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Biogeography of the recently described *Myotis alcathoe* von Helversen and Heller, 2001

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Since its description in 2001 Alcathoe's myotis (*Myotis alcathoe*) was recorded from several locations across Europe. Here we describe the first records of this species from Germany, Poland, Albania, and from the European part of Turkey, including the northernmost locality in central Germany (51°23'N, 11°01'E). Compilation of all up-to-date records shows that *M. alcathoe* has a wide European distribution although it seems to be rare at most places. The habitats where the bat was recorded are natural, moist and deciduous forests with old trees and water streams as can be found, for example, in canyons or forests of alluvial origin. Such habitats suggest that the species probably has a more continuous and wider distribution than currently known and might be expected to occur even further to the North.

Key words: *Myotis alcathoe*, biogeography, ecology

Introduction

The *Myotis mystacinus* group has recently attracted attention of several taxonomists because it comprises numerous taxa that are morphologically cryptic and whose taxonomic status is unclear (Benda and Tsytsulina, 2000; Helversen *et al.*, 2001; Benda and Karataş, 2005). Even genetically distantly related species like *Myotis mystacinus* and *M. brandtii* (Ruedi and Mayer, 2001) were not recognized as two separate species for a long time. Differences in the shape of bacula (Topál, 1958) and of other morphological characters (e.g., Hanák, 1965, 1970, 1971) finally led to the acceptance of *M. brandtii* as an independent species (Gauckler and Kraus, 1970). Based on morphological characters Benda and Tsytsulina (2000) proposed *Myotis aurascens* as new species whose taxonomic status remains equivocal even today (Helversen *et al.*, 2001; Mayer and Helversen, 2001; Benda and Karataş, 2005; Mayer *et al.*, 2007). The combination of morphological and genetic methods led to the description of another species from the *M. mystacinus* group — *Myotis alcathoe* (Helversen *et al.*, 2001). An unambiguous identification of this species can be done by mitochondrial DNA sequencing but the combination of several morphological characters also allows its identification (Dietz and Helversen, 2004). A detailed summary of the systematic history of the *M. mystacinus* group can be found in Benda and Karataş (2005).

Myotis alcathoe was initially found in Greece and northern Hungary (Helversen *et al.*, 2001; Helversen, 2004). Meanwhile, several records were reported from other geographic regions, including Slovakia (Benda *et al.*, 2003), Bulgaria (Schunger *et al*., 2004), France (Ruedi *et al.*, 2002), Switzerland (Stadelmann *et al.*, 2004) and Spain (Agirre-Mendi *et al.*, 2004). In this paper we describe the first findings of *M. alcathoe* from Germany, Poland, Albania, and Turkey. In addition we compile a list of all available records of this species to infer its geographic distribution and habitat use.

Materials and Methods

We compiled a list of all available records of *M. alcathoe* (see Appendix). Bats were identified using either morphological characters, mitochondrial DNA sequences or both methods. The following combination of morphological characters was taken into account to distinguish *M. alcathoe* from *M. mystacinus* and *M. brandtii*: forearm length, the length of tragus in relation to the length of the notch in the lateral margin of auricle, and colouration of hair, facial skin, ears, tragi, and wing membrane (e.g., Benda *et al.*, 2003; Dietz and Helversen, 2004). Genetic identification was carried out by sequencing a fragment of at least 350 bp of the mitochondrial ND1 gene that codes for the subunit 1 of the protein NADH dehydrogenase. Methodological details are given in Mayer and Helversen (2001). In some cases, however, records were confirmed by sequencing other mitochondrial genes (cytochrome *b* or 12S rDNA) — these records are specified in Appendix. Findings based solely on recordings of echolocation calls were not taken into consideration because it is unknown how reliably echolocation calls of *M. alcathoe* can be distinguished from other species.

Results

Myotis alcathoe was recorded for the first time in Albania, Germany, Poland and in the European part of Turkey. Additional records were made in Bulgaria, Hungary and France, and many more may be expected within the present species range.

Albania

A subadult male *M. alcathoe* was captured in a riparian forest of oriental planes (*Platanus orientalis*) and poplars (*Populus* spp.) in the Vjoses valley about 1 km south of Tepelene in August 2006. The mist net was set across a small branch of the river surrounded by old trees. Individuals of

Myotis mystacinus bulgaricus were also caught at the same location.

Bulgaria

The species was recorded for the first time in 2003 (Schunger *et al.*, 2004). Meanwhile it was registered at six locations in southern and eastern Bulgaria according to genetically examined captured individuals or museum specimens. Further records are based on morphological characters only. All these records come from riparian forests, mountain forests or swarming sites. One specimen was found dead (traffic casualty).

France

Myotis alcathoe has been recorded from France since 2000 (Jourde, 2000). The species occurs throughout the country. Most individuals were identified morphologically. It seems to be more widespread in its northern part, although recordings of echolocation calls indicate a wider distribution in the South of France. The species has been recorded up to 2,000 m a.s.l. It appears to occupy a broad spectrum of habitats including swamps, hedged farmland, wooden grounds and mixed and deciduous forests. Most records come from places close to water, but the species seems to occur in a variety of rich environments that are also exploited by other bat species. At the end of summer and in autumn, the species was caught at the entrance of caves. Reproduction has been established from most French regions by catching lactating females or juveniles.

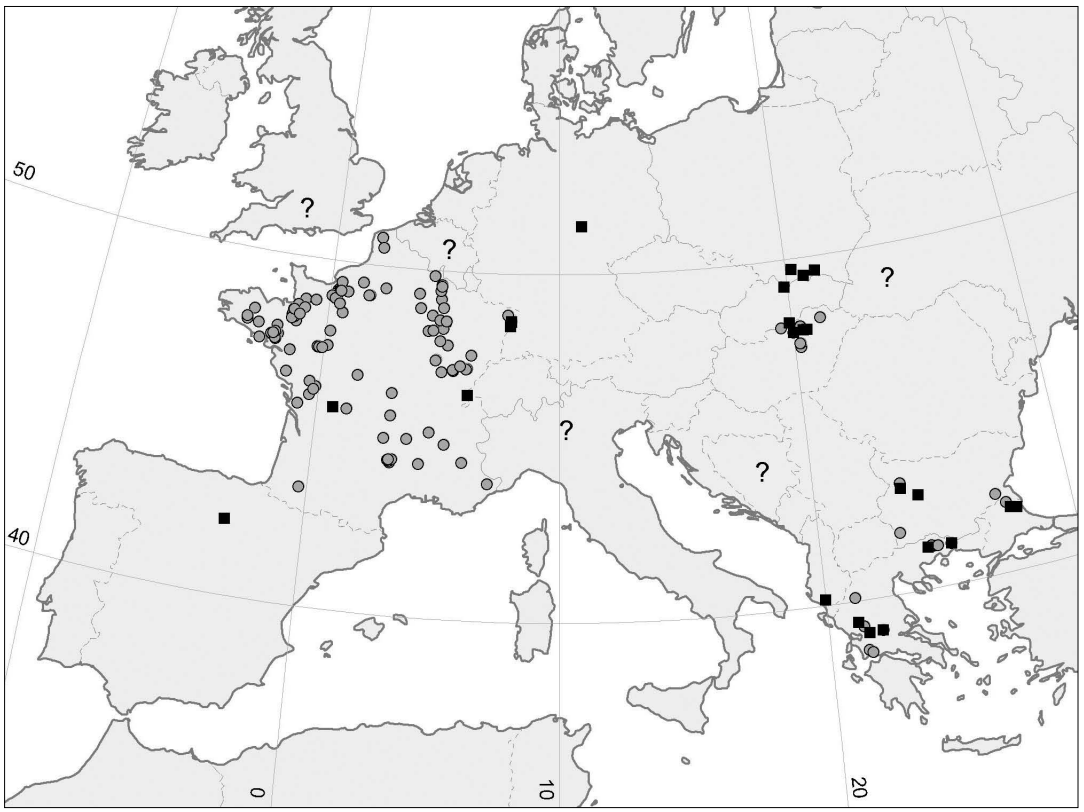

FIG. 1. Distribution of *M. alcathoe* in Europe. Circles refer to records based on morphological characters and squares indicate records that were genetically confirmed. Question marks indicate geographic regions where we expect the occurrence of *M. alcathoe*. Details on each record are given in Appendix

Germany

The first individual of *M. alcathoe* collected from Germany was a lactating female mist-netted on June 28, 2005 across a path in a deciduous, moist and old forest close to Rheinau in south-western Germany (federal state Baden-Württemberg) next to the border of France. The forest (440 ha, 130 m a.s.l.) is dominated by oaks (*Quercus robur*) and surrounded by fields, grassland and watercourses. The river Rhine with remains of alluvial forests is only 5 km apart. In addition to the first female, six males (3 adults and 3 subadults) were captured at the same location in 2006. Two additional individuals (adult male and adult female) were recorded in two different tunnels under a highway approximatelly 15 km south of the previous site.

The northernmost record of *M. alcathoe* refers to three bats (adult male, adult female and subadult male) that were mist-netted on August 16, 2006 in the lower mountain range Kyffhäuser (51°23'N, 11°02'E) in the federal state Thüringen. These bats were captured near a spring (170 m a.s.l.) in a gypsum karst landscape. The site is surrounded by a xerothermic deciduous forest with many oaks. Prior to the description of *M. alcathoe* several '*Myotis brandtii*' with suspiciously short forearm lengths (< 33 mm) were caught in the same region in 1998. These individuals likely represent *M. alcathoe*, and may suggest a common occurrence of this species in the study area.

Hungary

New records of *M. alcathoe* refer to mountains in northern Hungary, where the species was previously recorded (Helversen *et al.*, 2001; Estók *et al.*, 2006). Most Hungarian records were made by mist-netting in cluttered habitats near small lakes and brooks in mountainous forests (including oak forest *Quercetum petraeae-cerris*, hornbeam-oak mixed forest *Querco petraeae-Carpinetum*, submontane beech forests *Melittio-Fagetum*, montane beech forest *Aconito-Fagetum*, and alder association *Aegopodio-Alnetum*) or at swarming caves at altitudes between 230–670 m a.s.l. It seems that *M. alcathoe* is not a rare species in the forests of North-East Hungary, where it occurs syntopically with *M. mystacinus* and *M. brandtii*.

Poland

Between late July and late September in 2005 and 2006, 19 bats were captured in four caves in southern Poland at an altitude of 770 to 1294 m (Appendix). Their measurements (in mm, otherwise stated) were as follows: forearm length 28.4–33.4 (n = 10); thumb length 4.0–4.5 (n = 7); thumb claw length 1.6–1.8 (n = 7); 3rd finger length 44.7–53.1 (n = 7); 5th finger length 34.6–41.5 (n = 7); hind foot length 5.2–5.7 (n = 7); body mass 3.2–4.7 g (n = 10). These specimens were assigned to *M. alcathoe* according to morphological characters. Ten of these specimens were analysed genetically, confirming their specific identification. *Myotis mystacinus* and *M. brandtii* were captured in the same area. Three of the four caves were surrounded by a forest dominated by beach (*Fagus sylvatica)* with additions of fir (*Abies alba*), spruce (*Picea abies*), maples (*Acer pseudoplatanus* and *A. campestre*) and rowan tree (*Sorbus aucuparia*). The area around the fourth cave (Czarna) located at the highest altitude was covered by fir forest with thickets of rowan and — on rocky terrain — by dwarf mountain pine (*Pinus mugo*).

Turkey

A total of eight *M. alcathoe* were captured in close vicinity at three locations in Trakya in the European part of Turkey. Their specific identification was verified genetically (Appendix).

Discussion

Myotis alcathoe was initially recorded from Greece and Hungary, which led to the speculation that it might have a restricted distribution in south-eastern Europe (Helversen *et al.*, 2001). Several recent records across the European continent have changed this view considerably. Prior to the description of *M. alcathoe*, a particularly small *Myotis* that resembled *M. mystacinus* was recorded in six departments in France and was informally named 'Murin cantalou' (Jourde, 2000). Sequencing of the ND1 gene showed that two females of that taxon caught in the department Charente-Maritime represented *M. alcathoe* (Ruedi *et al.*, 2002). This suggests that other individuals of 'Murin cantalou' may also be assigned to this species since they shared similar morphological characters. Recently, the occurrence of *M. alcathoe* in the department Puy-de-Dôme was noted as well (Dietz, 2004). New records that were genetically verified were also published for Slovakia (Benda *et al.*, 2003), Bulgaria (Schunger *et al*., 2004), northern Spain (Agirre-Mendi, 2004; Ibañez *et al.*, 2006) and Switzerland (Stadelmann *et al.*, 2004). Two individuals of *M. alcathoe* were identified on the basis of molecular methods and morphology in 2003 from Croatia (Croatian Natural History Museum Bat Group, Fourth Report to the National Implementation of the Agreement on the Conservation of Bats in Europe).

Records from the Kyffhäuser mountains in central Germany represent the northernmost findings of *M. alcathoe* so far. This area is known as a hot spot of biodiversity, and several floristic and faunistic elements from the Mediterranean and continental biogeographic regions have disjunctive populations there, including *Rhinolophus hipposideros*.

In general, the geographic range of *M. alcathoe* covers a large part of Europe. In the south the species seems to be restricted to the mountain regions where specific habitat requirements are fulfilled. Selective forces acting at the northern distribution boundary are less obvious although it appears that the species may be found even further to the north. Occurrence of other bat taxa, such as *Rhinolophus ferrumequinum*, *R. hipposideros* or *Myotis emarginatus*, with similarly shaped geographic distributions in Europe (Mitchell-Jones *et al.*, 1999), suggests that *M. alcathoe* should be present in other countries within its present range (e.g., Austria, the Czech Republic, Romania) and possibly also in Benelux and southern parts of Great Britain. On the other hand, despite its wide distribution, *M. alcathoe* seems to be a rare species, at least at most places. The genetic screening of more than 50 small unidentified 'whiskered bats' from central Europe revealed either *M. mystacinus* or *M. brandtii* (authors' unpublished data).

New records suggest rather specific habitat requirements of *M. alcathoe*. It seems to prefer natural, moist and deciduous forests with old trees and water streams as can be found in canyons or in alluvial forests. A humid, mixed forest dominated by old trees of *Q. robur* and *Platanus* spp. and surrounded by a stream in a small valley was described for a French population (Ruedi *et al.*, 2002). A moist beech grove and a riparian forest were occupied by *M. alcathoe* in Spain (Agirre-Mendi *et al.*, 2004). Two Slovak individuals were captured at the entrance of a cave surrounded by 80 to 100-year-old deciduous forests (Benda *et al.*, 2003). The same applies to most of the Bulgarian records. In Greece *M. alcathoe* seems to be specialised for small valleys with brooks (Helversen *et al.*, 2001).

Such moist and often old forests represent habitats of high conservation value. They are particularly species rich and

harbour a high number of endangered taxa. This is exemplified by the forest in Rheinau, where already 14 different bat species were recorded, including *M brandtii*, *M. mystacinus*, and *M. alcathoe*. Therefore, all three species occur in sympatry although they are morphologically very similar and likely overlap in their prey spectrum and foraging strategies. The sympatric occurrence of *M. mystacinus* and *M. alcathoe* is known from France, Spain (Agirre-Mendi *et al.*, 2004), the Balkans (Schunger *et al.*, 2004; present study), Hungary, and Poland (present study). Apparent adaptation of *M. alcathoe* to an endangered habitat may require giving this taxon high conservation priority in all management programs.

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Appendix

List of all records of *M. alcathoe*. Animals were identified according to morphological characters. Genetically confirmed records by sequencing three different mitochondrial genes (ND1, cyt *b* and 12S rDNA) are specified. References: [1] — von Helversen *et al.* (2001); [2] — Benda *et al.* (2003); [3] — Agirre-Mendi *et al.* (2004); [4] — Stadelmann *et al.* (2004); [5] — Jourde (2000) and Ruedi *et al.* (2002). Institutions: AGEMINAT: Atelier de gestion des milieux naturels; ALEPE: Association Lozérienne pour l'Etude et la Protection de l'Environnement; BV: Bretagne Vivante-SEPNB; GCCA: Groupe Chiroptères Champagne Ardennes; GEPMA: Groupe d'Etude et de Protection des Mammifères d'Alsace; GMN: Groupe Mammalogique Normand; LPO: Ligue pour la Protection des Oiseaux; CPEPESC: Commission de Protection des Eaux, du Patrimoine, de l'Environnement, du Sous-sol et des Chiroptères

Country/Location	Altitude (m a.s.l.)	Date	Longitude/ Latitude (°)	Number of bats	♂♂	♀♀	juv.	Record	Identification based on
Albania									
Tepelene	119	20.08.2006	20.01/40.17	1	1			K. Sachanowicz, M. Ciechanowski, and A. Rachwald	morphology, ND1
Bulgaria									
Stara planina Mt., Vodnite Dupki, Severen Dzhendem Reserve, Distr. Lovech	1400	16.08.2003	24.09/42.73	1	1			C. Dietz and I. Dietz	morphology, ND1
Stara planina Mt., Vodnite Dupki, Severen Dzhendem Reserve, Distr. Lovech	1400	16.08.2003	24.09/42.73	1	1			C. Dietz and I. Dietz	morphology, ND1
Stara planina Mt., Vodnite Dupki, Severen Dzhendem Reserve, Distr. Lovech	1400	16.08.2003	24.09/42.73	1		1		C. Dietz and I. Dietz	morphology, ND1
Kresna gorge, Distr. Blagoevgrad, near rw. station Peyo Yavorov	180	18.08.2003	23.15/41.76	1				B. Petrov and A. Kovachev	morphology
Primorsko, Ropotamo Reserve, Distr. Burgas	5	11.06.2004	27.07/42.30	1		1		C. Dietz, B. Petrov, T. Stoyanov, and G. Kerth	morphology
Western Stara planina Mt., Bov, Distr. Svoge, Izdremets mine gallery	1450	17.09.2003	23.44/43.01	1	1			B. Petrov and T. Stoyanov	morphology, ND1
Vrachanska Stara planina Mt., Lyutadjik, Distr. Varshets, Sokolskata peshtera cave	790	01.08.2006	23.44/43.16	1	1			B. Petrov	morphology
Strandja Mt., Brashlyan, Distr. Malko Tarnovo, Bratanovata peshtera cave	450	19.09.2006	27.42/42.01	1	1			B. Petrov and T. Stoyanov	morphology

APPENDIX. Continued

Country/Location	Altitude (m a.s.l.)	Date	Longitude/ Latitude (°)	Number of bats	♂♂	♀♀	juv.	Record	Identification based on
Strandja Mt., Brashlyan, Distr. Malko Tarnovo, Bratanovata peshtera cave	450	19.09.2006	27.42/42.01	1		1		B. Petrov and T. Stoyanov	morphology
Germany									
Baden-Württemberg, Rheinbischofsheim, Geißenwald	130	28.06.2005	7.95/48.64	1		1		I. Niermann, R. Brinkmann, and H. Schauer-Weißhahn	morphology, ND1
Baden-Württemberg, Rheinbischofsheim, Geißenwald	130	26.06.2006	7.95/48.64	1	1			I. Niermann, R. Brinkmann, and H. Schauer	morphology
Baden-Württemberg, Rheinbischofsheim, Geißenwald	130	28.06.2006	7.95/48.63	1	1			I. Niermann, R. Brinkmann, and H. Schauer	morphology, ND1
Baden-Württemberg, Rheinbischofsheim, Geißenwald	130	29.06.2006	7.95/48.64	1	1			I. Niermann, R. Brinkmann, and H. Schauer	morphology, ND1
Baden-Württemberg, Rheinbischofsheim, Geißenwald	130	17.07.2006	7.95/48.64	3	3			I. Niermann, R. Brinkmann, and H. Schauer	morphology, ND1
Baden-Württemberg, Griesheim N Offenburg, tunnel under highway	140	17.08.2006	7.91/48.51	1	1			I. Niermann, R. Brinkmann, and H. Schauer	morphology, ND1
Baden-Württemberg, Griesheim N Offenburg, tunnel under highway	140	20.08.2006	7.91/48.52	1		1		I. Niermann, R. Brinkmann, and H. Schauer	morphology, ND1
Thüringen, Kyffhäuser		16.08.2006	11.04/51.38	2	1	1		W. Schorcht, W. Sauerbier, and M. Biedermann	morphology, ND1
Greece									
Kleistos[1]		14.08.1981	21.49/39.05	1	1			K.-G. Heller and O. von Helversen	morphology, 12S rDNA GenBank AY027824
Nestos, Sideroneron[1]		25.09.1985	24.13/41.21	1	1			R. Weid	morphology, ND1 GenBank AY027837
Loutropigi[1]		05.06.1991	22.01/39.07	1	1			K.-G. Heller	morphology, ND1 GenBank AY027832

APPENDIX. Continued

Country/Location	Altitude (m a.s.l.)	Date	Longitude/ Latitude (°)	Number of bats	♂♂	♀♀	juv.	Record	Identification based on
Loutropigi[1]		15.06.1992	22.01/39.07	2	1	1		O. von Helversen	morphology, ND1 GenBank AY027833
Loutropigi[1]		17.06.1992	22.01/39.07	3		3		O. von Helversen	morphology, ND1 GenBank AY027834
Loutropigi[1]		19.06.1993	22.01/39.07	1	1			K.-G. Heller	morphology
Arkoudorrema, Dipotama		18.08.1997	24.35/41.21	1		1		O. von Helversen	morphology
Loutra Thermia		02.09.1997	24.28/41.24	1		1		O. von Helversen	morphology
Tauropos, Karpenision		02.06.1998	21.41/38.55	1	1			O. von Helversen	morphology
Trikeriotis		25.08.2000	21.53/38.48	1	1			O. von Helversen	morphology
Between Medousa and Kottani NE of Echinos		15.06.2004	25.05/41.19	1		1		O. von Helversen	morphology
Between Medousa and Kottani NE of Echinos		04.09.2004	25.05/41.19	1	1			O. von Helversen	morphology, ND1
Melivoia		06.09.2004	24.53/41.20	1	1			O. von Helversen	morphology
Chaliki, Aspropotamos		24.07.2005	21.13/39.39	1		1		O. von Helversen	morphology, ND1
Pentalofos		31.07.2005	21.11/40.11	1		1		O. von Helversen	morphology
Pindos, Portaikos river		07.08.2005	21.32/39.26	1	1			O. von Helversen	morphology
Hungary									
Bükk Mts., Attila-kúti Lake	325	02.09.1998	20.27/47.47	3	1	2		P. Estók and P. Gombkötö	morphology
Bükk Mts., Attila-kúti Lake	325	01.07.2000	20.27/47.47	2	2			P. Estók and P. Gombkötö	morphology
Bükk Mts., Napsugár-pihenö	300	07.06.2001	20.25/48.00	2	1	1		P. Estók	morphology
Bükk Mts., Peskö Valley	515	16.07.2001	20.25/48.02	1			1	P. Estók	morphology
Bükk Mts., Kacs[1]		2001	20.62/47.95					P. Gombkötö	ND1 GenBank AY027835
Matra Mts., Parád[1]		2001	20.03/47.91					P. Gombkötö	ND1 GenBank AY027836
Zemplén Mts., István Spring	500	11.07.2002	21.24/48.24	1		1		Z. Bihari, P. Estók, and P. Gombkötö	morphology
Bükk Mts., Mellér Valley	300	12.08.2003	20.25/48.00	1		1		P. Estok	morphology
Bükk Mts., Mellér Valley	300	15.07.2004	20.25/48.00	1			1	P. Estok	morphology
Bükk Mts., Napsugár-pihenö	300	16.07.2004	20.25/48.00	1			1	P. Estok	morphology

APPENDIX. Continued

Country/Location	Altitude (m a.s.l.)	Date	Longitude/ Latitude (°)	Number of bats	♂♂	♀♀	juv.	Record	Identification based on
Matra Mts., Parád	670	02.08.2004	20.03/47.91	2			2	G. Corba, P. Estók, and P. Gombkötö	morphology
Matra Mts., Parád	670	04.09.2004	20.03/47.91	1		1		P. Estók	morphology
Bükk Mts., Felsötárkányi Lake	230	18.06.2005	20.26/47.58	1		1		P. Estok	morphology
Bükk Mts., Répás Valley	330	25.07.2005	20.27/47.58	1		1		P. Estok	morphology
Medves Mts., Zagyva Spring	520	27.07.2005	19.52/48.08	1			1	P. Estok	morphology
Bükk Mts., Felsötárkányi Lake	230	31.08.2005	20.26/47.58	1		1		P. Estok	morphology
Bükk Mts., Lök-völgyi Cave	385	05.09.2005	20.28/48.01	1	1			P. Estok	morphology
Bükk Mts., Fekete Cave	565	10.09.2005	20.33/48.06	1				P. Estok and P. Gombkötö	morphology
Bükk Mts., Jáspis Cave	588	26.09.2005	20.34/48.06	1				P. Estok	morphology
Attila-kúti Lake		02.08.2005	20.46/47.95					P. Estok	morphology, ND1
Poland									
Kornuty Reserve, Mroczna Cave in Kornuty	770	2005, 2006	21.32/49.58	4	3	1		W. Bogdanowicz, K. Piksa, and A. Tereba	morphology, ND1, cyt *b*
Beskid Sądecki Mountain Range, Wierch above Kamień, Niedźwiedzia Cave	985	2006	20.78/49.48	2	1	1		W. Bogdanowicz, K. Piksa, and A. Tereba	morphology, ND1, cyt *b*
Beskid Wyspowy Mountain Range, Mt. Łopień, Zbójecka in Łopień Cave	880	2005, 2006	20.28/49.70	11	7	4		W. Bogdanowicz, K. Piksa, and A. Tereba	morphology, ND1, cyt *b*
Tatra Mts, Organy Massif, Kościeliska Valley, Czarna Cave	1294	2006	19.87/49.23	2	1	1		W. Bogdanowicz, K. Piksa, and A. Tereba	morphology, ND1, cyt *b*
Slovakia									
Pohansk hrad, Stépová jaskyna cave[2]		2003	19.91/48.21						morphology, ND1
Spain									
La Rioja, 3 localities[3]		2004	-3.00/42.20						morphology, ND1
Switzerland									
Kanton Vaud[4]		2004	6.20/46.50						morphology, cyt *b*
Turkey									
Ferko's Garden, Bički Stream, Demirköy/Kirklareli		28.08.2006	27.80/41.79	1				B. Özkan and S. Paksuz	morphology, ND1
Sunny lakes (Hunter fountain), Bički Stream, Demirköy/Kirklareli		29.08.2006	27.80/41.79	2				B. Özkan and S. Paksuz	morphology, ND1

APPENDIX. Continued

Country/Location	Altitude (m a.s.l.)	Date	Longitude/ Latitude (°)	Number of bats	♂♂	♀♀	juv.	Record	Identification based on
Ferko's Garden, Biçki Stream, Demirköy/Kirklareli		09.09.2006	27.80/41.79	4				B. Özkan and S. Paksuz	morphology, ND1
Dunisa Cave, Sarpdere village, Demirköy/Kirklareli		15.10.2006	27.56/41.84	1				B. Özkan and S. Paksuz	morphology, ND1
France									
Department Aube[5]		2000							morphology
Department Calavados[5]		2000							morphology
			Morphologically confirmed French records						
Alsace, Haguenau		04.09.2004	7.79/48.82	1	1			J. Vittier, GEPMA	morphology
Aquitaine, Auriac		17.07.2003	-0.31/43.45	1	1			D. Vincent	morphology
Auvergne		27.08.2000	3.05/46.41	1	1			P. Giosa and J. Fombonnat, C.-S. Auvergne	morphology
Auvergne		23.07.1996	2.87/45.11	1		1		C.-S. Auvergne	morphology
Auvergne		02.08.1998	2.87/45.11	2	2			S. Y. Roue, J. Boireau, P. Giosa, S. Giosa, and C.-S. Auvergne	morphology
Auvergne		20.07.1996	3.81/45.14	3		3		S. Y. Roué, J. Koziol, and C.-S. Auvergne	morphology
Auvergne		21.07.1996	3.81/45.14	2		2		S. Y. Roué, J.-M. Serveau, P. Giosa, J. Fombonnat, and C.-S. Auvergne	morphology
Auvergne		27.07.1999	3.08/45.78	1	1			P. Giosa, J. Fombonnat, and C.-S. Auvergne	morphology
Basse-Normandie, Ouilly-du-Houley		14.08.2002	0.33/49.17	4	2	1	1	C. Rideau, L. Nicolle, GMN	morphology
Basse-Normandie, Tordouet		07.06.2003	0.33/49.05	4	2	2		C. Rideau, L. Nicolle, GMN	morphology
Basse-Normandie, Ouilly-du-Houley		04.08.2003	0.33/49.17	1			1	C. Rideau, L. Nicolle, GMN	morphology
Basse-Normandie, Champ-du-Boult		24.08.2003	-1.01/48.79	2		1	1	L. Nicolle, N. Avril, R. Harivel, F. Leboulenger, GMN	morphology
Basse-Normandie, Fumichon		26.08.2003	0.37/49.17	2	1	1		C. Rideau, L. Nicolle, GMN	morphology
Basse-Normandie, Saint-Julien-de-Mailloc		02.09.2003	0.33/49.08	1	1			L. Nicolle, GMN	morphology
Basse-Normandie, Ouilly-du-Houley		28.07.2004	0.33/49.17	3	2	1		C. Rideau, R. Jamault, GMN	morphology
Basse-Normandie, Pretreville		06.08.2004	0.25/49.07	1		1		C. Rideau, L. Nicolle, N. Avril, GMN	morphology

APPENDIX. Continued

Country/Location	Altitude (m a.s.l.)	Date	Longitude/ Latitude (°)	Number of bats	♂♂	♀♀	juv.	Record	Identification based on
Basse-Normandie, Cordebugle		07.08.2004	0.38/49.11	1			1	C. Rideau, N. Avril, GMN	morphology
Basse-Normandie, Montviette		23.06.2005	0.10/49.00	10	8	2		L. Nicolle, GMN	morphology
Basse-Normandie, Ducey		23.07.2004	-1.29/48.62	2	1	1		C. Rideau, R. Jamault, N. Avril, GMN	morphology
Basse-Normandie, Ducey		28.06.2005	-1.29/48.62	2	2			B. Burnouf, GMN	morphology
Basse-Normandie, Lingeard		16.07.2005	-1.02/48.56	2	1	1		L. Nicolle, GMN	morphology
Basse-Normandie, Feings		09.08.2003	0.63/48.55	1		1		C. Rideau, N. Avril, C. Herve, J.-B. James, GMN	morphology
Basse-Normandie, Pontchardon		11.09.2004	0.27/48.93	2	1	1		C. Rideau, L. Nicolle, N. Avril, GMN	morphology
Basse-Normandie, Feings		02.07.2005	0.63/48.55	3	2		1	R. Jamault, N. Avril, GMN	morphology
Basse-Normandie, St-Evroult-Notre-Dame-du-Bois		12.08.2005	0.47/48.79	1	1			C. Rideau, N. Avril, GMN	morphology
Basse-Normandie, Montilly-sur-Noireau		27.08.2005	-0.57/48.82	1			1	R. Haivel, GMN	morphology
Bourgogne, Vaux-Saules		05.07.2002	4.80/47.47	1	1			C. Guillaume, R. Kirsch, E. Sabourin, F. Malgouyres, S. Dambrun, Société d'Histoire Naturelle d'Autun	morphology
Bourgogne, Saint-Nicolas-les-Citeaux		03.07.2003	5.05/47.12	3			3	C. Guillaume, R. Kirsch, E. Sabourin, F. Malgouyres, S. Dambrus, S. G. Roué, S. Y. Roué, N. Varanguin, S. Mezani, E. Delerue, N. Pichon, V. Dumont, M. Boffet, M. Salmon, T. Poirot, S. Lutz, D. Lerat, Société d'Histoire Naturelle d'Autun	morphology
Bourgogne		Sept. 2004	4.79/47.44					C. Guillaume, R. Kirsch, E. Sabourin, F. Malgouyres, S. Dambrun, S. G. Roué, S. Y. Roué, N. Vranguin, S. Mezani, E. Delerue, N. Pichon, V. Dumont, M. Boffet, M. Salmon, T. Poirot, S. Lutz, D. Lerat, Société d'Histoire Naturelle d'Autun	morphology
Bretagne, Saint-Nicolas-du-Pelem		02.08.2005	-3.16/48.31	1	1			O. Farcy, BV	morphology
Bretagne, Mézières sur Couesnon		24.08.2003	-1.43/48.30	1	1			A. Le Houedec, BV	morphology
Bretagne, Mézières sur Couesnon		14.09.2003	-1.43/48.30	1	1			A. Le Houedec, BV	morphology
Bretagne, Antrain		22.05.2004	-1.48/48.46	6		6		A. Le Houedec, BV	morphology

APPENDIX. Continued

Country/Location	Altitude (m a.s.l.)	Date	Longitude/ Latitude (°)	Number of bats	♂♂	♀♀	juv.	Record	Identification based on
Bretagne, Antrain		05.07.2004	-1.48/48.46	3	1	2		A. Le Houedec, R. Jamault, BV	morphology
Bretagne, Saint Brice en Cogles		26.08.2004	-1.37/48.41	4	3	1		A. Le Houedec, BV	morphology
Bretagne, Antrain		01.09.2004	-1.48/48.46	1		1		A. Le Houedec, BV	morphology
Bretagne, Mézières sur Couesnon		08.09.2004	-1.43/48.30	2	2			A. Le Houedec, BV	morphology
Bretagne, Gahard		29.04.2005	-1.52/48.30	1		1		A. Le Houedec, BV	morphology
Bretagne, Champeaux		05.05.2005	-1.31/48.15	1		1		A. Le Houedec, BV	morphology
Bretagne, Saint Aubin du Cormier		21.06.2005	-1.40/48.26	2	1	1		A. Le Houedec, BV	morphology
Bretagne, Antrain		27.06.2005	-1.48/48.46	7	1	6		A. Le Houedec, BV	morphology
Bretagne, Saint Aubin du Cormier		08.07.2005	-1.40/48.26	1		1		A. Le Houedec, BV	morphology
Bretagne, Saint Aubin du Cormier		01.06.2006	-1.40/48.26	1	1			A. Le Houedec, BV	morphology
Bretagne, Saint Aubin du Cormier		14.06.2006	-1.40/48.26	1		1		A. Le Houedec, BV	morphology
Bretagne, Saint Aubin du Cormier		18.06.2006	-1.40/48.26	1		1		A. Le Houedec, BV	morphology
Bretagne, Saint Aubin du Cormier		21.06.2006	-1.40/48.26	1		1		A. Le Houedec, BV	morphology
Bretagne, Sainte-Marie de Redon		13.05.2004	-2.00/47.69	1	1			G.-L. Choquene, BV	morphology
Bretagne, Loutehel		19.06.2004	-2.08/47.94	1	1			Y. Le Bris and O. Farcy	morphology
Bretagne, Saint-Ouen la Rouërie		01.09.2004	-1.44/48.46	2	1		1	O. Farcy, BV	morphology
Bretagne, Vieux Vysur Couesnon		03.09.2004	-1.49/48.34	3	2	1		O. Farcy, BV	morphology
Bretagne, Saint-Ouen la Rouërie		07.09.2004	-1.44/48.46	5	4	1		O. Farcy, BV	morphology
Bretagne, Liffré		28.04.2005	-1.51/48.21	1	1			G.-L. Choquene, BV	morphology
Bretagne, Saint Ouen la Rouërie		18.09.2006	-1.44/48.46	1	1			A. Le Houedec, BV	morphology
Bretagne, Fougères		19.09.2006	-1.20/48.35	2	2			A. Le Houedec, BV	morphology
Bretagne, Sévérac		02.06.2006	-2.08/47.55	2	1	1		Y. Le Bris, BV	morphology
Bretagne, Sarzeau		04.08.2003	-2.77/47.53	1	1			A. Le Houedec, BV	morphology
Bretagne, Remungol		24.06.2004	-2.90/47.93	1		1		A. Le Mouel, BV	morphology
Bretagne, Berné		21.08.2004	-3.39/47.99	1		1		O. Farcy, BV	morphology
Bretagne, La Gacilly		11.09.2004	-2.13/47.77	1	1			Y, Le Bris, BV	morphology
Bretagne, Cournon		15.05.2005	-2.10/47.75	2	1	1		Y, Le Bris, BV	morphology
Bretagne, La Gacilly		26.05.2005	-2.13/47.77	2	1	1		Y. Le Bris, BV	morphology
Bretagne, La Gacilly		28.05.2005	-2.13/47.77	1		1		Y. Le Bris, BV	morphology
Bretagne, La Gacilly		12.06.2005	-2.13/47.77	1	1			Y. Le Bris, O. Farcy, BV	morphology
Bretagne, Malansac		27.06.2005	-2.30/47.68	1			1	O. Farcy, BV	morphology
Bretagne, Priziac		22.08.2005	-3.41/48.06	1	1			O. Farcy, BV	morphology
Bretagne, Théhillac		06.06.2006	-2.11/47.57	1		1		Y. Le Bris, O. Farcy, BV	morphology
Bretagne, La Gacilly		24.07.2006	-2.13/47.77	2		2		O. Farcy, Y. Le Bris, BV	morphology

APPENDIX. Continued

Country/Location	Altitude (m a.s.l.)	Date	Longitude/ Latitude (°)	Number of bats	♂♂	♀♀	juv.	Record	Identification based on
Bretagne, Peillac		02.08.2006	-2.22/47.71	1	1			Y. Le Bris, BV	morphology
Bretagne, Peillac		04.08.2006	-2.22/47.71	1			1	Y. Le Bris, BV	morphology
Centre, Niherne		19.07.2005	1.56/46.83	1		1		Y. Le Bris, P. Boyer, Indre Nature	morphology
Champagne-Ardennes, Chemery-sur-Bar		18.09.2004	4.87/49.60	1	1			C. Herve, GCCA	morphology
Champagne-Ardennes, Chevillon		04.09.2004	5.13/48.53	1		1		C. Herve, GCCA	morphology
Champagne-Ardennes, Vienne le Château		04.08.2004	4.89/49.19	5			5	C. Herve, N. Galand, GCCA	morphology
Champagne-Ardennes, Belval en Argonne		09.08.2005	5.00/48.95	1	1			C. Herve, N. Galand, GCCA	morphology
Champagne-Ardennes, Flammerecourt		03.08.2005	5.04/48.36	2			2	C. Herve, GCCA	morphology
Champagne-Ardennes, St. Ciergues		02.08.2005	5.25/47.88	1			1	C. Herve, GCCA	morphology
Champagne-Ardennes, Eclaron-Braucourt-Sainte-Liviere		26.08.2005	4.86/48.59	3	3			C. Herve, GCCA	morphology
Champagne-Ardennes, Trigny		05.09.2005	3.90/49.30	3	2	1		C. Herve, GCCA	morphology
Champagne-Ardennes, Glannes		16.09.2006	4.54/48.71	1	1			C. Herve, GCCA	morphology
Champagne-Ardennes, Eclaron-Braucourt-Sainte- Liviere		11.10.2006	4.86/48.59	1	1			C. Herve, GCCA	morphology
Champagne-Ardennes, Chateauvillain		07.09.2006	4.92/48.00	1		1		C. Herve, GCCA	morphology
Champagne-Ardennes, Vertus		20.09.2003	4.01/48.91	1	1			C. Herve, N. Galand, GCCA	morphology
Champagne-Ardennes, Loges au chêvres		14.08.1998	4.41/48.27	1		1		S. Roué, GCCA	morphology
Champagne-Ardennes, Bossancourt		27.09.2000	4.60/48.28	1		1		B. Fauvel, K. Auboin, GCCA	morphology
Champagne-Ardennes, Bossancourt		29.09.2006	4.60/48.28	1	1			B. Fauvel, GCCA	morphology,
Champagne-Ardennes, Bossancourt		29.09.2006	4.60/48.28	1	1			B. Fauvel, GCCA	morphology
Champagne-Ardennes, Boult aux Bois		31.08.2005	4.84/49.43	1		1		N. Galand, GCCA	morphology
Champagne-Ardennes, Rimogne		14.09.2006	4.54/49.84	1	1			N. Galand, GCCA	morphology
Champagne-Ardennes, Le Mont-Dieu		09.09.2006	4.87/49.55	1	1			N. Galand, GCCA	morphology
Franche-Comté, Gennes		02.08.2005	6.12/47.25	1			1	C. Guillaume, T. Le Campion, V. Charlet, CPEPESC Franche-Comté	morphology

APPENDIX. Continued

Country/Location	Altitude (m a.s.l.)	Date	Longitude/ Latitude (°)	Number of bats	♂♂	♀♀	juv.	Record	Identification based on
Franche-Comté, Gennes		30.08.2005	6.12/47.25	2	1		1	S. Y. Roué, C. Guillaume, CPEPESC Franche-Comté	morphology
Franche-Comté, Montfaucon		04.09.2005	6.08/47.24	1		1		S. Y. Roué, C. Guillaume, CPEPESC Franche-Comté	morphology
Franche-Comté, Amange		24.06.2004	5.56/47.17	1		1		C. Guillaume, CPEPESC Franche-Comté	morphology
Franche-Comté, Moissey		25.06.2004	5.52/47.20	5	3	2		S. Y. Roué, C. Guillaume, CPEPESC Franche-Comté	morphology
Franche-Comté, Moissey		20.07.2005	5.52/47.20	2		1	1	C. Guillaume, T. Le Campion, V. Charlet, CPEPESC Franche-Comté	morphology
Franche-Comté, Moissey		21.07.2005	5.52/47.20					S. Y. Roué, CPEPESC Franche-Comté	morphology
Franche-Comté, Moissey		24.06.2006	5.52/47.20					S. Y. Roué, CPEPESC Franche-Comté	morphology
Franche-Comté, Moissey		28.06.2006	5.52/47.20					S. Y. Roué, CPEPESC Franche-Comté	morphology
Franche-Comté, Moissey		01.07.2006	5.52/47.20					S. Y. Roué, CPEPESC Franche-Comté	morphology
Franche-Comté, Calmoutier		08.08.2004	6.28/47.65	1			1	S. Y. Roué, C. Guillaume, V. Charlet, CPEPESC Franche-Comté	morphology
Franche-Comté, Beaumotte-les-Pin		16.08.2005	5.83/47.32	1			1	C. Guillaume, CPEPESC Franche-Comté	morphology
Haute-Normandie, St-Sylvestre-de-Cormeilles		09.06.2003	0.40/49.24	1		1		C. Rideau, GMN	morphology
Haute-Normandie, Bailleul-la-Vallée		04.09.2003	0.43/49.20	3		3		C. Rideau, L. Nicolle, GMN	morphology
Haute-Normandie, Harcourt		22.07.2004	0.79/49.17	1		1		C. Rideau, R. Jamault, N. Avril, GMN	morphology
Haute-Normandie, Marais-Vernier		02.09.2004	0.45/49.42	2	1		1	R. Jamault, GMN	morphology
Haute-Normandie, St-Aubin-de-Scellon		22.06.2005	0.47/49.17	2	1	1		C. Rideau, R.Jamault, N. Avril, GMN	morphology
Haute-Normandie, Elbeuf-sur-Andelle		26.08.2005	1.40/49.47	1	1			A. Gourvennec, V. Firmin, GMN	morphology

APPENDIX. Continued

Country/Location	Altitude (m a.s.l.)	Date	Longitude/ Latitude (°)	Number of bats	♂♂	♀♀	juv.	Record	Identification based on
Ile-de-France, Genainville		25.08.2001	1.75/49.12					AGEMINAT, E. Chapoulie, and F. Dehondt	morphology
Ile-de-France, Chaussy		12.10.2002	1.69/49.12					AGEMINAT, E. Chapoulie, and V. Culicchi	morphology
Languedoc-Roussillon, St Pierre de Nogaret		23.07.2004	3.14/44.47	1	1			T. Deana, R. Destre, ALEPE S. Vincent	morphology
Languedoc-Roussillon, Montjézieux		14.08.2004	3.20/44.43	1	1			T. Deana, R. Destre, S. Vincent, ALEPE	morphology
Languedoc-Roussillon, St Germain du Teil		29.08.2004	3.17/44.48	1		1		T. Deana, R. Destre, S. Vincent, ALEPE	morphology
Languedoc-Roussillon, St Germain du Teil		29.08.2004	3.17/44.48	1	1			T. Deana, R. Destre, S. Vincent, ALEPE	morphology
Languedoc-Roussillon, Chirac		03.09.2004	3.27/44.52	1	1			T. Deana, R. Destre, S. Vincent, ALEPE	morphology
Languedoc-Roussillon, Trélans		04.09.2004	3.09/44.50	1		1		T. Deana, R. Destre, S. Vincent, ALEPE	morphology
Languedoc-Roussillon, Chirac		10.09.2004	3.27/44.52	1	1			T. Deana, R. Destre, S. Vincent, ALEPE	morphology
Languedoc-Roussillon, Les Hermaux		26.08.2005	3.13/44.51	1	1			T. Deana, R. Destre, S. Vincent, ALEPE	morphology
Limousin		Dec. 2003	1.26/45.83					Y. Grugier, M. Barataud, and F. Leblanc	morphology
Limousin		Feb. 2004	1.26/45.83					Y. Grugier, M. Barataud, and F. Leblanc	morphology
Lorraine, Brauviliers		10.09.2006	5.15/48.58	6		4	2	CPEPESC-Lorraine	morphology,
Nord-Pas de Calais		2003	2.13/50.51	3	3			V. Cohez	morphology
Nord-Pas de Calais, Tournehem-sur-la-Hem		18.09.2005	2.05/50.81	4	1	3		A. Dufour, A. Mionnet, C. Rideau, E. Parmentier, J. Vittier, P. Spiroux, and R. Jamault	morphology
Nord-Pas de Calais		2005	2.13/50.51	2	2			V. Cohez	morphology
Pays de la Loire, Mauves-sur-Loire		25.01.2004	-1.40/47.30					W. Maillard and T. Radigois	morphology
Pays de la Loire, Mauves-sur-Loire		09.06.2005	-1.40/47.30	1	1			O. Farcy, BV	morphology

APPENDIX. Continued

Country/Location	Altitude (m a.s.l.)	Date	Longitude/ Latitude (°)	Number of bats	♂♂	♀♀	juv.	Record	Identification based on
Pays de la Loire			0.20/48.00					B. Tilly and J.-P. Tilly	morphology
Pays de la Loire			-1.43/46.67					M. Vaslin	morphology
Pays de la Loire, Broc			0.17/47.58	3	3			B. Tilly	morphology
Pays de la Loire, Fontaine Guérin			-0.19/47.49	1	1			F. Noel and B. Tilly	morphology
Pays de la Loire, Saint Georges du bois			-0.22/47.50	1	1			B. Gaudemer	morphology
Pays de la Loire, Fontaine- Milon			-0.25/47.50	1	1			F. Noel	morphology
Pays de la Loire, Cuon			-0.10/47.48	1	1			F. Noel and H. Berjon	morphology
Pays de la Loire, Cuon			-0.10/47.48	1	1			F. Noel	morphology
Pays de la Loire, Fontaine Guérin			-0.19/47.49	1	1			F. Noel	morphology
Pays de la Loire, Le Guedeniau			-0.05/47.50	1	1			G. Mourgaud *et al.*	morphology
Picardie		2001	2.41/49.38					O. Bardet and R. Huet	morphology
Poitou-Charentes		14.07.1998	-0.79/45.82	1	1			P. Jourde, LPO	morphology
Poitou-Charentes		09.09.1998	-0.79/45.82	2		2		P. Jourde, LPO	morphology
Poitou-Charentes		10.09.1998	-0.79/45.82	1	1			P. Jourde, LPO	morphology
Poitou-Charentes		09.06.1999	-0.79/45.82	1		1		P. Jourde, LPO	morphology
Poitou-Charentes		11.08.2000	-0.79/45.82	1	1			P. Jourde, LPO	morphology
Poitou-Charentes		13.08.2000	-0.79/45.82	1	1			P. Jourde, LPO	morphology
Poitou-Charentes		15.08.2000	-0.79/45.82	1	1			P. Jourde, LPO	morphology
Poitou-Charentes		21.08.2000	-0.79/45.82	1		1		P. Jourde, LPO	morphology
Poitou-Charentes		21.06.2001	-0.79/45.82	2		2		P. Jourde, LPO	morphology
Poitou-Charentes, La Mothe Saint-Héray		04.09.2002	-0.11/46.36	1	1			T. Dieuleveut	morphology
Poitou-Charentes, Chizé		16.09.2002	-0.35/46.12	1		1		T. Dieuleveut	morphology
Poitou-Charentes, Champdeniers		05.09.2006	-0.41/46.49	1	1			T. Dieuleveut	morphology
Poitou-Charentes, Vitré		10.10.2006	-0.20/46.28	1		1		S. Bracco	morphology
Provence-Côte d'Azur, Gap		05.09.2000	6.08/44.56	1	1			P. Favre	morphology
Provence-Côte d'Azur, Bairols		12.09.2002	7.13/43.98	1	1			P. Favre	morphology
Rhone-Alpes, Ruoms		16.01.2005	4.34/44.45	1	1			G. Issartel	morphology
Rhone-Alpes, Sainte Eulalie en Royans		13.08.2004	5.34/45.05	1			1	S. Vincent and J. B. Bonnin	morphology
Rhone-Alpes, Lupé		23.08.2006	4.70/45.37	1	1			R. Letscher, P. Chico-Sarro, and C. Pouchoy	morphology