= Myotis alcathoe =

Myotis alcathoe is a European bat in the genus Myotis . Known only from Greece and Hungary when it was first described in 2001 , its known distribution has since expanded to Spain , England , Sweden , and Azerbaijan , among other countries . It is similar to the whiskered bat (Myotis mystacinus) and other species and is difficult to distinguish from them . However , its brown fur is distinctive and it is clearly different in characters of its karyotype and DNA sequences . Although some genetic data suggest that it is related to Geoffroy 's bat (Myotis emarginatus) , other analyses do not support a close relationship between M. alcathoe and any other species .

With a forearm length of 30 @.@ 8 to 34 @.@ 6 mm (1 @.@ 21 to 1 @.@ 36 in) and body mass of 3 @.@ 5 to 5 @.@ 5 g (0 @.@ 12 to 0 @.@ 19 oz) , Myotis alcathoe is a small bat . The fur is usually reddish @-@ brown on the upperparts and brown below , but more grayish in juveniles . The tragus (a projection on the inner side of the ear) is short , as is the ear itself , and the inner side of the ear is pale at the base . The wings are brown and the baculum (penis bone) is short and broad . M. alcathoe has a very high @-@ pitched echolocation call , with a frequency that falls from 120 kHz at the beginning of the call to about 43 kHz at the end .

Usually found in old @-@ growth deciduous forest near water , Myotis alcathoe forages high in the canopy and above water and mostly eats flies . The animal roosts in cavities high in trees . Although there are some winter records from caves , it may also spend the winter in tree cavities . Several parasites have been recorded on M. alcathoe . The IUCN Red List assesses Myotis alcathoe as " Data Deficient " , but it is considered threatened in several areas because of its rarity and vulnerability to habitat loss .

= = Taxonomy = =

The whiskered bat (Myotis mystacinus) and similar species in Eurasia (collectively known as " whiskered bats ") are difficult to distinguish from each other ; for example , the distantly related Brandt 's bat (Myotis brandtii) was not recognized as distinct from M. mystacinus until the 1970s . Small , unusual M. mystacinus @-@ like bats were first recorded in Greece in the 1970s , but it was not until the advent of genetic studies that these bats could be confirmed as representing a distinct species , named Myotis alcathoe . In 2001 , the species was described by German zoologists Otto von Helversen and Klaus @-@ Gerhard Heller on the basis of specimens from Greece and Hungary . Although it also differs from other whiskered bats by morphological characters , Myotis alcathoe is most clearly distinct in its genetics , including DNA sequences and the location of the nucleolus organizer regions . Two studies used microsatellites markers on european whiskered bats : the first one used West @-@ europeans smples and recovered three well @-@ defined species clusters for M. alcathoe , M. brandtii and M. mystacinus , the other one , conducted in Poland , suggesting a high level of hybridization with other whiskered bats that would further complicates attempts to identify M. alcathoe morphologically .

Von Helversen and Heller argued that none of the old names now considered synonyms of M. mystacinus could apply to M. alcathoe , because these names all have their type localities in western or central Europe . However , the more recent discovery of M. alcathoe further to the west renders it possible that an older name may be discovered . In addition , Russian researcher Suren Gazaryan has suggested that the name caucasicus Tsytsulina , 2000 (originally proposed for a subspecies of M. mystacinus from the Caucasus) may prove to be applicable to M. alcathoe ; in that case , the species would be renamed Myotis caucasicus . The species may have remained undetected in Germany for so long because bat researchers did not sample its preferred habitats and would dismiss unusual @-@ looking whiskered bats as being abnormal M. mystacinus or M. brandtii .

On the basis of mitochondrial DNA sequence analysis , Myotis alcathoe first appeared close to Geoffroy 's bat (Myotis emarginatus) of southern Europe , North Africa , and southwestern Asia . However , a study of the mitochondrial cytochrome b gene incorporating many Myotis species did not support this relationship , and could not place M. alcathoe securely at a specific position among

Eurasian Myotis . Two groups with slightly divergent mitochondrial DNA sequences (separated by 1 @.@ 3 to 1 @.@ 4 % sequence divergence) are distinguishable within the species , which probably correspond to different glacial refugia where M. alcathoe populations survived the last glacial period . One , known as the " Hungarian " group , has been recorded from Spain , France , Austria , Hungary , and Slovakia , and probably corresponds to a refugium in Iberia ; the other , the " Greek " group , is known only from Greece and Slovakia .

The specific name , alcathoe , refers to Alcathoe , a figure from Greek mythology who was turned into a bat when she refused the advances of the god Dionysus . She was associated with gorges and small streams , the preferred habitat of Myotis alcathoe in Greece . In their original description , von Helversen and colleagues described her as a nymph , and the common name " nymph bat " has therefore been used for this species . However , none of the classical sources speak of Alcathoe as a nymph ; instead , she was a princess , the daughter of King Minyas of Orchomenos . Therefore , Petr Benda recommended in 2008 that the common name " Alcathoe bat " or " Alcathoe myotis " be used instead . Other common names include " Alcathoe 's bat " and " Alcathoe whiskered bat " .

= = Description = =

Myotis alcathoe is the smallest European Myotis species . The fur is brownish on the upperparts , with a reddish tone in old specimens , and a slightly paler gray @-@ brown below . Younger animals may be completely gray @-@ brown . The brown fur distinguishes adult M. alcathoe from other whiskered bats , but juveniles cannot be unambiguously identified on the basis of morphology . M. alcathoe is similar to Daubenton 's bat (Myotis daubentonii) and M. emarginatus in color . On the upper side of the body , the hairs are 6 to 8 mm long and have dark bases and brown tips . The hairs on the lower side of the body are only slightly paler at the tip than at the base .

The face and the upper lips are reddish to pink , not dark brown to black as in M. mystacinus . Although most of the face is hairy , the area around the eyes is bare . The nostrils are heart @-@ shaped , and their back end is broad , as in M. brandtii , not narrow as in M. mystacinus . Several glands are present on the muzzle , most prominently in reproductively active males . The ears are brown and are lighter on the inside than the outside . There is a notch at the edge of the ear , and the pointed tragus (a projection inside the ear that is present in some bats) extends up to this notch ; the tragus is longer , extending beyond the notch , in both M. brandtii and M. mystacinus . The base of the inner side of the ear is white ; it is much darker in M. mystacinus . The feet and the thumbs are very small . The small size of the ear , tragus , feet , and thumb distinguishes M. alcathoe from the slightly larger M. mystacinus and M. brandtii , but the feet are relatively larger than in M. mystacinus .

The wings are brown , but lighter than those of M. mystacinus . The plagiopatagium (the portion of the wing between the last digit and the hindlegs) is attached to the fifth toe . The tail extends only about 1 mm beyond the back margin of the uropatagium (the portion of the wing membrane between the hindlegs) . The calcar , a cartilaginous spur supporting the uropatagium , is slender . With a width around 1 @.@ 3 mm , the penis is narrow , and it lacks a broadened tip (except in one Croatian specimen) . The baculum (penis bone) is about 0 @.@ 5 mm long . The short and broad shape of this bone distinguishes M. alcathoe from M. brandtii as well as M. ikonnikovi .

The skull is similar in shape to that of M. mystacinus and M. brandtii , but the front part of the braincase is higher . The second and third upper premolars (P2 and P3) are tiny and pressed against the upper canine (C1) and fourth premolar (P4) . The canine is less well @-@ developed than in M. mystacinus . There is a clear cusp present on the side of the P4 . The accessory cusp known as the protoconule is present on each of the upper molars when they are unworn . M. mystacinus lacks the P4 cusp and the protoconules on the molars , but M. brandtii has an even larger cusp on P4 .

As usual in Myotis species , Myotis alcathoe has a karyotype consisting of 44 chromosomes , with the fundamental number of chromosomal arms equal to 52 . However , a 1987 study already found that M. alcathoe (then called " Myotis sp . B ") differs from both M. mystacinus and M. brandtii in the pattern of active nucleolus organizer regions on the chromosomes . M. alcathoe also differs from

other Myotis species in the sequences of the mitochondrial genes 12S rRNA and NADH dehydrogenase subunit 1 by at least 5 % and 13 % , respectively .

Myotis alcathoe has the highest @-@ frequency echolocation call of any European Myotis . In open terrain , the call has an average duration of 2 @.@ 5 ms , but it may be up to 4 ms long . At the beginning , its frequency is around 120 kHz , but it then falls fast , subsequently falls slightly slower , and at the end falls faster again . The call reaches its highest amplitude at around 53 kHz . It terminates at around 43 to 46 kHz ; this characteristic is especially distinctive . In different experiments , the time between calls was found to be around 85 and 66 ms , respectively . The high @-@ pitched call may be an adaptation to the animal 's occurrence in dense vegetation .

Head and body length is about 4 cm (1 @.@ 6 in) and wingspan is around 20 cm (7 @.@ 9 in) . Forearm length is 30 @.@ 8 to 34 @.@ 6 mm (1 @.@ 21 to 1 @.@ 36 in) , tibia length is 13 @.@ 5 to 15 @.@ 9 mm (0 @.@ 53 to 0 @.@ 63 in) , hindfoot length is 5 @.@ 1 to 5 @.@ 8 mm (0 @.@ 20 to 0 @.@ 23 in) , and body mass is 3 @.@ 5 to 5 @.@ 5 g (0 @.@ 12 to 0 @.@ 19 oz) .

= = Distribution and habitat = =

Although Myotis alcathoe was initially known only from Greece and Hungary and was thought to be restricted to southeastern Europe , records since then have greatly expanded its range , and it is now known from Spain and England to Sweden and European Turkey . In several European countries , focused searches were conducted to detect its occurrence . Its habitat generally consists of moist , deciduous , mature forest near streams , for example in ravines or in alluvial forest (forest near a river) , where there are many decaying trees that the bat can use as roosting sites . In Germany , its preferred habitat consists of mixed deciduous forest . In the south of the continent , it usually occurs in mountain ranges , but the factors affecting its distribution in the north are less well known . Its range appears to be similar in shape to those of the greater and lesser horseshoe bats (Rhinolophus ferrumequinum and R. hipposideros) and Myotis emarginatus . It may yet be found in other European countries , such as the Benelux countries , Ireland , and Moldova . Although there are abundant records from some areas , such as France and Hungary , the species appears to be rare in most of its range .

Known records are as follows :

Albania

A single specimen was caught in 2006 in a forest of planes (Platanus orientalis) and poplars (Populus spp .) next to a small stream . M. mystacinus was recorded at the same place .

Austria

Three specimens of Myotis alcathoe were recorded in Burgenland , southeastern Austria , in 2006 . They were caught near fishponds in a region dominated by oak (Quercus petraea) and hornbeam (Carpinus betulus) .

Azerbaijan

The species was recorded around 2009 .

Belgium

The species is known from the 31 of July 2011 in two places around the city of Rochefort .

Bulgaria

The species is known from six localities in the south and west of the country ; the first record dates from 2003 . Habitats include river and mountain forests .

Caucasus

Bats collected in the Russian part of the Caucasus and in Abkhazia (a breakaway part of Georgia) from 2003 to 2009 may represent Myotis alcathoe . They are small and morphometrically distinct from other local Myotis mystacinus @-@ like bats . The affinity of these bats to M. alcathoe has recently been confirmed by the genetic and morphological analyses .

Croatia

In 2003 , Myotis alcathoe was recorded here on the basis of two specimens ; three additional specimens were found in 2004 .

Czech Republic

Here , the species was recorded at nine sites clustered in three regions , with the first record dating from 2001 , in addition to records from roadkilled specimens at three further sites . The typical habitat was mature oak @-@ hornbeam forest near water with dead , decaying trees , at altitudes ranging from 170 to 390 m (560 to 1 @,@ 280 ft) . Both M. mystacinus and M. brandtii occur in some of the same places in this country . M. alcathoe has a limited , patchy distribution within the country , but reaches a high abundance in suitable habitat .

France

Myotis alcathoe was informally recognized in France in 2000 as a small Myotis similar to Myotis mystacinus , the " Murin cantalou " ; in 2002 , it was realized that this bat represents Myotis alcathoe . A large number of sites are known , mostly in the north of the country . The species reaches altitudes of up to 2 @,@ 000 m (6 @,@ 600 ft) . It is usually found close to water , but it has been found in a variety of habitats , including farmlands , swamps , forests , and wooden grounds . In late summer and autumn , it occurs in caves .

Germany

The species is known from two different areas in the country . In 2005 and 2006 , specimens were caught in an old moist forest near the Rhine in western Baden @-@ Württemberg . Two other bats were found in highway tunnels close to this site . The species is also known from the Kyffhäuser hill range of Thuringia in central Germany , an island of relatively warm habitat with some unusual wildlife . There , bats were caught near a spring in a karst landscape amid oak @-@ dominated deciduous forest . The species was also recorded in deciduous forest at a former Soviet military training site in eastern Thuringia . Myotis alcathoe has also been recorded in the nearby states of Saxony @-@ Anhalt and Saxony , where it occurs in mixed deciduous forest . Many Saxony @-@ Anhalt records are from near water . However , the species was also recorded in the center of the city of Chemnitz in Saxony .

Greece

The species has been recorded in the Pindus and Rhodopi Mountains of central and northern Greece . Here , Myotis alcathoe is usually found in stands of plane or alder trees next to small streams in ravines . The bat hunts close to the trees , within the stand . It is often found together with the lesser horseshoe bat and with M. mystacinus .

Hungary

Myotis alcathoe is not uncommon in the mountain forests of northeastern Hungary . It has been found at brooks and lakes in oak , beech , alder , and hornbeam (Carpinetum) forests at 230 to 670 m (750 to 2 @,@ 200 ft) altitude . Both M. brandtii and M. mystacinus occur together with M. alcathoe there .

Italy

Myotis alcathoe has been recorded in beech forest in Majella National Park in the region of Abruzzo . Additional specimens of Myotis alcathoe have been identified in Italy using molecular methods . In December 2013 its presence has been confirmed in the protected area of Appennino Lucano National Park (Basilicata) .

Latvia

A small Myotis was captured at a cave in Latvia between 2007 and 2010 ; pending genetic testing , it is suspected to be M. alcathoe . However , this record had not been confirmed in the subsequent national report to EUROBATS in 2014 .

Luxembourg

A single male was caught in 2011 and confirmed as M. alcathoe on the basis of genetic data . Elsewhere in the country it has been recorded on the basis of acoustic data .

Poland

The species was recorded in four caves in southern Poland in 2005 and 2006 , and later at several other sites in the south of the country . It is known from 182 to 1 @,@ 294 m (597 to 4 @,@ 245 ft) above sea level , most often in beech forest (Fagus sylvatica) , but also in several other forest types .

Romania

A single Myotis alcathoe was captured in 2007 in a nature reserve in the eastern Carpathians ; the reserve contains riverine and conifer forest . The species was additionally recorded in a forested valley containing a small stream in Alba County .

Serbia

The species was reported on the basis of three specimens shortly before 2009 , but is probably rare .

Slovakia

Here , Myotis alcathoe is known from a single site , a cave in old deciduous forest at 525 m (1 @,@ 722 ft) altitude .

Slovenia

A single specimen was recorded in Slovenia in 2007 .

Spain

In Catalonia , the species is known from six sites , ranging from sea level to 1 @,@ 200 m (3 @,@ 900 ft) altitude . It is known in beech and riverine forest and was first recorded in 2006 . The species is known from three sites in La Rioja , where it was recorded in 2004 , and occurs amidst beech and riverine forest at 790 to 1 @,@ 390 m (2 @,@ 590 to 4 @,@ 560 ft) altitude . It has also been found at seven localities in Navarre , with the first record dating from 2004 . There , it occurs in beech and oak forest at altitudes from 140 to 980 m (460 to 3 @,@ 220 ft) . In Galicia , it is known from three localities at 300 to 680 m (980 to 2 @,@ 230 ft) above sea level .

Sweden

The species was recorded at five sites in the south of the country , starting in 2008 , on the basis of echolocation calls .

Switzerland

Myotis alcathoe has been recorded from the Col du Marchairuz in the Jura Mountains (canton of Vaud) . The species is acoustically detected in 2003 in the canton of Geneva , and subsequent captures led to the discovery of the first breeding sites for the country .

Turkey

Eight individuals have been caught at three sites in close vicinity in the European part of the country in 2006 .

Ukraine

In 2009 , the possible occurrence of Myotis alcathoe in Ukraine was recorded . In 2011 , the species was definitively recorded there on the basis of two bats caught in the far southwest of the country in 2009 .

United Kingdom

Myotis alcathoe has been recorded in England since 2003 , and is known from two swarming sites in the south and a third site in the north of the country . The northern England site , in Ryedale , is in a protected area with many old trees , and the southern sites (in Sussex) are in woodland .

The species is also known from Montenegro and possibly from Bosnia and Herzegovina . Early records of Myotis ikonnikovi ? now known to be an eastern Asian species ? from Ukraine , Bulgaria , and Romania may also pertain to this species . Because whiskered bats in many cases cannot easily be distinguished from each other without the use of genetic methods , some listings do not differentiate between them ; records of Myotis alcathoe and / or M. mystacinus and / or (in some cases) M. brandtii have been reported from Bulgaria , Belgium , and Montenegro .

= = Ecology and behavior = =

Myotis alcathoe is a rare species with narrow ecological requirements . According to a study in the Czech Republic , the diet of Myotis alcathoe mostly consists of nematoceran flies , but caddisflies , spiders , small lepidopterans , and neuropterans are also taken . The presence of spiders in the diet suggests that the species gleans prey from foliage . It forages mainly high in the canopy and over water , and is often found in dense vegetation . The parasitic mite Spinturnix mystacina has been found on M. alcathoe , and the mites on M. alcathoe , M. brandtii , and M. mystacinus are genetically closely related . The bat fly Basilia mongolensis nudior has been recorded on M.

alcathoe in Thuringia and the tick Ixodes vespertilionis in Romania . When caught , individuals of Myotis alcathoe are much calmer than M. mystacinus or M. brandtii .

Myotis alcathoe lives in small groups . In Greece , a maternity colony , containing three females and two juveniles , has been found in a plane tree . Additional roosts were found high in oak trees in Baden @-@ Württemberg and Saxony @-@ Anhalt . Twenty @-@ seven roosting sites have been found in the Czech Republic , all but one in trees (the last was in a concrete pole) . Most of the tree roosts were in oaks (Quercus robur) ; others were in limes (Tilia cordata) , birches (Betula pendula) , and various other species . Its strong preference for roosting sites in trees is unusual among European bats . Roosts tend to be located high in the canopy , and are often in old trees . In summer , roosts may contain large groups of up to 80 individuals , but autumn roosts in the Czech Republic are occupied by smaller groups . M. alcathoe swarms from late July to mid @-@ September in southern Poland .

In Saxony @-@ Anhalt , the species forages deep in valleys when temperatures are above 10 ° C (50 ° F) , but on warmer slopes or rocky areas when it is colder . There , Myotis alcathoe is relatively easy to capture in August , because M. brandtii and M. mystacinus already start swarming in late July . Although there are some records of Myotis alcathoe in caves during the winter , it is also possible that animals spend the winter in tree cavities , and whether swarming behavior occurs in Myotis alcathoe is unclear . An animal found in a cave in Saxony @-@ Anhalt in January was not sleeping deeply . Reproduction may also take place in caves , but pregnant females have been found as late as June . Relatively many juveniles are caught between July and September . In England , one individual of M. alcathoe was captured in 2003 (and identified at the time as M. brandtii) and again in 2009 . Three individuals that were telemetrically tracked (in eastern France , Thuringia , and Baden @-@ Württemberg , respectively) moved only 800 m (2 @,@ 600 ft) , 935 m (3 @,@ 068 ft) , and 1 @,@ 440 m (4 @,@ 720 ft) from their night quarters ; M. brandtii and M. mystacinus tend to move over longer distances . A study in Poland suggested frequent hybridization among M. alcathoe , M. brandtii , and M. mystacinus sharing the same swarming sites , probably attributable to male @-@ biased sex ratios (1 @.@ 7 : 1 in M. alcathoe) , a polygynous mating system , and the high number of bats at swarming sites . M. alcathoe showed a particularly high proportion of hybrids , perhaps because it occurs at lower densities than the other two species .

= = Conservation status = =

Because Myotis alcathoe remains poorly known , it is assessed as " Data Deficient " on the IUCN Red List . However , it may be endangered because of its narrow ecological preferences . Reservoir construction may threaten the species ' habitat in some places ; two Greek sites where it has been recorded have already been destroyed . Forest loss is another possible threat , and the species may be restricted to undisturbed habitats . Because of its patchy distribution and likely small population , it probably does not easily colonize new habitats . The species is protected by national and international measures , but the IUCN Red List recommends further research on various aspects of the species as well as efforts to increase public awareness of the animal . In addition , old forests need to be conserved and the species ' cave roosts need to be protected .

In Catalonia , the species is listed as " Endangered " in view of its apparent rarity there . The Red List of Germany 's Endangered Vertebrates lists Myotis alcathoe as " Critically Endangered " as of 2009 . In the Genevan region , the species is also listed as " Critically Endangered " as of 2015 . In Hungary , where the species is probably not uncommon in suitable habitat , it has been protected since 2005 . However , the species is declining there and is threatened by habitat loss and disturbance of caves .