






THE NORTHERNMOST FINDINGS OF THE ALCATHOE BAT (*MYOTIS ALCATHOE*) IN POLAND

Paweł Kmiecik¹, Anna Kmiecik², Joanna Furmankiewicz³ ,
Tomasz Postawa⁴ , Grzegorz Wojtaszyn⁵ , Krzysztof Antczak⁶

Key words

Alcathoe bat, *Myotis alcathoe*,
distribution range, lowland Poland

doi

<http://doi.org/10.15407/TU1909>

Article info

submitted 29.01.2020

revised 19.04.2020

accepted 25.06.2020

Language

English, Ukrainian summary

Affiliations

¹ Forest District Międzyzlesie (Międzyzlesie, Poland); ² Forest District Łądek (Strachocin, Poland); ³ Institute of Environmental Biology, University of Wrocław (Wrocław, Poland); ⁴ Institute of Systematics and Evolution of Animals Polish Academy of Sciences (Kraków, Poland); ⁵ Polish Society for Nature Protection "Salamandra" (Poznań, Poland); ⁶ Forest District Potrzebówice (Wleń, Poland)

Correspondence

Paweł Kmiecik; Forest District Międzyzlesie, Tysiąclecie Państwa Polskiego 7, 57-530 Międzyzlesie, Poland; e-mail: kmiecik_p@poczta.onet.pl; orcid: 0000-0002-2573-4524

Abstract

The Alcathoe bat *Myotis alcathoe* (von Helversen, Heller, 2001) is a newly described species of the cryptic complex of whiskered bat species living in sympatry across Europe. The habitats preferred by this species are natural, moist and deciduous forests with old trees and water streams. The majority of known locations of this species come from highlands, foothills and mountainous regions while practically not occurring in the lower elevations. They come mainly from cave areas, where bats were caught during autumn swarming, while records in other seasons are much less frequent. Currently, individual sites in Poland also come from lowlands, beyond the range of the mountains and uplands, which indicates a possible wider range of this species. The bats were captured using mist-nets in the Silesian Lowlands for three consecutive years (2013–2015). The localities were placed in various forest environments, ranging in elevation from 100 to 260 m a.s.l. Bats were initially identified based on morphological features, then the correctness of identification was confirmed by molecular methods. Two females and five males of *Myotis alcathoe* were captured into four new locations from the lowlands of Poland: Przemków, Głębowice, Chodlewo, and Dalkowskie Jary (Silesian Lowland). Old trees and a small watercourse were important elements in all these locations. Currently, these findings are the northernmost locations of the species in Poland and one of the northernmost locations in Central Europe. The latest findings of the species are located about 50 km to the south, but the vast majority of the rest of locations is from the foothills belt. This finding suggests that the species may inhabit regions much further north than previously suggested, and the limiting factor is the presence of old trees in wet environments.

Cite as

Kmiecik, P., A. Kmiecik, J. Furmankiewicz, T. Postawa, G. Wojtaszyn, K. Antczak. 2020. The northernmost findings of the Alcathoe bat (*Myotis alcathoe*) in Poland. *Therologia Ukrainica*, **19**: 90–95. [In English, with Ukrainian summary]

THE NORTHERNMOST FINDINGS OF THE ALCATHOE BAT (*MYOTIS ALCATHOE*) IN POLAND

Paweł Kmieciak¹, Anna Kmieciak², Joanna Furmankiewicz³,
Tomasz Postawa⁴, Grzegorz Wojtaszyn⁵, Krzysztof Antczak⁶

¹ Forest District Międzyzlesie (Międzyzlesie, Poland)

² Forest District Łądek (Strachocin, Poland)

³ Institute of Environmental Biology, University of Wrocław (Wrocław, Poland)

⁴ Institute of Systematics and Evolution of Animals Polish Academy of Sciences (Kraków, Poland)

⁵ Polish Society for Nature Protection "Salamandra" (Poznań, Poland)

⁶ Forest District Potrzebowice (Wleń, Poland)

The northernmost findings of the Alcaethoe bat (*Myotis alcaethoe*) in Poland. — P. Kmieciak, A. Kmieciak, J. Furmankiewicz, T. Postawa, G. Wojtaszyn, K. Antczak. — The Alcaethoe bat *Myotis alcaethoe* (von Helversen, Heller, 2001) is a newly described species of the cryptic complex of whiskered bat species living in sympatry across Europe. The habitats preferred by this species are natural, moist and deciduous forests with old trees and water streams. The majority of known locations of this species come from highlands, foothills and mountainous regions while practically not occurring in the lower elevations. They come mainly from cave areas, where bats were caught during autumn swarming, while records in other seasons are much less frequent. Currently, individual sites in Poland also come from lowlands, beyond the range of the mountains and uplands, which indicates a possible wider range of this species. The bats were captured using mist-nets in the Silesian Lowlands for three consecutive years (2013–2015). The localities were placed in various forest environments, ranging in elevation from 100 to 260 m a.s.l. Bats were initially identified based on morphological features, then the correctness of identification was confirmed by molecular methods. Two females and five males of *Myotis alcaethoe* were captured into four new locations from the lowlands of Poland: Przemków, Głębowice, Chodlewo, and Dalkowskie Jary (Silesian Lowland). Old trees and a small watercourse were important elements in all these locations. Currently, these findings are the northernmost locations of the species in Poland and one of the northernmost locations in Central Europe. The latest findings of the species are located about 50 km to the south, but the vast majority of the rest of locations is from the foothills belt. This finding suggests that the species may inhabit regions much further north than previously suggested, and the limiting factor is the presence of old trees in wet environments.

Key words: Alcaethoe bat, *Myotis alcaethoe*, distribution range, lowland Poland.

Correspondence to: Paweł Kmieciak; Forest District Międzyzlesie, Tysiąclecie Państwa Polskiego 7, 57-530 Międzyzlesie, Poland; e-mail: kmiecik_p@poczta.onet.pl

Submitted: 29.01.2020. Revised: 19.04.2020. Accepted: 25.06.2020.

Introduction

The Alcaethoe bat, *Myotis alcaethoe* (von Helversen, Heller, 2001), has been described as a new species in 2001, based on individuals originating from the Balkans and Inner Western Carpathians (von Helversen *et al.* 2001). The following years brought a number of new locations, but the range remained highly fragmented (Niermann *et al.* 2007).

Recently, the European distribution is extending and includes new countries from Great Britain (Boston *et al.* 2011) through Belgium (Nyssen *et al.* 2015), Luxemburg (Gessner 2012), Switzerland (Benda *et al.* 2016), and France (Niermann *et al.* 2007) to northern Spain (Coronado *et al.* 2017).

In Central and Eastern Europe, the Alcaethoe bat was recorded in Germany (Ohlendorf 2008, 2009; Pfeiffer *et al.* 2015), Austria (Hüttmeir *et al.* 2010; Spitzenberger *et al.* 2008), Bulgaria (Benda *et al.* 2016), the Czech Republic (Lučan *et al.* 2009; Řehák *et al.* 2008), Croatia (Pavlinic *et al.* 2012), Hungary (Estok *et al.* 2007), North Macedonia (Micevski *et al.* 2018), Romania (Jere & Dóczy 2007; Uhrin *et al.* 2014), Slovakia (Benda *et al.* 2003; Danko *et al.* 2010), Slovenia (Preset-

nik 2012), Ukraine (Bashta *et al.* 2010; Bashta *et al.* 2011), Italy (De Pasquale & Galimberti 2014), western Caucasus, Georgia, and Armenia (Niermann *et al.* 2007).

The range of the Alcathoe bat in the south extends from Montenegro (Benda 2004) to Greece and the European part of Turkey. Echolocation calls of the Alcathoe bat, but not living animals, were recorded in the southern part of Sweden (Ahlén 2010).

The distribution range of this species is still scattered and disjunctive (Dietz & Dietz 2015; Dietz & Kiefer 2016).

The Alcathoe bat occurs most often in dense, deciduous oak-hornbeam forests, riverine or beech forests, and less frequently in coniferous forests. The habitats are characterised by the presence of water in the form of ponds, streams, rivers, or oxbows. Currently, most of the records are restricted to mountains and uplands, between 300 to 700 m a.s.l. (Dietz & Dietz 2015; Dietz & Höhne 2015). However, preferred areas presumably are much more extended and the Alcathoe bat possibly occurs further in the north, in lowlands.

The first records of this species in Poland originate from the southern part of the country, mainly from the mountains and uplands. However, the latest research revealed that there are many of them in the lowlands. The species was recorded the most often in south-eastern Poland, while in south-western Poland it was observed in Lower Silesia on four occasions (Bashta *et al.* 2011; Bogdanowicz *et al.* 2012; Kmiecik *et al.* 2014; Niermann *et al.* 2007; Piksa *et al.* 2011; Piksa & Gubała 2012; Sachanowicz *et al.* 2012). New observations in recent years show that its occurrence in lowland Poland is much more frequent and it may extend much farther to the north than it was believed earlier. Here we present the latest northernmost records of the Alcathoe bat against the background of previous research in Poland.

Material and Methods

The observations in Silesian Lowland (south-western Poland) were carried out in 2013–2015 using bat nets (Fig. 1). The elevation of the studied sites ranges from 100 to 260 m a.s.l.

The bats were identified by metric characters such as forearm length and body mass, as well as non-metric characters, i.e. tragus shape and length, penis shape, colour of the snout and ear, presence of cingulum on the third upper premolar (Dietz & von Helversen 2004). Reproduction of females was suggested based on signs of lactation such as elongated nipples and lack of hair around them (Baagøe 1977; Racey 1988). To confirm the species identification, DNA was sampled from individuals captured in 2014–2015. The DNA samples came from 3 mm in diameter biopsies of one wing membrane, taken using sterile puncher. The material was preserved in 96 % ethyl alcohol. Molecular identification of the species was carried out based on the fragments of mitochondrial gene ND1 using multiplex combination of seven primers (Boston *et al.* 2011). Then the product was separated on agarose gel. Specific arrangement of bands allowed to distinguish *M. alcathoe*, *M. brandtii*, and *M. mystacinus* (for details of the method see: Boston *et al.* 2011). Molecular analysis was conducted in the laboratory of the Institute of Systematics and Evolution, Polish Academy of Sciences, Kraków. Bats were caught and sampled under license from the Polish General Directorate of Environmental Protection in Warsaw (decision: DZP-WG.6401.09.8.2014).



Fig. 1. Specimen of *Myotis alcathoe* (von Helversen, Heller, 2001) captured by mistnet in environs of Chodlewo near Żmigród (location 3, Fig. 2).

Рис. 1. Особина *Myotis alcathoe* (von Helversen, Heller, 2001), зловлена павутинною сіткою в околицях Ходлева біля Жмігруда (пункт 3 на рис. 2).

Results

A total of seven individuals of the Alcathe bat were captured at four localities (Fig. 2, Table 1). Species identification was confirmed by molecular analysis in four of the seven individuals (Table 1). The remaining three specimens yielded highly degraded DNA or no DNA at all. In these individuals, however, morphological characters typical for *Myotis alcathoe* were confirmed.

The observations were carried out in four localities in Lower Silesia (SW Poland) (Fig. 2): 1) Spring flush near the boundary of the reserve „Dalkowskie Jary” surrounded by a forest with dominance of pedunculate oak and pine, as well as warty birch and robinia (*Robinia pseudoacacia*) aged ca. 60 years. There are commercial mixed forests with prevalence of pine aged from 40 to 120 years. The forests, which are not exploited economically and are part of the nature reserve „Dalkowskie Jary”, are dominated by pedunculate oak aged ca. 140 years and beech aged ca. 160 years (The Forest Data Bank 2016).

2) Near the nature reserve „Łęgi Źródłiskowe koło Przemkowa”, which is surrounded by tree stands with the dominance of more than 80-year-old black alder (*Alnus glutinosa*) and ash (*Fraxinus excelsior*), with admixture of oak (*Quercus* sp.) and beech (*Fagus sylvatica*) aged more than 150 years (The Forest Data Bank 2016). The reserve holds numerous spring flushes with characteristic vegetation of *Montio-Cardaminetea*, as well as drainage ditches. This locality is close to fish ponds.

3) Forest of Chodlewo near Żmigród, in a 50-year-old mixed tree stand dominated by pedunculate oak and Scots pine (*Pinus sylvestris*), as well as beech and warty birch (*Betula pendula*), and single beech trees of 150 years of age. The tree stand is surrounded by a forest with the upper storey of pedunculate oak aged 150 years, and the lower storey of hornbeam (*Carpinus betulus*) aged 50 years. The forest has a dense understorey and herb layer, and much marshy ground covering ca. 50 % of the area (The Forest Data Bank 2016). A drainage canal is located near the site.

4) Manor park in Głębowice near Wołów, established in 1758, covering fish ponds and old ash-alder and oak-hornbeam tree stands. Seventy-five species of trees and shrubs were recorded there, numerous monumental specimens of pedunculate oak (*Quercus robur*) (Bobrowicz & Konieczny 1996) being a characteristic feature of the park.

Lactating females were captured in two localities: near the nature reserve „Łęgi Źródłiskowe koło Przemkowa” and near Chodlewo (Table 1). In the remaining sites, only adult males were captured. One individual was caught on the pond in the park in Głębowice, and a year later another two individuals in the same site. Two individuals were captured around the spring at the boundary of the nature reserve „Dalkowskie Jary” (Table 1).

Discussion

The currently known northernmost finds of the Alcathe bat in Europe were reported from Sweden based on echolocation pulses recorded in 2008–2010 (Ahlén 2010).

To date, there is no information on confirmed occurrence based on captured individuals thus those records are not fully comparable with the other findings. Further records of the species in northern Europe were reported from Great Britain, namely from Ryedale and Sussex (Jan *et al.* 2010). In continental Europe, the northernmost observations of the Alcathe bat were reported from Saxony, Germany (Ohlendorf 2008, 2009).

In Poland, the latest northernmost known locality of the Alcathe bat was known from the vicinities of Słup in the district of Środa Śląska (Kmiecik *et al.* 2014) (Fig. 2).

The observation from the site near the nature reserve „Dalkowskie Jary” is now the northernmost record of the species in Poland and is situated ca. 50 km north of the previous one. The record from vicinities of Słup was the first observation of the species in lowland Poland, and the next four localities described here are also lowland sites. All sites mentioned are located in the Silesian Lowland. The records of the Alcathe bat from the environs of Przemków and Chodlewo are especially important as they suggest that the occurrence of the species farther north may be expected.

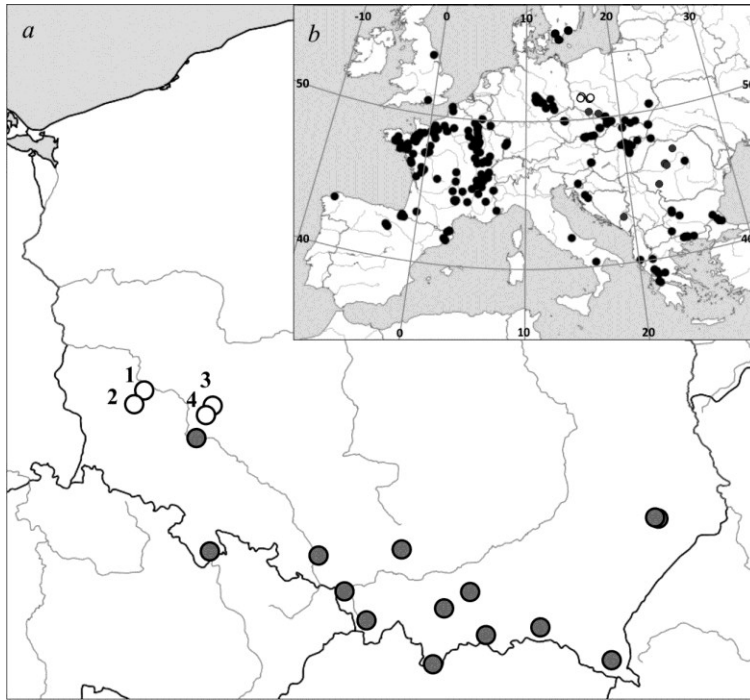


Fig. 2. Record localities of the Alcatthoe bat (*Myotis alcathoe*) in Poland (a) and in Europe (b, after: Niermann *et al.* 2007 with updates (<https://en.wikipedia.org>).

open circles — new findings in Poland (details below); dark points — previous records (after: Bashta *et al.* 2011; Bogdanowicz *et al.* 2012; Kmieciak *et al.* 2014; Sachanowicz *et al.* 2012).

New findings:

- 1) „Dalkowskie Jary”
51°39'02.4''N 15°52'34.6''E,
- 2) „Łęgi Źródłiskowe koło Przemkowa”
51°32'10.59''N 15°45'4.28''E,
- 3) Chodlewo near Źmigród
51°30'59.06''N 16°50'21.61''E,
- 4) Głębowice near Wołów
51°27'3.86''N 16°44'28.56''E.

Рис. 2. Місцезнаходження нічницї малої (*Myotis alcathoe*) у Польщі (a) та в цілому в Європі (b, за: Niermann *et al.* 2007, зі змінами за: <https://en.wikipedia.org>). Позначення: білі круги — нові знахідки, чорні точки — попередні знахідки (за: Bashta *et al.* 2011; Bogdanowicz *et al.* 2012; Kmieciak *et al.* 2014; Sachanowicz *et al.* 2012).

Table 1. New record localities of the Alcatthoe bat in the Silesian Lowland in SW Poland. Numbers in brackets correspond to numbers in Fig. 1

Таблиця 1. Нові місцезнаходження нічницї малої на Сілезькій низовині в південно-західній Польщі. Числа в дужках відповідають цифрам на рис. 1

Site	Capture date	Sex	Age	Reproductive status	Mass [g]	Forearm length [mm]	DNA identification
(1) Spring flush near the boundary of the reserve „Dalkowskie Jary”	11.08.15	M	ad	–	4.5	32.5	yes
(1) Spring flush near the boundary of the reserve „Dalkowskie Jary”	11.08.15	M	ad	–	4.5	32.5	yes
(2) Near the nature reserve „Łęgi Źródłiskowe koło Przemkowa”	27.07.13	F	ad	post-lactating	5.0	31.4	no
(3) Environs of Chodlewo near Źmigród	16.08.14	F	ad	post-lactating	6.0	33.0	yes
(4) Manor park in Głębowice near Wołów	08.08.13	M	ad	–	4.5	32.6	no
(4) Manor park in Głębowice near Wołów	06.08.14	M	ad	–	4.0	32.6	no
(4) Manor park in Głębowice near Wołów	06.08.14	M	ad	–	5.0	32.8	yes

New localities of the species described here are the one of the northernmost localities in Central Europe and are, along those in Sweden, Great Britain, and Germany, among the northernmost in the entire known range of the species in Europe. The observations from Lower Silesia confirm the results of radiotracking in Germany, which showed a strong preference of the species to old deciduous stands, especially oak forests (Dietz & Dietz 2015). Such forests may serve suitable shelters in hollow branches, cavities or crags (Coronado *et al.* 2017; Lučan *et al.* 2009).

Another distinctive feature of the habitats described here is the presence of standing and running water. Similar observations were reported from Hessen and Saxony in Germany (Dietz & Höhne 2015; Meisel *et al.* 2015). Habitat preferences were also confirmed by the diet composition (Lučan *et al.* 2009; Roswang *et al.* 2019). The observations suggest that the species' range extends over a much larger area in that part of Europe than it was formerly believed (Dietz & Dietz 2015) and is not restricted only to uplands and mountains.

Considering the rather small distance between the records from south-western Poland (Bogdanowicz *et al.* 2012; Kmiecik *et al.* 2014; Sachanowicz *et al.* 2012), Germany (Saxony) (Meisel *et al.* 2015), and the Czech Republic (Lučan *et al.* 2009), as well as the availability of suitable habitats in those regions, it can be concluded that in that part of Europe the range of this species is more continuous than it was formerly believed. Due to the species' preference to old, near-natural forests, this species can be considered as an indicator of such environments.

Conclusion

The presented data expand the knowledge on the occurrence of the Alcaethoe bat in Poland and Europe. Currently, the incomplete knowledge on the species' distribution does not allow an unequivocal determination of its geographic range in this part of the European continent.

The new data obtained from Poland indicate that the range of this species may be much wider than it was suggested earlier. More studies are needed to clarify the exact distribution and abundance of the species in Europe.

Acknowledgements

We thank the volunteers Maurycy Ignaczak, Krzysztof Konieczny, Julia Kończak, Anna Walner, and Anna Wójcicka-Rosińska who helped with fieldwork, as well as the anonymous reviewer for valuable comments.

References

- Ahlén, I. 2010. Nymffladdermus *Myotis alcathoe* – en nyupptäckt art i Sverige. *Fauna och Flora*, **105**: 8–15.
- Alcalde, J. T. 2009. *Myotis alcathoe* Helversen & Heller, 2001 and *Pipistrellus pygmaeus* (Leach, 1825), new species of Chiroptera in Navarre. *Munibe (Ciencias Naturales-Natur Zientziak)*, **57**: 225–236.
- Baagøe, H. J. 1977. Age determination in bats. *Videnskabelige Meddelelser Dansk Naturhistorisk Forening*, **140**: 53–92.
- Bashita, A. T., L. Pokrytiuk, P. Benda. 2010. Alcaethoe's bat *Myotis alcathoe* — a new bat species (Chiroptera: Vespertilionidae) in Ukraine. *Vestnik Zoologii*, **44**: 15–52.
- Bashita, A. T., M. Piskorski, R. W. Mysłajek, A. Tereba, K. Kurek, K. Sachanowicz. 2011. *Myotis alcathoe* in Poland and Ukraine: new data on its status and habitat in Central Europe. *Folia Zoologica*, **60**: 1–4. [CrossRef](#)
- Benda, P., M. Ruedi, M. Uhrin. 2003. First record of *Myotis alcathoe* (Chiroptera: Vespertilionidae) in Slovakia. *Folia Zoologica*, **52**: 359–365.
- Benda, P., S. Gazaryan, P. Vallo. 2016. On the distribution and taxonomy of bats of the *Myotis mystacinus* morphogroup from the Caucasus region (Chiroptera: Vespertilionidae). *Turkish Journal of Zoology*, **40**: 842–863. [CrossRef](#)
- Bobrowicz, G., K. Konieczny. 1996. *Dendroflora parku podworskiego w Głębowicach*. Msc. „Ciconia” Grzegorz Bobrowicz. Wołów.
- Bogdanowicz, W., K. Piksa, A. Tereba. 2012. Genetic structure in three species of whiskered bats (genus *Myotis*) during swarming. *Journal of Mammalogy*, **93**: 799–807. [CrossRef](#)
- Boston, E. S. M., N. Hanrahan, S. J. Puechmaille, M. Ruedi, D. J. Buckley, M. G. Lundy, D.D. Scott, P. A. Prodöhl, W. I. Montgomery, E. C. Teeling. 2011. A rapid PCR-based assay for identification of cryptic *Myotis* spp. (*M. mystacinus*, *M. brandtii* and *M. alcathoe*). *Conservation Genet Resour*, **3**: 557–563. [CrossRef](#)
- Coronado, A., C. Flaquer, X. Puig-Montserrat, E. Barthe, M. Mas, A. Arrizabalaga, A. Lopez-Baucells. 2017. The role of secondary trees in Mediterranean mature forests for the conservation of the forest-dwelling bat *Myotis alcathoe*. Are current logging guidelines appropriate? *Hystrix, the Italian Journal of Mammalogy*, **28** (2): 240–246.
- Danko, Š., A. Krištin, J. Krištofik. 2010. *Myotis alcathoe* in eastern Slovakia: occurrence, diet, ectoparasites and notes on its identification in the field. *Vespertilio*, **13-14**: 77–91.
- De Pasquale, P. P., A. Galimberti. 2014. New records of the Alcaethoe bat, *Myotis alcathoe* (Vespertilionidae) for Italy. *Barbastella, Journal of Bat Research*, **7** (1): 3–5. [CrossRef](#)
- Dietz, C., A. Kiefer. 2016. *Bats of Britain and Europe*. Bloomsbury Publishing Plc, 1–398.
- Gessner, B. 2012. Teichfledermaus (*Myotis dasycneme* Boie, 1825) und Nymphenfledermaus (*Myotis alcathoe* Helversen & Heller, 2001), zwei neue Fledermausarten für Luxemburg. *Bulletin de la Société des naturalistes luxembourgeois*, **113**: 137–140.
- Dietz, C., O. von Helversen. 2004. *Illustrated identification key to the bats of Europe*. Electronic publication, version 1.0. [biocenosi.dipbsf.uninsubria.it/didttica/bat_key1.pdf].
- Dietz, C., O. von Helversen, D. Nill. 2009. *Nietoperze Europy i Afryki północno-zachodniej*. MULTICO Oficyna Wydawnicza, Warszawa, 1–398.
- Dietz, I., C. Dietz. 2015. Beutetiere, Quartierwahl und Jagdgebietsnutzung der Nymphenfledermaus *Myotis alcathoe*. In: *Tagungsband „Verbreitung und Ökologie der Nymphenfledermaus“ – herausgegeben vom Bayerischen Landesamt für Umwelt*. Augsburg, 35–48.
- Dietz, M., E. Höhne. 2015. Kenntnisstand zur Verbreitung und zu den Lebensräumen der Nymphenfledermaus *Myotis alca-*

- thoe in Hessen. In: *Tagungsband „Verbreitung und Ökologie der Nymphenfledermaus“ – herausgegeben vom Bayerischen Landesamt für Umwelt*. Augsburg, 115–126.
- Hutson, A. M., M. Paunović. 2016. *Myotis alcathoe*. The IUCN Red List of Threatened Species 2016: e.T136680A518740. <https://bit.ly/2V2BqkS> (Accessed: 3 January 2017).
- Hüttmeir, U., A. Reiter, G. Reiter G. 2010. Fledermäuse in den Nationalparks Thayatal und Podyji, sowie Erstnachweis der Nymphenfledermaus (*Myotis alcathoe* Helversen & Heller, 2001) in Niederösterreich. *Wissenschaftliche Mitteilungen Niederösterreichisches Landesmuseum*, **21**: 433–444.
- Jan, C. M. I., K. Frith, A. M. Glover, R. K. Butlin, C.D. Scott, F. Greenaway, M. Ruedi, A.C. Frantz, D.A. Dawson, J.D. Altringham. 2010. *Myotis alcathoe* confirmed in the UK from mitochondrial and microsatellite DNA. *Acta Chiropterologica*, **12**: 471–483. [CrossRef](#)
- Jere, C., A. Dóczy. 2007. Prima semnalare a speciei de liliiac *Myotis alcathoe* Helversen et Heller, 2001 (Chiroptera, Vespertilionidae) din Romania. *Acta Siculica*, 179–183.
- Kmiecik, P., A. Kmiecik, J. Furmankiewicz. 2014. Nowe stanowiska nokca Alkatoe *Myotis alcathoe* Helversen et Heller, 2001 na Dolnym Śląsku. *Nietoperze*, **13** (1-2): 36–39.
- Kondracki, J. 2009. *Geografia regionalna Polski*. Wydawnictwo Naukowe PWN, Warszawa, 1–441.
- Lučan, R. K., M. Andreas, P. Benda, T. Bartonička, T. Březinová, A. Hoffmannová, Š. Hulová, P. Hulva, J. Neckářová, A. Reiter, T. Svačina, M. Šálek, I. Horáček. 2009. *Alcathoe* bat (*Myotis alcathoe*) in the Czech Republic: distributional status, roosting and feeding ecology. *Acta Chiropterologica*, **11**: 61–69.
- Lučan, R. K., P. Benda, A. Reiter, J. Zima. 2011. Reliability of field determination in three cryptic whiskered bats (*Myotis alcathoe*, *M. mystacinus*, *M. brandtii*) and basic biometric characters: evidence from the Czech Republic. *Vespertilio*, **15**: 55–62. [CrossRef](#)
- Meisel, F., T. Frank, M. Roßner, U. Zöphel, C. Schmidt. 2015. Nachweise der Nymphenfledermaus (*Myotis alcathoe*) in Sachsen. In: *Tagungsband „Verbreitung und Ökologie der Nymphenfledermaus“ – herausgegeben vom Bayerischen Landesamt für Umwelt*. Augsburg, 127–136.
- Micevski, N., J. Juste, B. Micevski. 2018. First record of *Myotis alcathoe* von Helversen & Heller, 2001 (Chiroptera: Vespertilionidae) in Macedonia. *Journal of Bat Research & Conservation*, **11** (1): 1–5. [CrossRef](#)
- Niermann, I., M. Biedermann, W. Bogdanowicz, R. Brinkmann, Y. Le Bris, M. Ciechanowski, C. Dietz, I. Dietz, P. Estók, O. von Helversen, A. Le Houédec, S. Paksuz, B. P. Petrov, B. Özkan, K. Piksa, A. Rachwald, S. Y. Roué, K. Sachanowicz, W. Schorcht, A. Tereb, F. Mayer. 2007. Biogeography of the recently described *Myotis alcathoe* von Helversen and Heller, 2001. *Acta Chiropterologica*, **9**: 361–378. [CrossRef](#)
- Nyssen, P., Q. Smits, M. Van de Sijpe, B. Vandendriessche, D. Halfmaerten, D. Dekeukeleire. 2015. First records of *Myotis alcathoe* von Helversen & Heller, 2001 in Belgium. *Belgian Journal of Zoology*, **145** (2): 130–136. [CrossRef](#)
- Ohlendorf, B. 2008. Status und Schutz der Nymphenfledermaus in Sachsen-Anhalt. *Naturschutz im Land Sachsen-Anhalt*, **45** (2): 44–49.
- Ohlendorf, B. 2009. Aktivitäten der Nymphenfledermaus (*Myotis alcathoe*) vor Felsquartieren und erster Winternachweis im Harz (Sachsen-Anhalt). *Nyctalus*, **14**: 149–157.
- Pavlinić, I., N. Tvrtković, M. Podnar. 2012. Preliminary data on genetics and morphometrics of *Myotis alcathoe* (Chiroptera, Vespertilionidae) in Croatia. *Mammalia*, **76** (3): 331–334. [CrossRef](#)
- Piksa, K., W. Bogdanowicz, A. Tereba. 2011. Swarming of bats at different elevations in the Carpathian Mountains. *Acta Chiropterologica*, **13**: 113–122. [CrossRef](#)
- Piksa, K., W. J. Gubala. 2012. Fauna nietoperzy Jaskini Mrocznej (Rezerwat Kornuty, Beskid Niski). *Roczniki Bieszczadzkie*, **20**: 134–145.
- Presetnik, P. 2012. Descriptions of first records of *Myotis alcathoe* in Slovenia. *Natura Sloveniae*, **14** (1): 5–13.
- Presetnik, P., M. Paunović, B. Karapandža, M. Durović, Č. Ivanović, M. Ždralević, P. Benda, I. Budinski. 2014. Distribution of bats (Chiroptera) in Montenegro. *Vespertilio*, **17**: 129–156.
- Pfeiffer, B., M. Hammer, U. Marckmann, J. Thein, G. Hübner, B-U. Rudolph. 2015. Die Verbreitung der Nymphenfledermaus *Myotis alcathoe* in Bayern. In: *Tagungsband „Verbreitung und Ökologie der Nymphenfledermaus“ – herausgegeben vom Bayerischen Landesamt für Umwelt*. Augsburg, 98–114.
- Racey, P.A. 1988. Reproductive assessment in bats. In: T. H. Kunz (ed.). *Ecological and Behavioral Methods for the Study of Bats*. Smithsonian Institution Press, Washington, 31–45.
- Řehák, Z., T. Bartonička, J. Bryja, J. Gaisler. 2008. New records of the *Alcathoe* bat, *Myotis alcathoe* in Moravia (Czech Republic). *Folia Zoologica*, **57**: 465–469.
- Roswag, A., N. I. Becker, R. Drangusch, K. Kuhring, B. Ohlendorf, J.A. Encarnação. 2019. Teasing apart cryptic species groups: Nutritional ecology and its implications for species-specific conservation of the *Myotis mystacinus* group. *Population Ecology*, **61**: 14–24. [CrossRef](#)
- Sachanowicz, K., T. Mleczek, T. Gottfried, M. Ignaczak, K. Piksa, M. Piskorski. 2012. Winter records of *Myotis alcathoe* in southern Poland and comments on identification of the species during hibernation. *Acta Zoologica Cracoviensia*, **55** (1): 97–101. [CrossRef](#)
- Schorcht, W., I. Karst, M. Biedermann. 2009. Die Nymphenfledermaus (*Myotis alcathoe* von Helversen & Heller, 2001) im Kyffhäusergebirge/Thüringen (Mammalia: Chiroptera) – aktuelle Kenntnisse zu Vorkommen und Habitatnutzung. *Vernate*, **28**: 115–129.
- Spitzenberger, F., I. Pavlinić, M. Podnar. 2008. On the occurrence of *Myotis alcathoe* von Helversen and Heller, 2001 in Austria. *Hystrix, the Italian Journal of Mammalogy*, **19**: 3–12.
- The Forest Data Bank*, Available at: <https://bit.ly/3q1QFZK> (Accessed: 3 January 2020).
- Uhrin, M., B. Benda, R. Lučan, E. Miková, M. Rendoš, I. Horáček. 2014. Noteworthy bat records from Romania. *Vespertilio*, **17**: 197–213.
- Alcathoe* bat *Myotis alcathoe*. *Wikipedia*. [<https://bit.ly/2Je6uMr>; map: 16.02.16, access: 20.08.2020].
- Von Helversen, O. 2004. *Myotis alcathoe* v. Helversen und Heller, 2001 – Nymphenfledermaus. Pp.: 1159–1167. In: F. Krapp (ed.). *Handbuch der Säugetiere Europas*. Band 4: Fledertiere. Teil II: Chiroptera II. Vespertilionidae 2, Molossidae, Nycteridae. Aula-Verlag, Wiebelsheim, X + 605–1186. [CrossRef](#)
- Von Helversen, O., K. G. Heller, F. Mayer, A. Nemeth, M. Volleth, P. Gombkoto. 2001. Cryptic mammalian species: a new species of whiskered bat (*Myotis alcathoe* n. sp.) in Europe. *Naturwissenschaften*, **88**: 217–223.