

The elusive pygmy moth *Bohemannia auriciliella* (DE JOANNIS, 1909): overview of its distribution, with new records for Germany and Bulgaria (Lepidoptera: Nepticulidae)

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Abstract. An overview of the records of *Bohemannia auriciliella* (DE JOANNIS, 1909) in Europe is given, including the first record for Germany (Lower Saxony, Hannover, 2018) and Bulgaria (Burgas, 2002) and new records for the Netherlands and France. In total only 28 specimens are known. Information on the recognition of the moth, and on DNA barcode is provided and additionally, its hidden lifecycle is briefly discussed.

Zusammenfassung. Für die Zwergmüliermotte *Bohemannia auriciliella* (DE JOANNIS, 1909) wird eine Zusammenstellung aller bisherigen Fundorte Europas präsentiert, einschließlich der Erstfunde für Deutschland (Niedersachsen, Hannover, 2018) und Bulgarien (Burgas, 2002), und weiterer Nachweise für die Niederlande und Frankreich. Insgesamt sind lediglich 28 Exemplare bekannt. Des Weiteren werden Diagnosemerkmale genannt und Informationen zum DNA-Barcode gegeben. Zusätzlich wird kurz auf den noch immer unbekanntem Lebenszyklus dieser Art eingegangen.

Key words. Germany, Bulgaria, France, Palaearctic Region, first record, host-plant, birch, *Betula*, *Bohemannia*, *auriciliella*, Nepticulidae, Lepidoptera.

Introduction

The pygmy moths (Nepticulidae) include some of the smallest moths in the world. In some species the wing length measures just over one millimetre (GARCÍA-BARROS et al. 2017). Consistent with their tiny size, little is known about the biology and distribution of many species, although the larval leafmines of the majority of species are quite characteristic and more often found than the moths. Especially when the caterpillars do not make such mines, the distribution maps show still many gaps as few people collect or photograph these tiny insects. Despite of being described over a hundred years ago, and being a relatively large nepticulid species (wing-span 6–7 mm), knowledge about the distribution of the species *Bohemannia auriciliella* (DE JOANNIS, 1909) in Europe only increased in the past five decades. Including the new records presented here, 28 specimens of this species are now known from throughout Europe.

Discovery and distribution

It all starts in the year 1909 when *Nepticula auriciliella* was described by J. DE JOANNIS on one female specimen, collected in Vannes by his brother L. DE JOANNIS during the 17 preceding years (France, département Morbihan). The species was more or less forgotten for 70 years, and KLIMESCH (1975) contributed to that by synonymizing it with *Bohemannia quadrimaculella* (BOHEMAN, 1853).

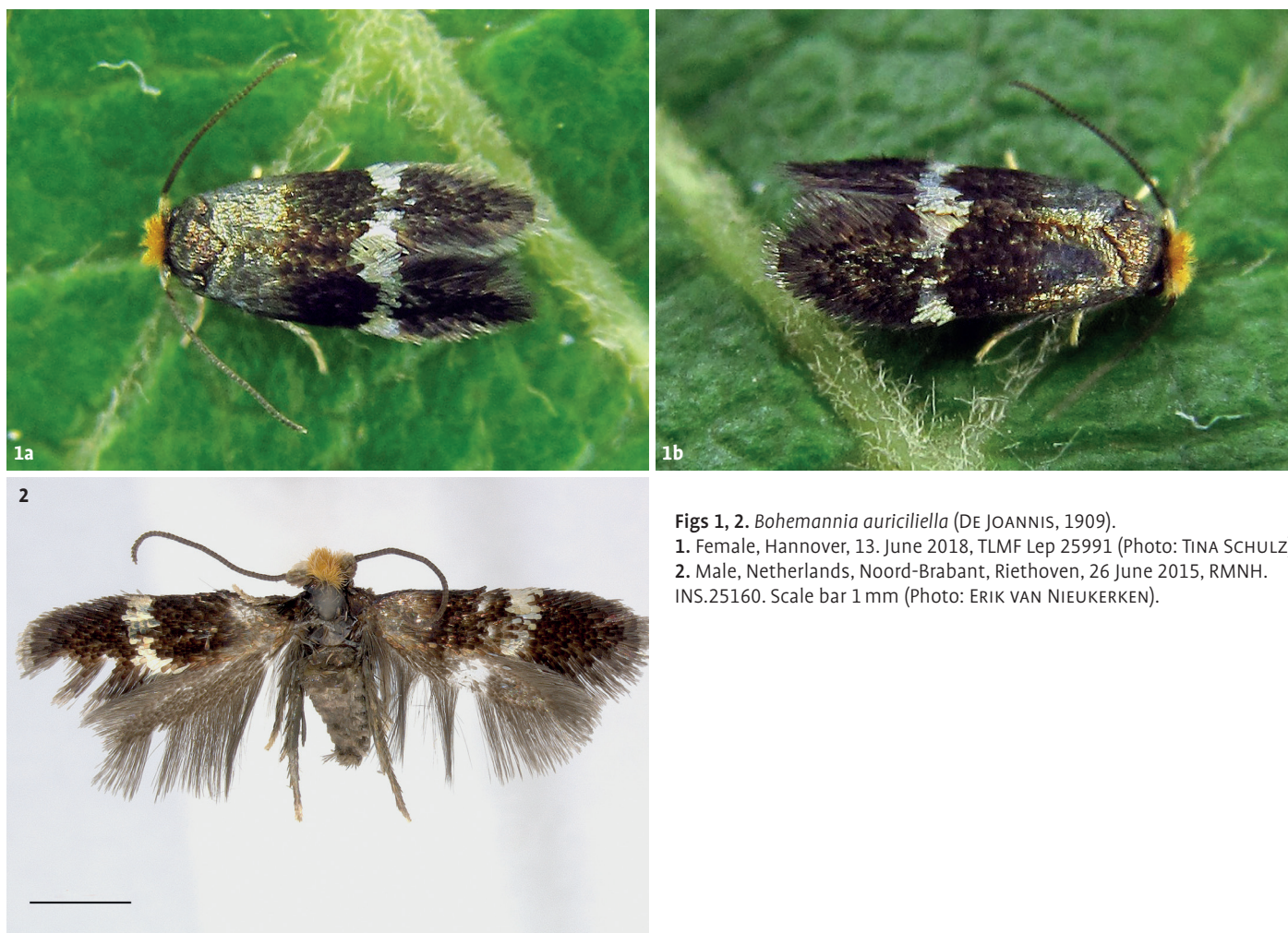
Around the same time, another specimen was discovered in Kent (Great Britain). The well-known British Microlepidoptera specialist MAITLAND EMMET published the find by E. S. BRADFORD in 1974 as a new species, *Ectoedemia bradfordi* EMMET, 1974, also based on the advice of JOSEF KLIMESCH, who did not see the resemblance with JOANNIS' type that he must have seen before. The second specimen of "*Ectoedemia bradfordi*" was found amongst unidentified material in the collection of the Zoological Museum Amsterdam, caught already in 1931 in Hatert, near

Nijmegen (Netherlands) (VAN NIEUKERKEN 1982).

Eventually, in 1986, the second author discovered the synonymy of the male *Ectoedemia bradfordi* EMMET, 1974 with the female *Nepticula auriciliella* DE JOANNIS, 1909 based on externals, and recombined it with *Bohemannia* STANTON, 1859 (VAN NIEUKERKEN 1986a). Soon thereafter he found an additional old specimen in the Copenhagen collection: a female moth from Southampton, accidentally reared in 1937 by W. FASSNIDGE (VAN NIEUKERKEN 1986b). Step by step, more specimens were found. The Netherlands followed with two more records from the year 1988 (Meijnweg and Mariapeel). In the next decade active British and Dutch collectors found more specimens: 1993 (Lover, South Wiltshire), Twello and Wageningen-Hoog (Gelderland 1996), and two moths from Gietelo (Gelderland) at the turn of the millennium. Additional records from Great Britain presumably document the activity of British microlepidopterists: moths were found in 2001 (Berkshire), 2003 (Hampshire), 2010 (Surrey), 2011 (Buckinghamshire), 2014 (Suffolk), 2015 (Southend-on-Sea) and reached the point of culmination in 2017 with three new records (Gloucestershire, Buckinghamshire and Worcestershire).

Nevertheless, after 2000 the species also shows up in other European countries. In 2003 it appears in Czechia (LIŠKA et al. 2005), and 2007 in Switzerland (SWISS-LEPTEAM 2010). The first record for Bulgaria is made in 2002 (Burgas; two specimens, leg. JARI JUNNILAINEN), here published for the first time, a second French specimen was collected in the Pyrenees (2010), and two new specimens were recently found in the Netherlands (2015, 2018), here recorded (Table 1, Fig. 5).

In the light of these data, Germany would perfectly fit in the distribution. In this paper the long awaited record is reported:



Figs 1, 2. *Bohemannia auriciliella* (DE JOANNIS, 1909).
 1. Female, Hannover, 13. June 2018, TLMF Lep 25991 (Photo: TINA SCHULZ).
 2. Male, Netherlands, Noord-Brabant, Riethoven, 26 June 2015, RMNH.
 INS.25160. Scale bar 1 mm (Photo: ERIK VAN NIEUKERKEN).

on the 13th of June 2018 one specimen of *Bohemannia auriciliella* was collected on a sheet with 160 W mixed light, 2 x 18 W black light, 2 x 20 W superactinic light during a public mothing event in the Eilenriede, the city forest of Hannover. There, around the “Waldstation” (which is a place to learn more about the forest’s ecosystem) the biotope type can be classified as “Bodensaurer Buchenwald” (literally “beech forest on acidic soil”), with a tree age of 65–130 years. Other trees occurring there, besides European beech (*Fagus sylvatica*, Fagaceae), are Scots pine (*Pinus sylvestris*, Pinaceae), European spruce (*Picea abies*, Pinaceae), European larch (*Larix decidua*, Pinaceae), oaks (*Quercus* sp. Fagaceae), European black alder (*Alnus glutinosa*, Betulaceae), Silver birch (*Betula pendula*, Betulaceae) and Douglas fir (*Pseudotsuga menziesii*, Pinaceae). Since a few ponds have been laid out in close proximity to the “Waldstation”, the air humidity is relatively high.

Molecular analysis (Barcoding)

A sample of the Hanoverian specimen was sequenced by the Canadian Centre for

DNA Barcoding (Guelph). The result was very surprising, and was confirmed by EvN whom TS sent a photo of the moth per email. Three other specimens were barcoded in Leiden according to procedures as described before (DOORENWEERD et al. 2016, VAN NIEUKERKEN et al. 2012). In all now four specimens have been barcoded, and all show almost the same sequence, with Barcode Identification Number BOLD:ACG8823, and a maximal distance of 0.16%. The records can be seen on the BOLD Website: <http://dx.doi.org/10.5883/BOLD:ACG8823>. The Nearest Neighbour interestingly is the unrelated *Gonionota amauroptera* CLARK, 1971, a Depressariidae from Argentina. The barcode distance to other known *Bohemannia* species is always larger than 15%.

Recognition

Bohemannia auriciliella (Figs 1, 2) is relatively easy to recognise. It is one of the medium large Nepticulidae with a yellow head, wingspan 6–7 mm, collar rather small with lamellar scales (as in *Stigmella* species) and scape (eyecap) with the posterior quarter grey (but this is not the case

in one female) and a relatively long antenna with 44–53 segments in male, 35–38 in female. The forewing has a silver fascia beyond the middle, sometimes broken in two spots, and a brassy basal quarter. *Bohemannia quadrimaculella* (BOHEMAN, 1853) is larger, 7.0–8.5 mm wingspan, has a uniform scape, antenna white tipped and forewing without a brassy base. Only some *Stigmella* species have a scape with a dark edge, males of the much smaller *S. betulicola* (STAINTON, 1856), *S. alnetella* (STAINTON, 1856) and the male of *S. lemniscella* (ZELLER, 1839), but that has a black head and black androconial scales on the hindwing. See also VAN NIEUKERKEN & JOHANSSON (1990) and LAŠTŮVKA & LAŠTŮVKA (1997), also for genitalia illustrations. The male genitalia are very characteristic (Fig. 3), the female genitalia lack the characteristic signa of most related species, the terminal segments of the holotype are illustrated in Fig. 4.

Discussion

Considering the small size of this species and the only few interested parties for very small moths like Nepticulidae, it seems not

Tab. 1. Synopsis of records of *Bohemannia auriciliella* (DE JOANNIS, 1909), listed more or less chronologically, grouped by country. Geographic coordinates were in most instances derived from Google Earth.

Country, Location	Date	Number, Sex	Coordinates	Collector	Note/References
F, Morbihan: Vannes	23.VI.(before 1909)	1 ♀	47.67N 2.73W	J. DE JOANNIS	Holotype, DE JOANNIS 1909
F, Pyrenées Or.: Caixas, La Serre	29.V.–19.VI.2010	1 ♀	42.582 N 2.6765E	B. WIKSTRÖM	RMNH.INS.25199, New record
NL, Gelderland: Hatert, near Nijmegen	21.VI.1931	1 ♂	51.804N 5.828E	LYCKLAMA à NIJEHOLT	RMNH.INS.20115, VAN NIEUKERKEN 1982, 1986b
NL, Limburg: Mariapeel, near Helenaveen	17.VI.1988	1 ♀	51.403N 5.92E	J. H. KUCHLEIN	KUCHLEIN et al. 2000
NL, Limburg: Meijnweg	9.VII.1988	1 ♂	51.173N 6.125E	G. R. LANGOHR	VAN NIEUKERKEN et al. 1993
NL, Gelderland: Twello	10.VII.1996	1 ♂	52.2426N 6.1084E	J. B. WOLSCHEIJN	KUCHLEIN et al. 2000
NL, Gelderland: Wageningen-Hoog	12.VII.1996	1 ♂	51.988N 5.6892E	J. H. KUCHLEIN	pers. comm. J. KUCHLEIN
NL, Gelderland: Gietelo	11.VI.2000	1 ♀	52.183N 6.139E	J. B. WOLSCHEIJN	WOLSCHEIJN & KUCHLEIN 2001
NL, Gelderland: Gietelo	16.VI.2000	1 ♂	52.183N 6.139E	J. B. WOLSCHEIJN	RMNH.INS.23747, WOLSCHEIJN & KUCHLEIN 2001
NL, Noord-Brabant: Bergeijk, Riethoven	26.VI.2015	1 ♂	51.375N 5.422E	F. GROENEN	RMNH.INS.25160, New record
NL, Gelderland: Wageningen-Hoog	12.VI.2018	1 ♂	51.988N 5.6892E	J. H. KUCHLEIN	pers. comm. J. KUCHLEIN
GB, Kent (VC15): Childs Forstal Wood, East Blean	7.VII.1973	1 ♂	51.337N 1.123E	E. S. BRADFORD	Holotype <i>E. bradfordi</i> , EMMET 1974, VAN NIEUKERKEN 1986a
GB, Hampshire (VC11): Southampton	11.VII.1937	1 ♀	50.90N 1.40W	W. FASSNIDGE	VAN NIEUKERKEN 1986b
GB, South Wiltshire (VC8): Lover	24.VI.1993	1	50.978N 1.696W	M. F. W. CORLEY	CORLEY 1994
GB, Berkshire (VC22): Pine Wood	22.VI.2001	1	51.385N 0.793W	D. J. GIBBS	GIBBS 2002, LANGMAID & YOUNG 2002
GB, Hampshire (VC11): Wickham Common	29.VI.2003	1	50.894N 1.16W	R. J. DICKSON	LANGMAID & YOUNG 2004
GB, Surrey (VC17): Knaphill	27.VI.2010	1 ♂	51.317N 0.615W	A. J. HALSTEAD	LANGMAID & YOUNG 2011
GB, Buckinghamshire (VC24): Amersham, Hodgemoor Wood	2.VII.2011	1 ♂	51.632N 0.607W	P. HALL	HALL 2012
GB, Suffolk (VC25): Tangham Forest	21.VI.2014	1 ♂	52.075N 1.437E	A. WATSON	LANGMAID & YOUNG 2015
GB, Essex (VC18): Southend-on-Sea, Belfairs Woods	30.VI.2015	1 ♂	51.557N 0.635E	C. LEWIS	LEWIS 2015
GB, Gloucestershire (VC34): Dymock Wood	19.VI.2017	1 ♂	51.953N 2.458W	G. H. J. MEREDITH	MEREDITH 2019
GB, Buckinghamshire (VC24): Bernwood Forest, Hell Coppice	21.VI.2017	1 ♂	51.788N 1.113E	P. HALL	HALL 2019
GB, Worcestershire (VC37): Shoulton	22.VIII.2017	1 ♂	52.226N 2.288W	P. CLEMENT	CLEMENT 2017
BG, Burgas, 40 km SE: Ropotamo	5.VI.2002	2 ♂	42.27N 27.73E	J. JUNNILAINEN	RMNH.INS.23932, New record
CZ, Moravia: Lanžhot, Soutok	24.V.2003	1 ♀	48.618N 16.94E	J. LIŠKA	LIŠKA et al. 2005
CH, Canton of Geneva: Jussy	5.VI.2007	1 ♂	46.247N 6.288E	B. LANDRY & D. RUBINOFF	SWISSLEPTeam 2010
DE, Niedersachsen: Hannover	13.VI.2018	1 ♀	52.3898N 9.7887E	T. SCHULZ	TLMF Lep 25991, New record

so astonishing that *Bohemannia auriciliella* was discovered relatively late in Germany. Yet this has more reasons. There remains still some uncertainty concerning the host plant and especially the immature stages. What we know for sure is that adults occur between late May and August, with most records from June and early July. The host plant is thought to be birch, mostly because the collection label of W. FASSNIDGE's specimen says it was reared from birch. EMMET (1987) suggested a scenario that FASSNIDGE reared the moth only accidentally from branches collected to get *Lampronia fuscata*

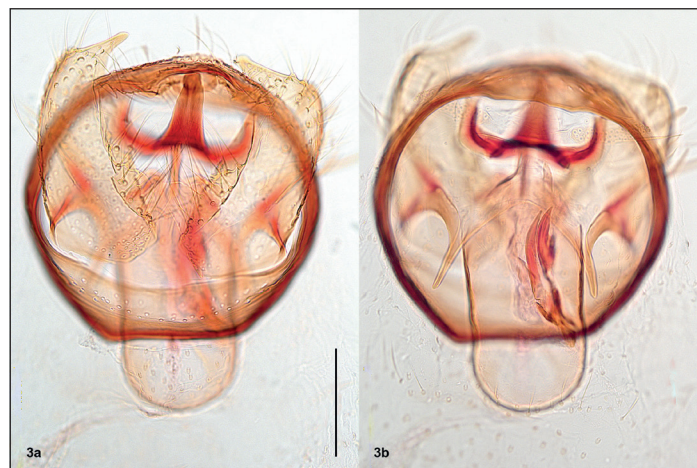


Fig. 3. Male genitalia of *Bohemannia auriciliella* (DE JOANNIS, 1909). **3a.** Ventral view. **3b.** Focussed more dorsally. Genitalia slide EvN5160, RMNH.INS.25160. Scale bars 100 µm (Photo: ERIK VAN NIEUKERKEN).

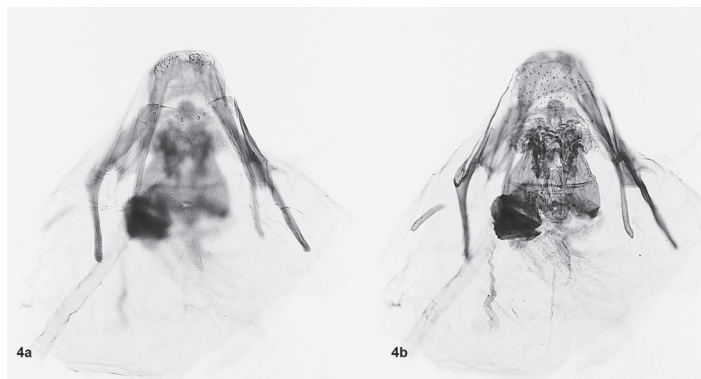


Fig. 4. Female genitalia of *Bohemannia auriciliella* (DE JOANNIS, 1909), Holotype. Only the terminal segments are illustrated, as the bursa did not show any detail.
4a. Dorsal view.
4b. Focussed more ventrally. Genitalia slide KL0720 (Photo: ERIK VAN NIEUKERKEN).

(TENGRÖM, 1848), which lives in twig galls in birch. Unfortunately, there are no further notes by FASSNIDGE to enlighten this case. This was the exclusive record of a larva of *B. auriciliella*; since then it has not been found again.

If one considers that the main method to find pygmy moths is by searching their mining tracks, it seems clear that the mine of *B. auriciliella* can not be easily recognised. So the larva's lifestyle is expected to be concealed; it is unlikely to be a leaf miner. Perhaps the larva lives inside a bud or a petiole (VAN NIEUKERKEN et al. 1986b), as it is known from a related species, *Bohemannia quadrimaculella* (BOHEMAN, 1853), which most likely inhabits alder buds (EMMET 1984, VAN NIEUKERKEN 1986c).

Further, it may be interesting, that one moth was beaten from birch (VAN NIEUKERKEN et al. 1993), although all other specimens were swept from different bushes or low vegetation, or came to light, like the Hanoverian specimen did. At least one prominent silver birch is growing approximately ten metres apart from the sheet where it was collected. Nearby there are also black alders next to the ponds' edges. All Dutch records are also from relatively poor sandy soils with birch commonly present. However, it is doubtful that birch occurs at the more Mediterranean localities in Bulgaria and the Pyrenees. The elusive larval life history is one explanation, but still *B. auriciliella* is much less frequently found than *B. quadrimaculella*, so that possibly also the adult is more elusive and more difficult to find.



Fig. 5. Map showing the records of *Bohemannia auriciliella* (DE JOANNIS, 1909) in Europe. Map made with ArcGis software.

Although *B. auriciliella* was described 111 years ago, its larva and lifecycle are still unknown. Furthermore, it is expected to be less scarce than it seems, as the known distribution covers a large part of Europe, and more and more specimens are found, especially in countries with many active microlepidopterists. What we need, to prove this, is a suitable method for finding the larva. By now many Nepticulidae species can be recorded only by the larva's host plant and their way of mining. For *B. auriciliella* this approved method hopefully is possible too – we are lacking only the knowledge to do so. This enigma should encourage us to finally disclose the secret of its hidden biology. The recent finding and photographing of the similarly poorly known larval feeding of *Etainia* species in winter is somewhat promising in this respect (SOBCZYK et al. 2018).

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Note added

The year 2020 apparently has been very good for this species. After the paper went to press, several records became available and EvN even collected one female himself, increasing the total known number of specimens from 28 to 38.

DIETER ROBRECHT collected two males as the second record for Germany and first record for Nordrhein-Westfalen (NSG Haselbachaue, 19.VI.2020, see Lepiforum.de). GUY H. J. MEREDITH recorded a total of four specimens in Dymock Wood (28.VI.–4.VII.2020), where he found it some

years ago (https://www.facebook.com/groups/1058038610890196/?post_id=3544304065596959, will be published in detail in Entomologist's Record) and EJvN collected one female at light in the Netherlands, Gelderland (Harfsen, Calluna Park, 25.VI.2020).

We received further information on older records: a second specimen in Wickham Common (GB, Hampshire) from 8.VII.2005, earlier overlooked by us (<http://www.hantsmoths.org.uk/index.htm>); a third female from France, Cotes d'Amor in

Brittany (Trégenestre, mid.VIII.1997, on *Salix caprea*, PATRICE LERAUT, pers. comm.) and another overlooked specimen from the Netherlands, province of Overijssel (Springendal, 10.VII.2013, PAUL VAN WONDEREN, TYMO MUUS (https://www.facebook.com/groups/microlepidoptera/?post_id=660319497331340)).

All records of this species will be submitted as dataset to GBIF (www.gbif.org). We thank all recorders for the information.