W), 1 JP; Zambujal (38°32'N, 8°41'W), Alcácer do Sal, 9 JP; Pinheiro (38°28'N, 8°43'W), Alcácer do Sal, 6 JP.

Beja Dist.—Moura (38°8'N, 7°27'W), 13 JP.

Faro Dist.—Ludo (37°2'N, 7°59'W), Faro, 4 JP; Olhão (37°2'N, 7°50'W), 2 JP.

Lisboa, Santarém or Portalegre Dists.—Ribatejo Prov., 10 MB.

Unknown Origin.—10 MZUC and 2 MB.

Other Records.—Valongo (Braga, 1941); Moncorvo (Nobre, 1903); Porto (Harrison, 1958); Vilar do Pinheiro, Vila do Conde (Nobre, 1903); Torrão, Marco de Canavezes (Nobre, 1904); Serra da Estrela (Cabrera, 1912); Coimbra (Ayres, 1914; Oliveira and Vieira, 1896); Alcochete (Seabra, 1910); Lisboa (Seabra, 1900); Alfeite (Seabra, 1900).

PIPISTRELLUS NATHUSII

Specimens Examined.—None.

Other Records.—Condeixa (Ayres, 1914); Mafra (Oliveira and Vieira, 1896; Seabra, 1900); Alcochete (Seabra, 1910).

PIPISTRELLUS KUHLII

Viseu Dist.—Sabugosa (40°34'N, 8°2'W), Tondela, 1 MB.

Lisboa Dist.—Sintra (38°48'N, 9°23'W), 1 JP.

Évora Dist.—Lavre (38°46'N, 8°22'W), Montemor-o-Novo, 1 JP; Portel (38°18'N, 7°42'W), 1 JP.

Setúbal Dist.—Serra da Arrábida (38°30'N, 8°59'W), Setúbal, 1 JP.

Other Records.—Chaves (Brunet-Lecomte and Delibes, 1982); Coimbra (Themido, 1928); Lagos (Bauer, 1956).

PIPISTRELLUS SAVII

Specimens Examined.—None.

Other Records.—Alvoco da Serra da Estrela (Seabra, 1900, 1905, 1910).

BARBASTELLA BARBASTELLUS

Setúbal Dist.—Zambujal (38°32'N, 8°41'W), Alcácer do Sal, 6 JP.

PLECOTUS AURITUS

Bragança Dist.—Serra da Nogueira (41°46'N, 6°53'W), Bragança, 2 JP.

Other Records.—Most or even all the existing records of *P. auritus* in Portugal are likely to refer to *P. austriacus*.

PLECOTUS AUSTRIACUS

Aveiro Dist.—Vale da Mó (40°26'N, 8°22'W), Anadia, 3 JP.

Guarda Dist.—Alvoco da Serra (40°18'N, 7°40'W), Seia, 1 MB.

Santarém Dist.—Ferreira do Zêzere (39°42'N, 8°18'W), 1 JP.

Portalegre Dist.—Flor da Rosa (39°18'N, 7°39'W), Crato, 1 JP.

Lisboa Dist.—Sintra (38°47'N, 9°24'W), 1 JP; Lisboa (38°43'N, 9°8'W), 1 MB.

Setúbal Dist.—Cotovia (38°29'N, 9°7'W), Sesimbra, 1 JP; Pinheiro (38°28'N, 8°43'W), Alcácer do Sal, 1 JP.

Beja Dist.—Moura (38°8'N, 7°27'W), 2 JP.

Faro Dist.—Monchique (37°19'N, 8°33'W), 1 BMNH.

Lisboa, Santarém, or Portalegre Dists.—Ribatejo Prov., 1 MB.

Other Records.—Mafra (Lanza, 1960); Ribatejo Prov. (Corbet, 1964); Monchique (Dulic, 1980).

MINIOPTERUS SCHREIBERSII

Bragança Dist.—Minas de Sto. Adrião (41°30'N, 6°26'W), Miranda do Douro, 1 JP and many more caught and released.

Coimbra Dist.—Bordalo (40°12'N, 8°27'W), Coimbra, 3 MZUC; Coimbra (40°12'N, 8°25'W), 1 MZUC; Condeixa (40°7'N, 8°30'W), 3 MB and 2 MZUC.

Santarém Dist.—Tomar (39°36'N, 8°25'W), 1 JP and many more caught and released; Almonda (39°30'N, 8°37'W), Torres Novas, 2 MB; Amiais de Baixo (39°27'N, 8°43'W), Alcanena, 17 JP and many more caught and released; Cartaxo (39°9'N, 8°45'W), several caught and released.

Leiria Dist.—Porto de Mós (39°31'N, 8°45'W), 3 JP; Serra d'El-Rei (39°20'N, 9°15'W), Obidos, 3 JP.

Lisboa Dist.—Pragança (39°12'N, 9°3'W), Cadaval, 3 MB and 1 JP; Belas (38°46'N, 9°16'W), Sintra, 1 MZUC; Belas (38°46'N, 9°16'W) and Benfica (38°45'N, 9°12'W), Sintra, 22 MB; Barcarena (38°44'N, 9°17'W), Oeiras, 5 MB; Jardim Botânico, Lisboa (38°43'N, 9°9'W), 1 caught and released.

Portalegre Dist.—S. Salvador da Aramenha (39°21'N, 7°22'W), Marvão, 2 JP.

Setúbal Dist.—Seixal (38°38'N; 9°6'W), 1 JP; Serra da Arrábida (38°30'N, 9°0'W), 2 JP.

Beja Dist.—Preguiça (38°2'N, 7°18'W), Moura, several caught and released.

Faro Dist.—Aljezur (37°21'N, 8°51'W), 1 JP; Pena (37°15'N, 8°5'W), Loulé, several caught and released; Querença (37°12'N, 7°59'W), Loulé, 1 JP.

Lisboa, Aveiro or Castelo Branco Dists.—Idanha, 1 MB.

Unknown Origin.—13 MZUC.

Other Records.—Vimioso (Braga, 1941); Serra do Valongo (Nobre, 1903); Coimbra (Themido, 1928); near Coimbra (Nobre, 1903); Bordalo, Coimbra (Themido, 1928); Condeixa (Oliveira and Vieira, 1896; Seabra, 1900; Themido, 1928); Legação, Penela (Lindberg, 1962); Almonda, Torres Novas (Lindberg, 1962); Alcochete (Seabra, 1910); Lapa dos Morcegos, Arrábida (Lindberg, 1962); Soidos, Alte, Loulé (Braga, 1941; Lindberg, 1962).

TADARIDA TENIOTIS

Coimbra Dist.—Coimbra (40°12'N, 8°25'W), 8 MZUC.

Lisboa Dist.—Sintra (38°48'N, 9°23'W) 1 MB.

Unknown Origin.—2 MZUC.

Other Records.—Chaves (Brunet-Lecomte and Delibes, 1982); Covilhã (Seabra, 1910); Coimbra (Ayres, 1914; Oliveira and Vieira, 1896; Seabra, 1900; Themido, 1928); Sintra (Miller, 1912; Seabra, 1900); Alcochete (Seabra, 1910, 1911).

69. The *Eleutherodactylus* of the Amazonian slopes of the Ecuadorian Andes (Anura: Leptodactylidae). By John D. Lynch and William E. Duellman. Pp. 1–86, 8 text-figures. August 29, 1980. Paper bound.

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80. Phylogenetic studies of north american minnows, with emphasis on the genus *Cyprinella* (Teleostei: Cypriniformes). By Richard L. Mayden. Pp. 1–189, 85 text-figures, 4 color plates. June 1, 1989. Paper bound. ISBN: 0–89338–029–6.

81. A phylogenetic analysis and taxonomy of iguanian lizards (Reptilia: Squamata). By Darrel R. Frost and Richard Etheridge. Pp. 1–65, 24 text-figures, 3 appendices. September 28, 1989. Paper bound. ISBN: 0–89338–033–4.