Systematics of Slovenian *Dahlica* Enderlein, 1912, subgenus *Brevantennia* Sieder, 1953 (Lepidoptera, Psychidae)

Jurij Rekelj[1], Željko Predovnik[2], Peter Huemer[3], Carlos Lopez-Vaamonde[4,5]

1 *Struževo 35, 4000 Kranj, Slovenia; jurij.rekelj@gmail.com*

2 *Ob železnici 82, 3313 Polzela, Slovenia; predovnik1@gmail.com*

3 *Tiroler Landemuseen Betriebsges.m.b.H., Naturwissenschaftliche Sammlungen, Krajnc-Str. 1, 6060 Hall in Tirol, Austria; p.huemer@tiroler-landesmuseen.at*

4 *INRAE, URZF, Zoologie Forestiere, Orléans, France*

5 *IRBI, UMR 7261, CNRS-Université de Tours, Tours, France; carlos.lopezvaamonde@inrae.fr*

http://zoobank.org/3DB0F27F-4AE1-420F-A0E6-95A3A19E6DBE

Received 3 February 2022; accepted 25 May 2022; published: 17 June 2022
Subject Editor: David C. Lees.

Abstract. The subgenus *Brevantennia* Sieder, 1953 of the genus *Dahlica* Enderlein, 1912 (Psychidae: Dahlicini) is represented by a group of 10 bagworm moth species, distributed in south-west and south-east Europe northwards to the Alps and Carpathians. This study is a revision of the subgenus *Brevantennia* species occurring in Slovenia based on our own comprehensive field studies, DNA barcoding and morphological analysis. *Dahlica* (*B*.) *santicensis* (Sieder, 1957) is established as **bona spec.** and *D*. (*B*.) *gorskikotarica* Weidlich, 2015, **syn. nov.** is synonymised with *D*. (*B*.) *santicensis*. Both *D.* (*B.*) *adriatica* (Rebel, 1919) and *D.* (*B.*) *triglavensis* (Rebel, 1919) are confirmed to occur in Slovenia. *D.* (*B*.) *styriaca* (Meier, 1957) is excluded from the checklist of Slovenian Lepidoptera fauna.

Introduction

The European Lepidoptera fauna with ca. 10,700 species (Lepiforum 2021a) is the best-known continental insect fauna in the world. However, some genera are notoriously difficult to identify due to the lack of reliable morphological characters. Amongst those "difficult" genera lies the *Dahlica*/*Siederia* complex of species (Psychidae), whose taxonomy needs revision. The difficulty of identifying specimens accurately has led to numerous misidentifications in the literature and in public genetic databases like BOLD (https://www.boldsystems.org/). Indeed, the *Dahlica*/*Siederia* species complex was excluded from a general analysis of DNA barcodes of European Lepidoptera due to inaccurate identifications (Elzinga et al. 2014). In this paper we use both DNA barcodes and detailed morphological analyses to try to identify a small group of species of the subgenus *Brevantennia* Sieder, 1953 focusing on the Slovenian fauna.

The subgenus *Brevantennia* includes 10 species of small psychids distributed in south-west and south-east Europe northwards to the Alps and Carpathians (Arnscheid and Weidlich 2017). Three of them, *D*. (*B*.) *adriatica* (Rebel, 1919), *D*. (*B*.) *triglavensis* (Rebel, 1919) and *D*. (*B*.) *styriaca* (Meier, 1957), have been recorded from Slovenia (Lesar and Govedič 2010; Weidlich 2012; Arnscheid and Weidlich 2017).

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In this study we revise the Slovenian *Dahlica* species of the subgenus *Brevantennia*, presenting new data based on our field collections across the country, morphological and DNA barcoding analyses and review of published records. We also describe the bionomics of each species based on our own observations in the field.

Materials and methods

Sampling

Slovenian specimens of the subgenus *Brevantennia* were collected in four regions in Slovenia at Gorenjska, Štajerska, Notranjska and Dolenjska, at 35 locations. In addition, we also considered material collected at primary type localities in neighbouring countries to compare and clarify the identity of some species, including *D. styriaca* - Austria, Steiermark, Häuslberg bei Leoben; *D. santicensis* (Sieder, 1957) - Austria, Kärnten, Warmbad-Villach; *D. siederi* - Schweiz, Ticino, Monte Generoso; *D. reliqua* (Sieder, 1953) - Austria, Kärnten, Launsdorf; *D. gorskikotarica* Weidlich, 2015 - Croatia, Gorski Kotar, Mrzla Vodica; *D. ilonae* Weidlich, 2014 - Slovakia, Nizke Tatry, Malužinská Dolina Malužiná; *D. herrmanni* Weidlich, 1996 - Hungary, Mátra, Matraháza; and *D. pinkeri* Sieder, 1964 - Spain, Massis de l'Albera, Colera.

Adult specimens examined in this study were obtained mainly by collecting larval cases with mature larvae or pupae in nature. Some adults of *D. triglavensis* and *D. adriatica* were also observed and collected by net in the early morning in their natural habitat. Collected pupae (larval cases) were later laid on filter paper and stored in plastic 250 ml containers with a perforated cover until the adults emerged. Containers were kept under laboratory conditions at room temperature of 22±1 °C, and the light / dark 18:6 h photoperiod. Humidity was regulated by gently spraying with water on a daily basis.

DNA barcoding

For the DNA barcoding analyses, one or two legs were removed from each dried specimen or from females that were stored in ethanol and then transferred to lysis plates. DNA extraction, amplification and Sanger sequencing of the DNA barcode region of the mitochondrial cytochrome c oxidase I (COI) gene (658 base pairs) were carried out at the Canadian Centre for DNA Barcoding, Guelph, Ontario, Canada (CCDB), using standard high throughput protocols (Ivanova et al. 2006).

Sequence divergences within and between species were calculated using the Kimura 2-parameter model as implemented in the Barcode of Life Data System (BOLD v4, www.barcodinglife.org) (Ratnasingham and Hebert 2007). We analyzed the COI sequences using the Neighbor-joining algorithm in PAUP* 4.0a169 (http://phylosolutions.com/paup-test/) (Swofford 2002). The level of support for individual nodes was evaluated by nonparametric bootstrapping with 1000 replicates in using PAUP*. DNA sequences, along with the voucher data, images, and trace files are deposited in BOLD and the sequences were deposited in GenBank. Barcode Index Numbers (BINs) (Ratnasingham and Hebert 2013) were obtained from BOLD. All data are available in BOLD through the public dataset: DS-BREVANTE. (dx.doi.org/10.5883/DS-BREVANTE).

Morphology

Descriptions of morphological structures for the subgenus *Brevantennia* follow the current terminology by Sauter (1956), Meier (1958) and Hättenschwiler (1977). We used three methods for distinguishing males. The first method distinguishes the shape of cloaking scales following Sauter

(1956). The scales are classified into six classes, characterised by their relative widths and the number of tines (Fig. 1a). The second, method focuses on the origin of the veins m2 and m3 from the discoidal cell in the hind wings (Meier 1958). This method distinguishes six different patterns of branching, *i.e.*: - (I) veins are connate; - (II) veins are fused more than 2/3 of their lengths; - (III) veins are fused from 2/3 to 1/3 of their lengths; - (IV) veins are fused for a short distance; - (V) the veins originate from a single point; - (VI) veins arise separately. The third method, representing maybe the most important morphometric characteristic, is used for the descriptions of the species of this genus. A ratio is calculated by measuring the length of the phallus and dividing this value by the length of the valva (Fig. 1b). The quotient resulting from this division is converted into an index, known as the "genital index" (Sauter 1956).

The taxonomic key for the family follows Sauter and Hättenschwiler (1991, 1999) and the nomenclature follows Arnscheid and Weidlich (2017).

For all photographs we used a Canon EOS 40D digital camera. High resolution images were taken through Olympus SZ 51 stereomicroscope and later edited using ADOBE PHOTOSHOP CS5 MASTER COLLECTION software. Measurements of genitalia were done with Olympus SZ 51 and SOFT IMAGING SYSTEM ANALYSIS software. All drawings and photographs are the work of the first author.

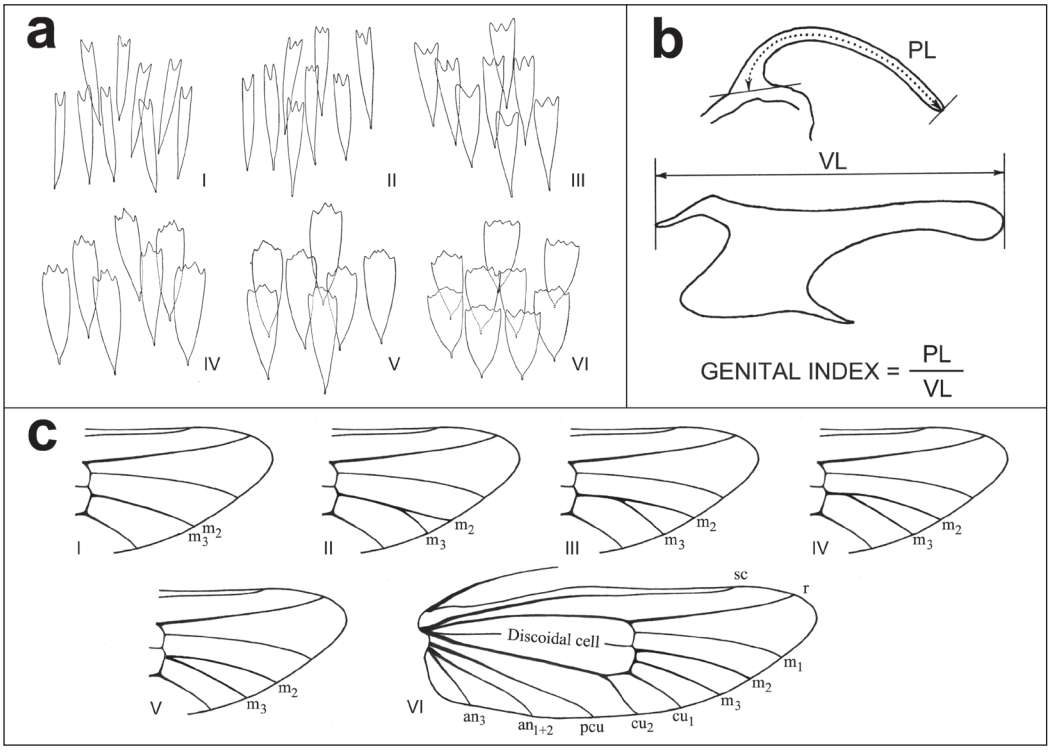

Figure 1. Important morphological structures. **a.** Six classes of forewing-cloaking scales after Sauter (1956); **b.** Male genitalia of subgenus *Brevantennia* sp. in lateral view. Measured distances: PL= Phallus length (black dotted); VL= Valve length, after Sauter (1956) - modified; **c.** Six classes of the origin of the veins m2 and m3 from the discoidal cell in the hind wings after Meier (1958).

Abbreviations

Localities are written in the local language style, except for the names of countries for which we used the English naming. International abbreviations for the countries (Eurostat 2021) used in figures are:

AT	Austria;
HR	Croatia;
HU	Hungary;
IT	Italy;
SI	Slovenia;
coll.	collection;
e.l.	ex larva;
e.p.	ex pupa;
leg.	legit (si.) or legerunt (pl.) from legere in Latin (to collect);
m	media;
n	number of specimens examined;
pcu	postcubitus.

Specimen depositories and private collections

The following abbreviations indicate the depository of the specimens investigated:

PCJR	Private collection of Jurij Rekelj, Kranj, Slovenia;
PCML	Private collection of Mojmir Lasan, Ljubljana, Slovenia;
PCMP	Private collection of † Miloslav Petrů, coll. stored at František Fiala, Praha, Czech Republic;
NHMW	Naturhistorisches Museum, Wien, Austria (Evenhuis 2020);
PCŽP	Private collection of Željko Predovnik, Polzela, Slovenia.

Results

Key to the Slovenian *Dahlica*, subgenus *Brevantennia* species

Subgenus *Brevantennia* can be easely separated from the other *Dahlicini* by unique female characteristics. The most reliable and important are two: antenna noticeable short, with one to 11 segments (in Slovenian species three to seven), female exuviae slightly shrunk and curved. All of these characteristics are evident in Fig. 6b.

Analysis of the Slovenian specimens, both morphological and genetic, confirms the existence of three species in the subgenus *Brevantennia*. Their determination is based on male morphological characteristics (see Figs 1, 9, 10).

1 Cloaking scales wide, class IV–V. Genital index low, 0.61–0.68 ..... ***Dahlica* (*Brevantennia) adriatica* (Rebel, 1919)**

– Cloaking scales narrow, class I–III. Genital index higher 0.64–0.86 ..... **2**

2 Cloaking scales class II–III, with two to four tines. Ground colour of forewings greyish brown. Pattern (bright spots) light grey to greyish white, distinct and well-expressed. Fringes silvery greyish..... ***Dahlica* (*Brevantennia) santicensis* (Sieder, 1957)**

– Cloaking scales class narrower I–II, with two to three tines. Ground colour of forewings light grey. Pattern creamy white, faint, often connected. Fringes creamy silver..... ..... ***Dahlica* (*Brevantennia) triglavensis* (Rebel, 1919)**

Chronological overview of major studies of the subgenus *Brevantennia*

1919 Rebel - described two new species: *D. triglavensis* sp. nov. (as *Solenobia triglavensis*), and *D. adriatica* sp. nov. (as *Solenobia adriatica*) from Croatia.

1953 Sieder - recognized an independent group and described as *Brevantennia* subgenus nov. As the type species he designated *D. triglavensis*. He described a new species *D. reliqua* sp. nov. (as *Solenobia reliqua*) from Austria.

1954 Sieder - described a new species *D. saxatilis* sp. nov. (as *Solenobia saxatilis*) from Austria.

1954 Sauter - described a new species *D. siederi* sp. nov. (as *Solenobia siederi*) from Switzerland.

1956 Sauter - published a seminal work of the morphology and systematics of the genus *Solenobia* (genital index, class of cloaking scales ...).

1957 Meier - described as a new species *D. styriaca* sp. nov. (as *Solenobia styriaca*) from Austria.

1957 Sieder - published an article pointing out the mistake in the description of the species *B. saxatilis* and described as a new species *D. santicensis* sp. nov. (as *Solenobia santicensis*) from Austria.

1964 Sieder - described a new species *D. pinkeri* sp. nov. (as *Brevantennia pinkeri*) from Spain.

1983 Sauter - the genus *Brevantennia* for the first time as a valid genus.

1988 Arnscheid - recognised *D. santicensis* as a synonym of *D. styriaca* and *D. adriatica* as a new combination for *S. adriatica*, thus:
Brevantennia santicensis = Brevantennia styriaca
Solenobia adriatica = Brevantennia adriatica

1996 Weidlich - described a new species *D. herrmanni* sp. nov. (as *Brevantennia herrmanni*) from Hungary and published a table of all hitherto known species of the subgenus *Brevantennia* with important distinguishing features of the adults.

2012 Arnscheid - described a new species *D. estrela* sp. nov. (as *Brevantennia estrela*) from Portugal.

2014 Weidlich - described a new species *D. ilonae* sp. nov. (as *Brevantennia ilonae*) from Slovakia.

2015 Weidlich - described a new species *D. gorskikotarica* sp. nov. (as *Brevantennia gorskikotarica*) from Croatia.

2017 Arnscheid and Weidlich - established the genus *Brevantennia* as a subgenus of *Dahlica*.

Morphology, biology and distribution

Here we present information about literature sources, biology and distribution of Slovenian species and a detailed morphological re-description of *D. santicensis*. We include in material examined the process IDs specified by BOLD for each DNA barcoded specimen (i.e., the dataset: dx.doi.org/10.5883/DS-BREVANTE).

Dahlica (*Brevantennia*) *adriatica* (Rebel, 1919)

Figs 2a–c, 8e, 9–11

Solenobia adriatica Rebel, 1919: 110

References for Slovenia. Rebel 1919: 110; Weidlich 2012: 16; Rekelj and Predovnik 2014: 5. Arnscheid and Weidlich 2017: 74.

Material examined. Slovenia • Several old larval cases; Vremščica, Prelovce; 633 m; 21.viii.2010; leg. Ž. Predovnik, coll. PCŽP • 2♂♂, with larval cases; same locality; 640 m; 20.iii.2011; leg. J. Rekelj; DNA barcode sample: 1♂ TIPSY160-12, 1♂ TIPSY161-12); coll. PCJR • 3♂♂, with larval cases; same locality; 640 m; 25.iii.2011 (e.p., 25–30.iii.2011); leg. J. Rekelj; coll. PCJR • 6♂♂, 19♀♀, with larval cases; Ribnica ob Reki, Potok Mrzlek; 420 m; 18.iii.2012 (e.p. 25.3–30.iii. 2012); leg. J. Rekelj; DNA barcode sample: 1♂ TIPSY621-12, 1♂ TIPSY622-12; coll. PCJR • 10♂♂, 5♀♀, with larval cases; same locality; 30.iii.2014 (e.p. 1–5.iv.2014); leg. J. Rekelj; 5♂♂ genit. prep. №: 259–263, Rekelj; coll. PCJR • 2♂♂, 11♀♀, with larval cases; Vremščica, Črni Vrh; 680 m; 25.iii.2012 (e.p. 25–30.iii.2012); leg. J. Rekelj; coll. PCJR • 19♂♂, 23♀♀, with larval cases; same locality; 30.iii.2014 (e.p. 1–5.iv.2014); leg. J. Rekelj; 5♂♂ genit. prep. №: 254–258, Rekelj; DNA barcode sample: 1♂ TIPSY623-12; coll. PCJR • ♂, with larval case; Koritnice, Žlebovi; 670 m; 25.iii.2012 (e.p. 13.iv.2012); leg. J. Rekelj; coll. PCJR • Several fresh exuviae ♂♂ and ♀♀, with larval cases; Ilirska Bistrica; Devin-Župnica; 1010 m; 18.iii.2012; leg. J. Rekelj; coll. PCJR • 1♂ and several fresh exuviae ♂♂ and ♀♀, with larval cases; Slavnik; 940 m; 19.v.2012; leg. J. Rekelj; coll. PCJR • Several old larval cases; Brkini, Misliče; 619 m; 24. xi.2012; leg. Ž. Predovnik; coll. PCŽP • 15 old larval cases; Brkini, Pregarje-Huje; 710 m; 24.xi.2012; leg. Ž. Predovnik; coll. PCŽP.

Distribution. *D. adriatica* is distributed in the area of the Dinaric Alps. Known in Slovenia, Croatia, and Bosnia and Herzegovina (Weidlich 2012: 16, 2015: 65. Arnscheid and Weidlich 2017: 74).

Slovenia is the northern border of its distribution range, with presence in Brkini and surrounding hills: Snežnik in the east, Vremščica in the north and Slavnik in the west. All Slovenian localities are ilustrated in Fig. 11.

Biology. We found this species well-represented in various biotopes with a mainly humid character. The lowest locality, where we found larval cases was a south-west facing slope of the cold valley of Potok Mrzlek (420 m), where the species inhabits sunny, mossy and lightly overgrown rocks consisting of Eocene flysch sandstone, just 10 m above the creek. Most other localities were found in south to south-west facing slopes in Illyric Ostryo-Quercetum zonal forest community (*Ostryo-Carpinion orientalis*) from 600–700 m elevation. The subsoil here consists of limestone. Larval cases were fixed on the south side of rocks, retaining walls and bark of trees. We noticed that the larvae are likely to avoid places with high light intensity; micro-localities shadowed with vegetation are more populated. The most typical population of this zone is Črni Vrh, Vremščica (680 m) (Fig. 2c). It is interesting that the species is also represented on south-facing meadows at higher elevations, usually just above the edge of the Illyrian *Fagus sylvatica* forests zone (*Aremonio-Fagion*) from 940–1010 m. Due to the higher elevation and consequently the colder climate, the larval cases were found on the warmest places: on the south side of rocks, usually where rocks were lying in larger groups - Devin, Župnica (1010 m).

The species is univoltine. The adults are on the wing, depending on the location from late March to early May.

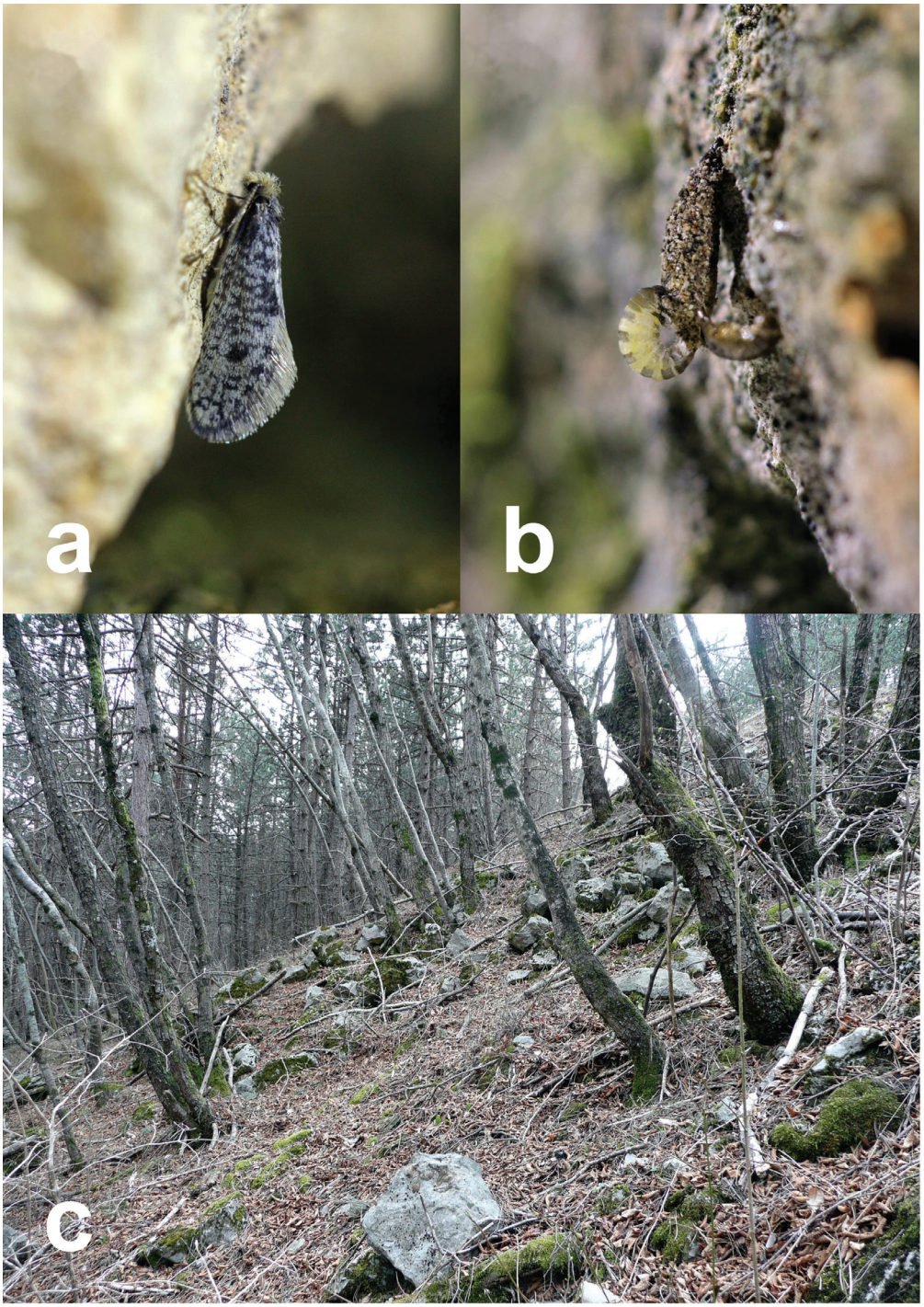

Figure 2. *D. adriatica*. **a.** Adult male resting on rock, Potok Mrzlek; **b.** Fresh adult female in assembling mode, Potok Mrzlek; **c**. Illyric Ostryo-Quercetum zonal forest community, natural habitat of *D. adriatica*, Črni Vrh, Vremščica, 680 m.

Remarks. The first record of the presence of *D. adriatica* in Slovenia dates back to the year 1919. Rebel (1919: 110) reports one male specimen caught in Istrien (H. Kozina, leg. Naufock, 10. Mai '08). By the place name "H. Kozina" he probably considered the villages Hrpelje and Kozina in Slovenia, or most likely the Kozina railway station there. Travelling by train was most popular at that time. The single specimen showed slightly wider and darker wings than specimens from type locality Senj ("Zengg"), Croatia, and therefore the author defines it as "belongs probably also to *adriatica*". This uncertainty is likely the reason why *D. adriatica* was not subsequently placed on the list of the Slovenian fauna, despite the fact that that is has been confirmed as present many times by Slovenian entomologists (Mojmir Lasan, personal communication 2012). The species was officially included in the list in 2012 (Weidlich 2012: 16).

The genital index of males slightly deviates from the known values, which were 0.61–0.64 (Weidlich 1996: 167, 2012: 15). The new index is slightly higher, from 0.61–0.68 (Fig. 9).

Dahlica (*Brevantennia*) *santicensis* (Sieder, 1957), stat. rev.

Figs 3a, b, 4a–c, 5, 8a, b, 9–11

Solenobia (*Brevantennia*) *santicensis* Sieder, 1957: 108.
= *Brevantennia gorskikotarica* Weidlich, 2015, **syn. nov.** Type locality: Mrzla Vodica, Crni Lug, Gorski Kotar, Croatia.

Material examined. ***Lectotype.*** Labelled as follows: 1. White label bordered in red: Det. L. Sieder 1957, *Sol. Brevant. santicensis* Sied. Typus ♂; 2. White label: 18.5.56, Warmb.-Villach, Kärnten, leg. L. Sieder; 3. Red label: LECTOTYPUS, *Dahlica* (*Brevantennia*) *santicensis*, (Sieder, 1957), designated by Rekelj J. et al. 2022 (Fig. 3a).

The lectotype is deposited in the NHMW [Hauptsammlung - Psychidae].

The total number of syntypes is unknown (in the original description Sieder unfortunately does not specify the number of specimens of the type material), but it must be larger than those we found in the museum (NHMW) in Vienna: Austria • Kärnten, Warmbad-Villach; 1♂, 11.v.1956; 3♂♂, 16.v.1956; 6♂♂, 17.v.1956; 5♂♂, 18.v.1956; 1♂, 19.v.1956; 1♂, 26.v.1956; 1♂, 29.v.1956; 2♂♂, 26.iv.1957; 1♂, 25.iv.1959; 1♂, 1.v.1959; 1♂, 8.v.1959; 1 larval case, 18.v.1956 [labeled as a "Sack-Typus ♂" - Fig. 3b]; 6 larval cases, (iv/v)1956; 1 larval case, 28.iv.1957; 1 larval case, 28.v.1957; all leg. L. Sieder; coll. NHMW.

Other material. Austria • 1♂; Kärnten, Warmbad-Villach; 16.v.1956, leg. L. Sieder; coll. PCMP • 9♂♂, 10♀♀, with larval cases; Kärnten, Warmbad-Villach; 540 m; 28.iv.2013 (e.p. 28.-30.iv.2014); leg. J. Rekelj; 5♂♂ genit. prep. №:184–188, Rekelj; coll. PCJR • 12♂♂, 2♀♀, with larval cases; Kärnten, Faaker Zee; 540 m; 21.iv.2013 (e.p. 25–30. iv.2014); leg. J. Rekelj; coll. PCJR • 1♂, 1♀, with larval cases; Kärnten, Loibltal; 700 m; 17.iii.2012 (e.p. 20.iii.2012); leg. J. Rekelj; DNA barcode sample: 1♂ TIPSY620-12; coll. PCJR • 2♂♂, with larval cases; Osttirol, Lengberg; 800m, 4.iv.2010 e.l.; leg. H. Deutsch; DNA barcode sample: 1♂ TIPSY155-12; 1♂ genit. prep. №: 234, Rekelj; coll. PCJR. Slovenia • 1♂, with larval case; Gorenjska, Gozd Martuljek; 740 m; 7–9.v.2002; leg. M. Lasan; genit. prep. №: 313, Rekelj; coll. PCML • 20♂♂, 5♀♀, with larval cases; same locality; 710 m; 28.iv.2013, (e.p. 1–5.v.2013); leg. J. Rekelj; coll. PCJR • 26♂♂, 3♀♀, with larval cases; same locality; 10.iv.2014 (e.p. 17–22.iv.2014); leg. J. Rekelj; 5♂♂ genit. prep. №: 214–218; Rekelj coll. PCJR • 1♂, with larval case; Gorenjska, Rateče; 850 m; 10.iv.2014 (e.p. 22.iv.2014); leg. J. Rekelj; coll. PCJR • 1♂, with larval case; Julijske Alpe, Mala Mojstrovka; 1600 m; 17.iv.2011 (e.p. 1.v.2011); leg. J. Rekelj; DNA barcode sample: TIPSY125-12; 1♂ genit. prep. №: 233, Rekelj; coll. PCJR • 1♂, with larval case; same locality; 9.v.2020 (e.p. 11.v.2020); leg. J. Rekelj; genit. prep. №: 380, Rekelj; coll. PCJR • 2♀♀, with larval cases, several empty larval cases; Julijske Alpe, Zgornja Trenta, Mlinarica; 1100 m; 9.v.2020, (e.p. 10.v.2020); leg. J. Rekelj; coll. PCJR • 8♂♂, 12♀♀, with

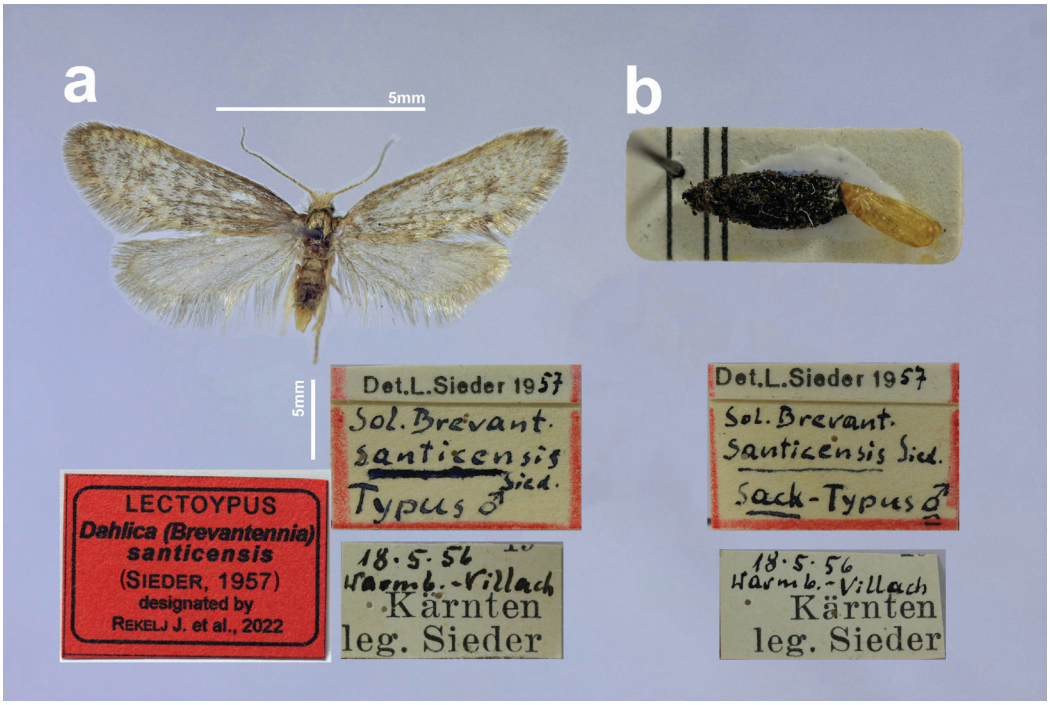

Figure 3. *D. santicensis.* **a.** Lectotype male with original labels in NHMW; **b.** Syntype male (mislabelled as neotype), larval case with original labels in NHMW.

larval cases; Julijske Alpe, Strmec na Predelu; 1015 m; 21.v.2017; (e.p. 25–30.v.2017); leg. J. Rekelj; coll. PCJR • 27♂♂, 2♀♀, with larval cases; same locality; 9.v.2020, (e.p. 9–15.v.2020); leg. J. Rekelj; 5♂♂ genit. prep. №: 284–287, Rekelj; coll. PCJR • 3 larval cases with ♂ exuvia, 1 larval case with ♀ exuvia; Cerkno, Kladje; 780m; 21.vi.2017; leg. J. Rekelj; coll. PCJR • 2♂♂, with larval cases, several old cases; Zgornja Sorica [road to Soriška Planina]; 940 m; 23.iii.2019, (e.p. 1–9.iv.2019); leg. J. Rekelj; coll. PCJR • 1♂, 3♀♀, with larval cases, several empty larval cases; Naklo, Gradišče; 380 m; 16.iv.2016 (e.p. 17.iv.2016); leg. J. Rekelj; coll. PCJR • 9♂♂, 7♀♀, with larval cases; Kamniško Savinjske Alpe, Črnivec pod Plešivcem; 900 m; 14.iv.2013 (e.p. 20., 25.iv.2013); DNA barcode sample: 1♂ TIPSY672-15; 5♂♂ genit. prep. №: 228–2232, Rekelj; leg. J. Rekelj; coll. PCJR • 6♂♂, with larval cases, same locality; 9.iii.2014 (e.p. 20–22.iii.2014); leg. J. Rekelj; coll. PCJR • 1♂, 5♀♀, with larval cases; Kamniško Savinjske Alpe, Raduha, Strmec [Pečovnik]; 730 m; 19.iv.2014 (e.p. 20–24.iv.2014); leg. Ž. Predovnik; DNA barcode sample: 1♂ TIPSY736-15, 1♀ TIPSY734-15; coll. PCŽP • 1♀, with larval case, 3 adult larvae; same locality; 4.iv.2015 (e.l.-e.p. 14.iv.2015); leg. Ž. Predovnik; coll. PCŽP • 3♀, with larval cases; Pohorje, Oplotnica, Cezlak-Lukanja [Oplotnica creek]; 789 m; 29.iii.2014 (e.p. 4–6.iv.2014); leg. Ž. Predovnik; DNA barcode sample: 1♀ TIPSY733-15; coll. PCŽP • 1♀, with larval cases; same locality; 28.iii.2015 (e.l. 22.4.2014); leg. Ž. Predovnik; coll. PCŽP • 1♀, with larval cases; same locality; 11.iv.2015 (e.l. 21.iv.2014); leg Ž. Predovnik; coll. PCŽP • 1♀, with larval case; Mrzlo polje [Gračnica creek]; 392 m; 28.iii.2012 (e.p. 5.iv.2012); leg. Ž. Predovnik; DNA barcode sample: 1♀, TIPSY718-15; coll. PCŽP • 1♀, with larval case; same locality; 13.iii.2014 (e.p. 18.iii.2014); leg Ž. Predovnik; coll. PCŽP • 2♂, with larval cases; Kalce [Logatec], Hrušica, Laniše; 640 m; 23.iii.2012 (e.p. 2.iv., 7.iv.2012); leg. Ž. Predovnik; DNA barcode sample: 1♂ TIPSY628-12; coll. PCŽP • 1♂, with larval case; Notranjska, Nanos; 1250 m; 31.v.2004, leg J. Skyva; genit. prep. №: 367, Rekelj; coll. PCJR • 27 old larval cases, Želimlje, Kurešček [Stara žaga]; 680 m; 14.i.2012; leg. Ž. Predovnik; coll. PCŽP • 2♂♂, with larval cases; same locality; 23.iii.2012 (e.l.-e.p. 2.iv.2012);

leg. Ž. Predovnik; DNA barcode sample: 1♂ TIPSY629-12; 1 ♂ genit. prep. №:118, Rekelj; coll. PCŽP • 2♂♂, with larval cases; same locality; 5.iv.2013 (e.p. 15–16.iv.2013); leg. Ž. Predovnik; 1♂ genit. prep. №:122, Rekelj; coll. PCŽP • 6♂♂, 4♀♀, with larval cases; same locality; 12.iv.2014 (e.p. 2., 13., 14., 15., 18.iv.2013); leg. Ž. Predovnik; 4♂♂ genit. prep. №:119–122 Rekelj; coll. PCŽP • 7♂, 1♀, with 61 larval cases; Ribnica, Retje; 843 m; (15.iv.2013 (e.p. 25–27.iv.2013); leg. Ž. Predovnik; 4♂♂, genit. prep. №:103, 115–117, Rekelj; coll. PCŽP • 44♂♂, 58♀♀, with 150 larval cases, fresh exuviae ♂, 4 adult larvae; same locality; 12.iv.2014 (e.l.-e.p. 12–22.iv.2014); leg. Ž. Predovnik; DNA barcode sample: 1♂ TIPSY742-15; 6♂, genit. prep. №:104–107, 113,114, Rekelj; coll. PCŽP • 2♂♂, with 8 larval cases; same locality; 30.iii.2015 (e.p. 9–10.iv.2015); leg. Ž. Predovnik; coll. PCŽP and PCJR • 15 larval cases, exuviae ♂♂ and ♀♀, Podplanina, Trava; 660 m; 7.iv.2012; leg. Ž. Predovnik; coll. PCŽP • 2♀, with larval cases; same locality; 12.iv.2014 (e.p. 16.iv., 21.iv.2014), [ca.10 minutes long copula: 1♂ Retje x 1♀ Trava]; leg. Ž. Predovnik; DNA barcode sample: 1♀ TIPSY741-15; coll. PCŽP • Several old cases, exuviae ♂ and ♀; Paški Kozjak [Mountain Lodge]; 1028 m; 17.ii.2019; leg. Ž. Predovnik; coll. PCŽP • 2♂, 7♀, with larval cases; 13.iv.2019 (e.p. 14.iv–22.iv. 2019); leg. Ž. Predovnik; coll. PCŽP • 17 old larval cases; Mislinja, Tolsti vrh [Polenica creek]; 805 m; 23.xii.2018; leg. Ž. Predovnik; coll. PCŽP • 4♂, 7♀, with larval cases; same locality; 13.iv.2019 (ex.p. 16.iv–22.iv.2019); leg. Ž. Predovnik; coll. PCŽP • A few old larvae cases; Sodražica, Zg. Globel, Ravni vrh; 728 m; 30.iii.2015; leg. Ž. Predovnik; coll. PCŽP • 3 old larvae cases; Velike Lašče, Mala Slevica; 608 m; 15.iii.2015; leg. Ž. Predovnik; coll. PCŽP • 2 old larvae cases; Ribnica, Breg pri Ribnici na Dolenjskem; 494 m; 30. iii.2015; leg. Ž. Predovnik; coll. PCŽP.

Diagnosis. (Figs 9, 10) *D. santicensis* can easily be distinguished from the wide- cloaking scaled species: *D. pinkeri* (class III–IV), *D. adriatica* (class IV–V), *D. herrmanni* (class IV–V) and *D. estrela* (class V–VI) by the narrower cloaking scales (class II–III), and also by the different genital index.

D. santicensis (0.64–0.80) differs from *D. reliqua* (0.94–0.956), *D. styriaca* (0.99–1.14) and *D. ilonae* (1.19–1.24), by a much lower genital index and more distinct pattern on the forewings.

D. triglavensis is distinguished by smaller class of cloaking scales (I–II), more unclear and less noticeable pattern and much lighter ground colour of forewings. Fringes are lighter creamy silver, the apex of the forewing in the area of stigma is creamy and noticeably brighter.

D. santicensis is most similar to the *D. siederi* by the genital index and class of cloaking scales, but *siederi* is distinguished by lighter (yellowish white) pattern on fore wings, noticeably brighter (creamy silver) apex of the forewing in the stigma area and by the brighter (whitish silver) fringes on forewing.

Redescription. Male (Figs 3a, 4a). Exp. 10 to 13 mm, forewing length 4.5–6 mm. Specimens very variable in size and colouring. ***Head*****:** Vertex and frons (Fig. 8a, b) covered with yellowish grey to grey dense hairs, labial palpi small, covered with grey hairs. Eyes small, black, ocelli lacking. Antennae relatively short, in most specimens not exceeding half length of the costal margin of the forewings, with 27–34 segments (n = 25), including scapus and pedicellus, filiform (in original description Sieder states 30–34 segments). Ventral to the first third, usually covered with broad, light creamy scales, with three to four short tines, especially when the vertex hairs are light creamy. If the hairs are darker, yellowish grey, then the antennae scales are (in first third) mixed with darker scales. In the second third, the scales become darker and gradually to the apex narrower and sparser. ***Forewings*****:** (Figs 3a, 4a, 10) length 2.3 times exceeding its width (n = 4). The ground colour of forewings greyish brown. Pattern (bright spots) light grey to greyish white, distinct and well expressed, more strongly than at the other narrow scales *Dahlica* subgenus *Brevantennia* species. Discal and anal spot less well expressed or no recognizable. Cloaking scales with two to

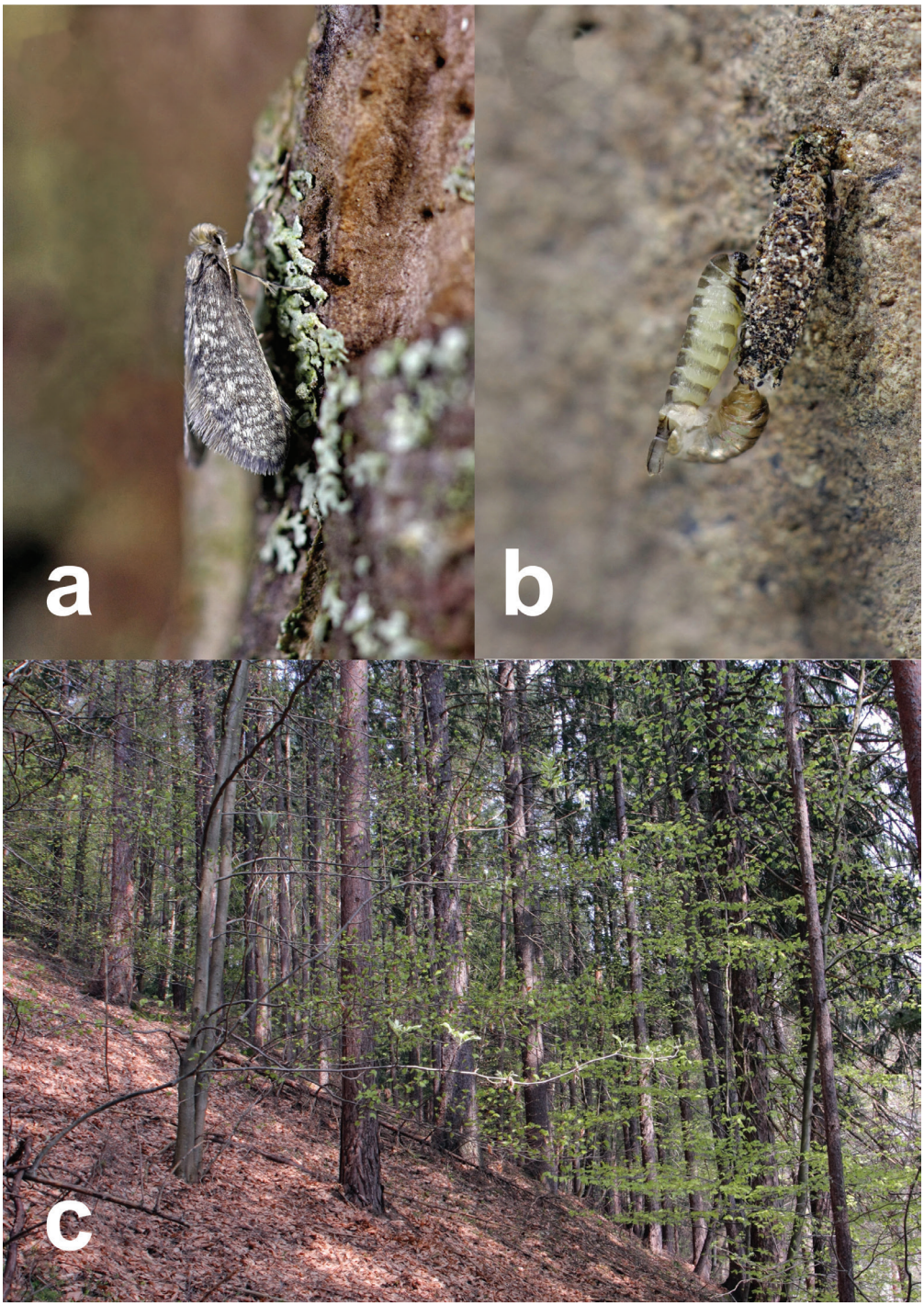

Figure 4. *D. santicensis*. **a.** Fresh adult male resting on rock, Gozd Martuljek; **b.** Fresh adult female transmitting pheromones, Gozd Martuljek; **c.** Mixed forest with Scots pine, natural habitat of *D. santicensis*, Gozd Martuljek, 740 m.

four, mostly with three short tines, classified into class II and III. Fringes silvery greyish, coloured strongly at the base, long, with two to four tines. Forewing venation with nine veins, originates from the discoidal cell. Vein pcu less well expressed, accessory cell present (n = 5). ***Hindwings*:** Colour greyish brown. Fringes medium length, with two to three tines, brightly coloured than the basic colour of hindwings. Venation with six veins originates from the discoidal cell. Veins m2 and m3 very variable, separated or approximated at the base, sometimes also fused for a short distance - class IV, V or VI. All three classes of venation differ greatly, depending on the location, or even the year of collecting specimens. ***Thorax*:** Colour greyish brown, in brighter specimens grading into creamy brown. Legs greyish brown, foretibia without epiphysis. Midtibia with one pair of spurs, hindtibia with two pairs. All legs with five tarsal segments. ***Abdomen*:** Dark brown colour, becoming lighter towards the genitalia. Terminal segments covered with creamy or pale yellow hairs. ***Genitalia*:** Typical for Dahlicini. Tegumen relatively broad, with a shallow groove at the front. Valva narrow and long. Dorsal margin of valva towards the top slightly curved, apex slightly extended, without any special characteristics. Clavus long, pointed and curved at the end. Phallus quite short, curved, without specifics. Genital index 0.64–0.80, average 0.72 (n = 52). The index varies depending on location, as expressed in Fig. 5.

Female (Fig. 4b). Wingless, ground colour pale yellow, with broad, light brown plates dorsally. Freshly hatched specimens having a slight greenish appearance. Dimensions: three mm long and less than one mm wide. Eyes small, black, ocelli lacking. Antennae short with three to seven segments (including scapus and pedicellus). Tibiae of forelegs without epiphysis, all legs usually with three-segmented tarsi, fused tarsi in two segments rare but present. 7th abdominal segment densely covered with creamy white hairs.

Female exuvia pale brown colour, curved - typical for the subgenus *Brevantennia*.

Larval cases. Typical for Dahlicini, cases are small, more or less round and slightly rounded on the edges. They are composed of finely chewed dark brown particles of bark, small pieces of soil and brighter pieces of sand. There is an inevitable slight deviation in composition of larval cases as a result of the different surfaces available in the natural habitat. Male larval cases are 5.5–6.5 mm long and 2 mm wide; female cases are smaller, 4.5–5 mm long and 1.5 mm wide.

Morphological variation. We noticed considerable variation between populations and also between specimens from the same population, reflected in the colour of the dense vertex hairs, intensity of wing colouration and the genital index. Northern populations (Warmbad-Villach, Strmec na Predelu, Gozd Martuljek) have mostly yellowish-grey coloured vertex hairs, but among those we also found about 10% grey-coloured specimens. Their abundance increases towards the south and in southern localities (Retje, Trava) only grey-coloured specimens can be found. Differences between dense vertex hair colours are shown in Fig. 8a, b.

Intensity of wing colouration is also quite variable, but it seems that is not location dependent. Within one population (Gozd Martuljek locality) we found specimens with intensive colouration alongside more pale specimens.

Differences related to the geography of the locality are also noticeable in the genital index. Higher values were found in moths from northern locations of a more alpine character. Southern locations produce lower values, but they do not fall linearly proportionate to the latitude and the values are overlapping. Comparison of genital indexes with locations is expressed in Fig. 5.

Morphologically, the nearest species to *D. santicensis* is *D. siederi* (Weidlich, 2015), which has the same class of cloaking scales (II–III) and shows almost the same genital index (Fig. 9).

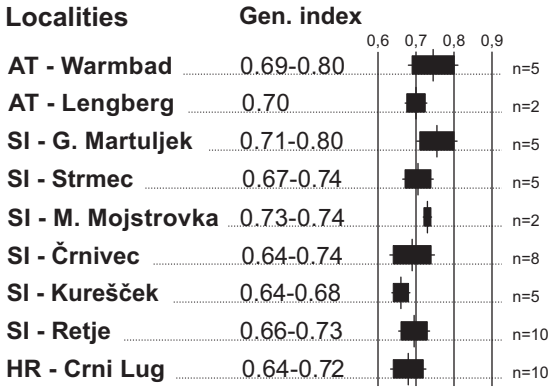

Figure 5. Graphical representation of genital indexes on different localities of *D. santicensis*.

Synonymy. Weidlich (2015) described *D. gorskikotarica* from Croatia - Gorski Kotar. We have examined the following material from the type locality: Croatia • 8 larvae, 1 old exuviae ♀, Gorski Kotar, Crni Lug, Mrzla Vodica; 880 m; 18.x.2015; leg. J. Rekelj; coll. PCJR • 14♂♂, 8♀♀, with larval cases, same locality; 2.iv.2017 (e.p. 6–10.iv.2017); leg. J. Rekelj, 5♂♂ genit. prep. №: 370–374, Rekelj; coll. PCJR • 19♂♂, 6♀♀, with larval cases; Gorski Kotar, Crni Lug, Vela Voda; 747 m; 2.iv.2017 (e.p. 6–10.iv.2017); leg. J. Rekelj; 5♂♂ genit. prep. №: 375–379, Rekelj; coll. PCJR.

In addition, we have DNA barcoded one specimen from the type series (DNA barcode sample: LEATC004-13) from Mrzla Vodica. This specimen falls within the same BIN (BOLD:AAQ1227) as *D. santicensis* (Suppl. material 1: Table S1). In addition, we found no diagnostic morphological character (forewing colouration and pattern, class of cloaking scales and genital index) to distinguish *D. gorskikotarica* from Slovenian populations of *D. santicensis*. Both molecular and morphological data show that *D. gorskikotarica* is a synonym of *D. santicensis*:

***Brevantennia gorskikotarica* Weidlich, 2015, syn. nov.**

= *Dahlica* (*Brevantennia*) *santicensis* (Sieder, 1957).

Distribution. The species is distributed in Austria, Slovenia and northern Croatia. In Austria by Sieder (1957) in Kärnten: Warmbad-Villach (type locality), Arnoldstein - Gailtal, Rattendorfer Alm - Karnischen Alpen and Spitzegels by Hermagor. Confirmed localities are also Faaker Zee - Kärnten and Lengberg - Osttirol (Deutsch 2003: 10 - as *B. styriaca*, Lepiforum 2021b - as *B. styriaca*). In Croatia the species is known from Gorski Kotar (Weidlich 2015 - as *B. gorskikotarica*).

In Slovenia we found *D. santicensis* in Gorenjska, Notranjska, Dolenjska and Štajerska regions, in total 22 localities, which indicates a wide distribution across the country. All Slovenian localities are illustrated in Fig. 11.

Etymology. Santicum, Roman Castrum near Warmbad-Villach.

Biology. At the type locality (Warmbad-Villach, Austria), larval cases can be found on the northern slopes of mixed forest, more often in shady areas. The subsoil consists of limestone. Lar-

val cases are present in particular on conifers such as *Larix decidua* Mill., *Pinus sylvestris* L. and *Picea abies* L. and also on rocks. They are mainly found in shady parts of tree trunks, which are covered with lichens and algae and at a height of up to two metres above the ground.

Recent investigations in Slovenia show that the species is more widespread than previously known, more adaptable and occurring in different habitats in cold areas. In lowlands, where the temperatures are higher on average, we found larval cases in northern exposed slopes, in shady humid areas of mixed forest dominated by conifers, mostly *Pinus sylvestris* and *Picea abies* and in cold and damp shady valleys of creeks. Sometimes the river or lake allows cooler microclimate conditions, so animals there can also be found on the sunny, south exposed positions (location, Gozd Martuljek - Fig. 4c). The highest locality where the species has been observed is on the subalpine southern slopes of Mala Mojstrovka, where we found larval cases on the cliffs and rocks just a little above the tree line - the *Larix decidua* and *Pinus mugo* Turra zone. At all locations, the subsoil consists of limestone and larval cases were mostly found on the shady trunks of coniferous trees, wooden fences, and rocks. Only exceptionally, at Črnivec and Cezlak-Lukanja, the substrate is of volcanic origin. Larval cases were found there, mainly on the tuffite boulders and stones which are, unlike limestone, covered with algae and mosses in abundance. They were found also on the walls of the old wooden buildings, such as an old arbour in the forest and at bus stations. The lowest elevation was in the valley of the stream Gračnica is 392 m and the highest was at 1600 m on Mala Mojstrovka mountain.

Research in Slovenia shows that the species is univoltine. Pupation occurs between late March and early April. The flight period of adults lasts from the beginning of April to early May, depending on the location and year. Males hatch in the evening and become active in the early morning, after occurrence of females, between 05:30–07:00.

D. santicensis in Slovenia cohabits with the following species of bagworms: *Dahlica triquetrella* f. parth. (Hübner, 1813); *Dahlica lichenella* (Linnaeus, 1761) f. bisex.; *Dahlica croatica* Weidlich, 2016; *Dahlica* sp.; *Taleporia tubulosa* (Retzius, 1783); *Proutia comitella* (Bruand, 1853); *Psyche casta* (Pallas, 1767) and *Bacotia claustrella* (Bruand, 1845). An exception is the locality Mala Mojstrovka, where the species cohabits only with *Dahlica* (*Siederia*) *meierella* (Sieder, 1956) and *Dahlica triquetrella* f. parth.

Remarks. Historical overview: The discovery and description of *Dahlica* (*Brevantennia*) *santicensis* has an interesting and informative history and is maybe among the most interesting for species in this group. For this reason, it was mentioned several times in different publications (Arnscheid, 1988, 1993). The story began in the year 1952, when Mr. Herbert Hölzl from Klagenfurt found small larval cases while climbing to Rattendorfer Alm in the Carnic Alps. The following year Mr. Thurner, also from Klagenfurt picked up a lot of specimens. Those specimens were later on described as a new species *Dahlica* (*Brevantennia*) *saxatilis* (Sieder, 1954). Two years after the description, Sieder himself visited that locality, one week after another specialist, H. Meier. Together, they found, that two species of Dahlicini occur syntopically - *Dahlica* (*Siederia*) *alpicolella* (Rebel, 1919) and the newly described *D. saxatilis*. This is nothing special, but we now know that Sieder used two different species for his description: males of *D. alpicolella* and females of his new species *D. saxatilis*. Later, he corrected his mistake in a new article "Fünfte Vorarbeit über die Gattung *Solenobia*", synonymised *D. saxatilis* with *D. alpicolella* and added a new and corrected description of the new species *D. santicensis*, this time with matched males (Sieder 1957). For the new type locality, he chose the forest of Warmbad-Villach (the first specimens from that locality he got in the year 1955 from Trasischker), but considering the imprecisely assembled earlier material, he visited the place and collected the type material himself. Approximately one month previously, Meier's description of *Dahlica* (*Brevantennia*) *styriaca* was

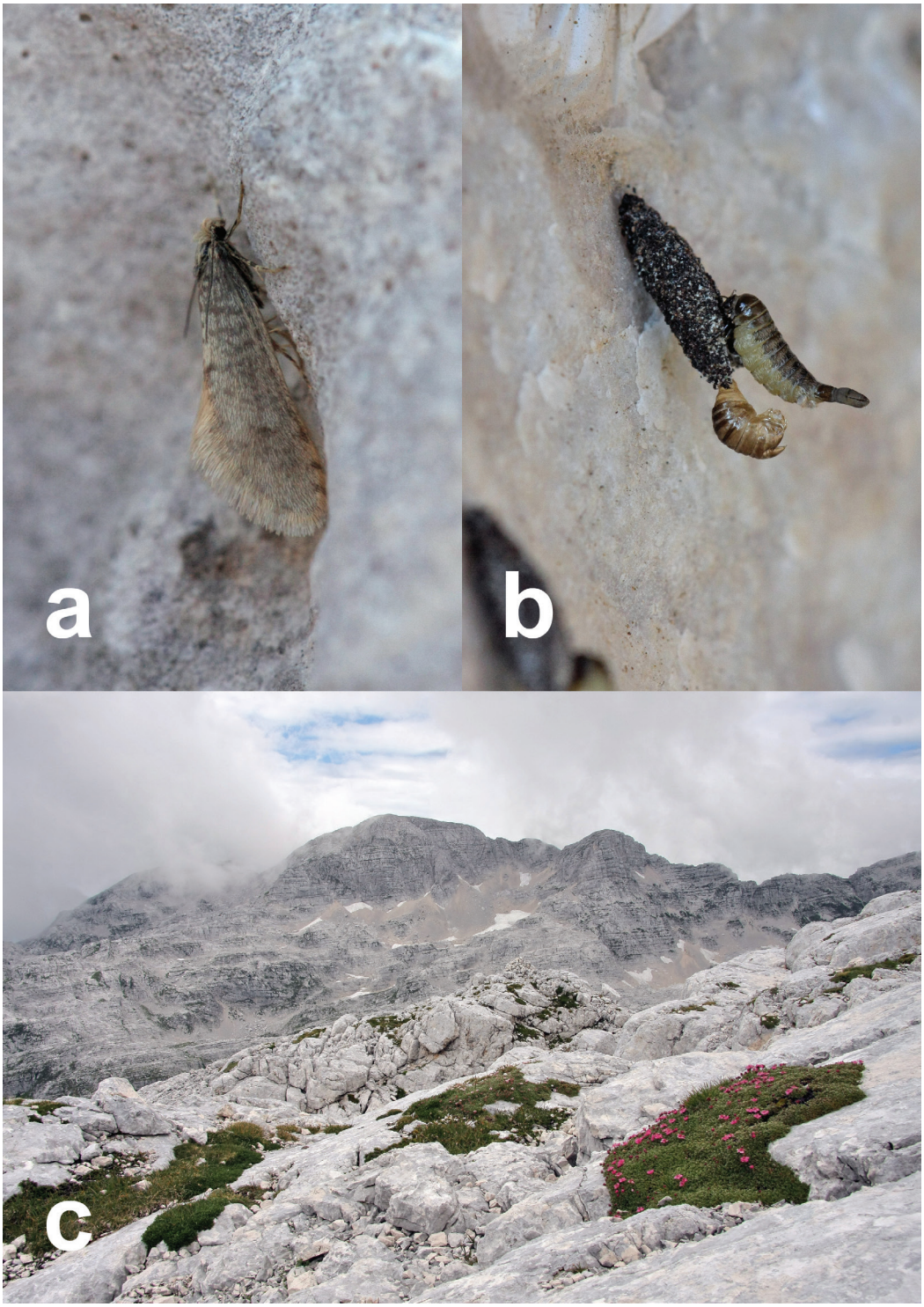

Figure 6. *D. triglavensis*. **a.** Adult male resting on rock, Kanin; **b.** Female on the larval case in attracting mode, Kanin; **c.** Rocky slope with alpine vegetation, natural habitat of *D. triglavensis*, Kanin, 2250 m.

published. In spite of the fact that he had material from Rattendorfer Alm, Meier neither compared his new species with Sieder's *D. saxatilis*, nor did he mention this taxon in his work. However, both *D. styriaca* and *D. santicensis* were known as separate species (*bona species*) for 31 years, until Arnscheid's publication in 1988, where he established the species *D. santicensis* as synonym of *D. styriaca*. Here we give his reasons: "During a personal conversation in September 1976, Sieder told the author that both taxa are most likely identical. Investigations to date of numerous specimens, males and females of both species, actually showed no significant differences which would exceed the normal range of variations, that are specific to a particular species". Unfortunately, the authors did not use the already well-known and generally confirmed methods of determination (Sauter 1956), especially the genital index. The fact is that this species remained unnoticed until today. Only recent comparisons of Slovenian populations with already known species (according to established morphological and newer genetic methods), have shown that they are clearly separated from Styrian populations and that they are identical to those from the forest of Warmbad-Villach.

Dahlica (*Brevantennia) styriaca* (Meier, 1957)

Figs 8f, 9, 10,

Solenobia (*Brevantennia*) *styriaca* Meier, 1957: 59.

References for Slovenia. Carnelutti 1992: 79; Verovnik 2003: 444 [»the far northeast of the country«]; Lesar and Habeler 2005: 23; Lesar and Govedič 2010: 49; Sobczyk 2011: 78; Arnscheid and Weidlich 2017: 72.

Material examined. ***Paratype.*** Austria • 1♂, Steiermark, Leoben, Hinterberg; 12.iv.1953; leg. H. Meier; coll. NHMW [Hauptsammlung - Psychidae].

Other material. Austria • 1♂, Steiermark, Gulsenberg b. Preg; 2.v.1953; leg. H. Meier; genit. prep. №: 236, Rekelj; coll. PCMP • 1♂; Steiermark, Leoben [Bahnhof]; 3.iv.1960; leg. H. Meier; genit. prep. №: 237, Rekelj; coll. PCMP • 51♂♂, 7♀♀, with larval cases; Steiermark, Häuslberg bei Leoben; 660 m; 1.iv.2012 (e.p. 1–5. iv.2012); leg. J. Rekelj; DNA barcode sample: 1♂ TIPSY618-12, 1 ♂ TIPSY619-12; 1♂ genit. prep. №: 227, Rekelj; coll. PCJR • 3♂♂, 3♀♀, with larval cases; same locality; 31.iii.2013 (e.p. 13.iv.2013); leg. J. Rekelj; 3♂♂ genit. prep. №: 224–226, Rekelj; coll. PCJR • 3♂♂, 1♀, with larval cases; same locality; 31.iii.2013 (e.p. 23.iii, 28.iii., 30.iii., 1.iv 2013); leg. Ž. Predovnik; coll. PCŽP.

Distribution. The species is only known to occur in Austria. So far, its presence is confirmed from few localities, all in the Steiermark - Murtal districts: Häuslberg bei Leoben (type locality), Hinterberg, Kaiserberg and Gulsenberg b. Preg.

All references for Slovenia originate from the first literary source: Carnelutti 1992. Unfortunately, there is no record of the locality where those specimens were found and no evident material in Carnelutti's collection. The first author found out about one locality where those specimens were probably collected (Mojmir Lasan, personal conversation 2012) and a visit to this locality, in Gozd Martuljek, in 2013 confirmed presence of *D. santicensis* population there.

Therefore, we exclude for now *D. styriaca* from the list of Psychidae from Slovenia.

Remarks. The genital index of males of this species after verification of old and new material from different localities, slightly differs from the previously reported values of 1.06–1.14 in Weidlich (1996); the revised index has lower values from 0.99–1.14.

Dahlica (*Brevantennia*) *triglavensis* (Rebel, 1919)

Figs 6 a–c, 7, 8c, d, 9–11

Solenobia triglavensis Rebel, 1919: 111.

References for Slovenia. Rebel 1919: 110; Kusdas 1944: 247; Sieder 1953: 120; Meier 1955; Sieder 1956b: 225; Forster and Wohlfahrt 1960: 201; Sieder 1972: 297; Carnelutti 1978, Carnelutti 1992: 79; Sauter and Hättenschwiler 1996: 40; Weidlich 1996: 166; Verovnik 2003: 444 [»Julijci«]; Lesar and Govedič 2010: 49; Sobczyk 2011: 78; Arnscheid and Weidlich 2017: 71.

Material examined. ***Paratype***. Slovenia • 1♂; Julijske Alpe, Triglav; 2400 m; 17.vii.1912; leg. R. Spitz; coll. NHMW [Hauptsammlung - Psychidae].

Other material. Slovenia • 3♂♂; Julijske Alpe, Kanin, Podi; 2250 m; 19–20.vii.2009; leg. J. Rekelj; DNA barcode sample: 1♂ TIPSY164-12); coll. PCJR • 6♂♂, 13♀♀, with larval cases; same locality; 26.vi.2010 (e.p. 26–28.vi.2010); leg. J. Rekelj; DNA barcode sample: 1♂ TIPSY162-12; coll. PCJR • 9♂♂, 7♀♀, with larval cases; same locality; 26.6.2010 (e.p. 26.6–4.7.2010); leg. Ž. Predovnik; DNA barcode sample: 1♂ TIPSY293-12; genit. prep. №:356, 329, T. Sobczyk; coll. PCŽP • 7♂♂; same locality; 16–18.vi.2012; leg. J. Rekelj; 5♂♂ genit. prep. №: 204–207, 297, 299; coll. PCJR • 59♂♂, 35♀♀, with larval cases; same locality; 16–18.iv.2012 (e.p. 23–25.iv.2012); leg. J. Rekelj; 1♂ genit. prep. №: 208; coll. PCJR • 14♂♂; same locality; 10–11.iv.2017; leg. J. Rekelj; 1♂ genit. prep. №: 208; coll. PCJR • 3♂♂; with larval cases; same locality; 10–11.iv.2017 (e.p. 15–20.iv.2017); leg. J. Rekelj; coll. PCJR • 6 ♂♂, 4 ♀♀, with larval cases; Julijske Alpe, Mangart; 2050 m; 26.vi.2016 (e.p. 1–3.vii.2016); leg. J. Rekelj; 5♂♂ genit. prep. №: 244–248, Rekelj; coll. PCJR • 19♂♂, 12♀♀, with larval cases; Mojstrana - Belca; 900 m; 15.4.2004 (e.p. 18–25.iv.2004); leg. M. Lasan; coll. PCML • Several old larval cases; Karavanke, Belca, Jurčkov vrh; 840–907 m; 25.ix.2009, leg. Ž. Predovnik; coll. PCŽP • 7♂♂, 10♀♀, with larval cases; same locality; 28.iii.2010 (e.p. 4–9. iv.2010); leg. Ž. Predovnik; DNA barcode sample: 1♂ TIPSY294-12, 1♂ TIPSY295-12, 1♂ TIPSY296-12; coll. PCŽP • 21♂♂, 18♀♀, with larval cases; same locality; 25.iii.2011 (e.p. 8.iv.2011); leg J. Rekelj; DNA barcode sample: 1♂ TIPSY156-12, 1♂ TIPSY157-12, 1♂ TIPSY158-12, 1♂ TIPSY159-12; coll. PCJR • 8♂♂, 8♀♀, with larval cases; same locality; 24.iii.2012 (e.p. 25–30.iii.2012), leg J. Rekelj; coll. PCJR • 21♂♂, 10♀♀, with larval cases; same locality; 21.iv.2013 (e.p. 22–25.iv.2013), leg J. Rekelj; 5♂♂ genit. prep. №: 219–223, Rekelj; coll. PCJR • 3♂♂; Karavanke, Stol; 2140 m; 22.vi.2014, leg J. Rekelj; 1♂ genit. prep. №:124, Rekelj; coll. PCJR • 9♂♂, 6♀♀, with larval cases; same locality; 22.vi.2014 (e.p. 22–25.vi.2014); leg J. Rekelj; DNA barcode sample: 1♂ TIPSY748-15; 5♂♂ genit. prep. №: 209–213, Rekelj; coll. PCJR • 5♂♂; 21.vi.2014, same locality; leg. Ž. Predovnik; coll. PCŽP • 19♂♂, 1♀, with larval cases; same locality; 21.vi.2014 (e.p. 21–22.vi.2014); leg. Ž. Predovnik; coll. PCŽP • 10♂♂, 2♀♀, with larval cases, same locality; 4.vi.2017 (e.p. 5–14.vi.2017); leg J. Rekelj; coll. PCJR.

Distribution. *D. triglavensis* is distributed westwards to the Carnian Alps of Austria and Italy (Sobczyk 2011, Arnscheid and Weidlich 2017). In Slovenia, the species is restricted to alpine areas in Julijske Alpe, and Karavanke. All localities are illustrated in Fig. 11.

Biology. *D. triglavensis* is a characteristic montane-alpine species. It is restricted to rocky habitats where the subsoil consists of limestone at an elevation from 800–2500 m. Observations in the natural habitat were carried out particularly on Mt. Kanin (Fig. 6c), where we found them in the southern and south-eastern facing rocky slopes at an elevation from 2000–2300 m. The species inhabits slightly elevated areas of slopes that are sparsely covered with alpine vegetation such as *Dryas octopetala* L., *Potentilla nitida* L. and *Carex* sp. In the early spring, those areas become snow-free and later obtain less moisture and quickly heat up. The larval cases were fixed to the underside of small stones or gravel, individually also on the sides of the stones, or in cracks. *D. triglavensis* uses a mixed voltinism strategy

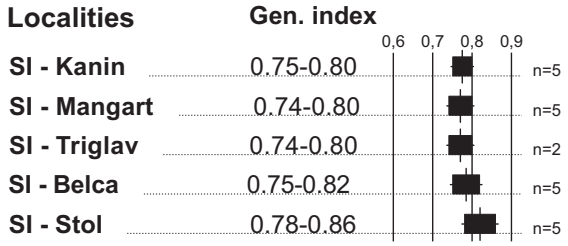

Figure 7. Graphical representation of genital indexes on different localities of *D. triglavensis*.

Figure 8. Heads, colouration of vertex and frons dense hairs. **a.** *D. santicensis*, Gozd Martuljek; **b.** *D. santicensis*, Retje, Ribnica; **c.** *D. triglavensis*, Jurčkov vrh, Belca; **d.** *D. triglavensis*, Kanin; **e.** *D. adriatica*, Potok Mrzlek; **f.** *D. styriaca,* Häuslberg bei Leoben.

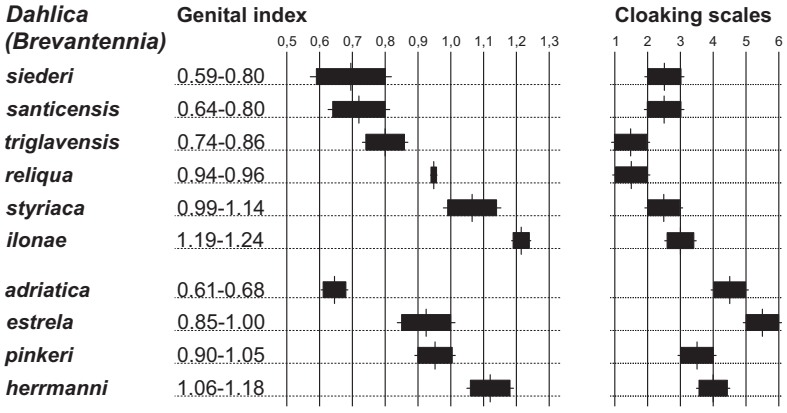

Figure 9. Graphical representation of genital indexes and classes of cloaking scales of all species in subgenus *Brevantennia* (after Arnscheid and Weidlich 2017, enriched by our own investigations).

(see below) which helps populations to persist in high alpine areas where the weather can be poor towards the end of the season. We found on the same stone old empty larval cases from previous years and new fresh cases with pupae from the current season as well as young larvae of different sizes. This behaviour at this elevation indicates that the species is semivoltine, likely with a two-year cycle (Sieder 1953: 122).

Adults emerge from the beginning of June to mid-July, about three weeks after snow melt. They are active in the morning, when the habitat is illuminated by the first sunlight. *D. triglavensis* in Kanin locality cohabits with the following species of bagworms: *Dahlica klimeschi* (Sieder, 1953); *Dahlica* (*Siederia*) *meierella*; *Proutia raiblensis* (Mann, 1870) and *Leptopterix hirsutella* (Denis & Schiffermüller, 1775).

On the Karavanke mountains we found this species on two localities at very different elevations. The first locality Jurčkov vrh, Belca lies on the south-eastern steep, rocky slope of entry Belca creek in a *Genisto januensis* - *Pinetum* zonal forest community, from 840–907 m. The vegetation is dominated by *Pinus sylvestris* L., *Fraxinus ornus* L., and *Ostrya carpinifolia* Scop. The larval cases were found on the underside of stones or gravel, also on the low areas of larger rocks or cliffs. The larvae are quite hidden throughout the season and feed on mosses, decomposing plants and lichens. At this elevation the species is univoltine. This behaviour has already been observed for *D. triglavensis* by Sieder (1953: 122). Larvae begin pupation in mid March to early April. The flight period of adults is in April and depends on the duration of the winter and the amount of snow cover.

At the Jurčkov vrh locality, *D. triglavensis* cohabits with the following bagworms: *Dahlica triquetrella* f. parth; *Dahlica* (*Siederia*) *meierella*; *Taleporia tubulosa*; *Typhonia* sp.; *Psyche casta*; *Bijugis bombycella* (Denis & Schiffermüller, 1775); *Rebelia* sp.; *Canephora hirsuta* (Poda, 1761); *Leptopterix plumistrella* (Hübner, 1793); *Megalophanes viciella* (Denis & Schiffermüller, 1775) and *Sterrhopterix* sp.

The second Karavanke locality lies on the rocky slope of eastern ridge of Mt. Stol, just below the summit at an elevation of 2140 m in the alpine zone. The subsoil consists of limestone. The larval cases were found there in a microhabitat where rocks are in contact with soil, on the underside of stones or gravel and on the lower parts of larger rocks. Among the collected larval cases were also found a few active young larvae which indicate that the species is semivoltine, likely with a two-year cycle. At this locality we observed activity of adults as early as the end of June.

In Stol this species cohabits with the following species of bagworms: *Dahlica goltella* Rekelj & Predovnik, 2014; *Dahlica klimeschi* (Sieder, 1953); *Proutia raiblensis* and *Epichnopterix ardua* Mann, 1867.

Remarks. Subendemic, type species of the subgenus *Brevantennia* (Sieder, 1953: 120), with type locality in Slovenia: Julijske Alpe, Triglav, 2400 m (Rebel 1919: 111).

Our DNA barcoding study revealed two distinct genetic lineages within the *D. triglavensis* group, representing different BINs (Suppl. material 1: Table S1). The first lineage consists of specimens from Julijske Alpe (BOLD:ABU8640), and a second one from Karavanke mountains (BOLD:ABU8641). Morphologically, these lineages are remarkably similar and despite precise studies of adults and immature stages of many specimens, no tangible morphological differences could be found that would exceed the normal range of variation of each population.

However, the morphology-based taxonomy and the distribution boundaries of these groups remain poorly defined, so we have decided to keep the same name for both populations.

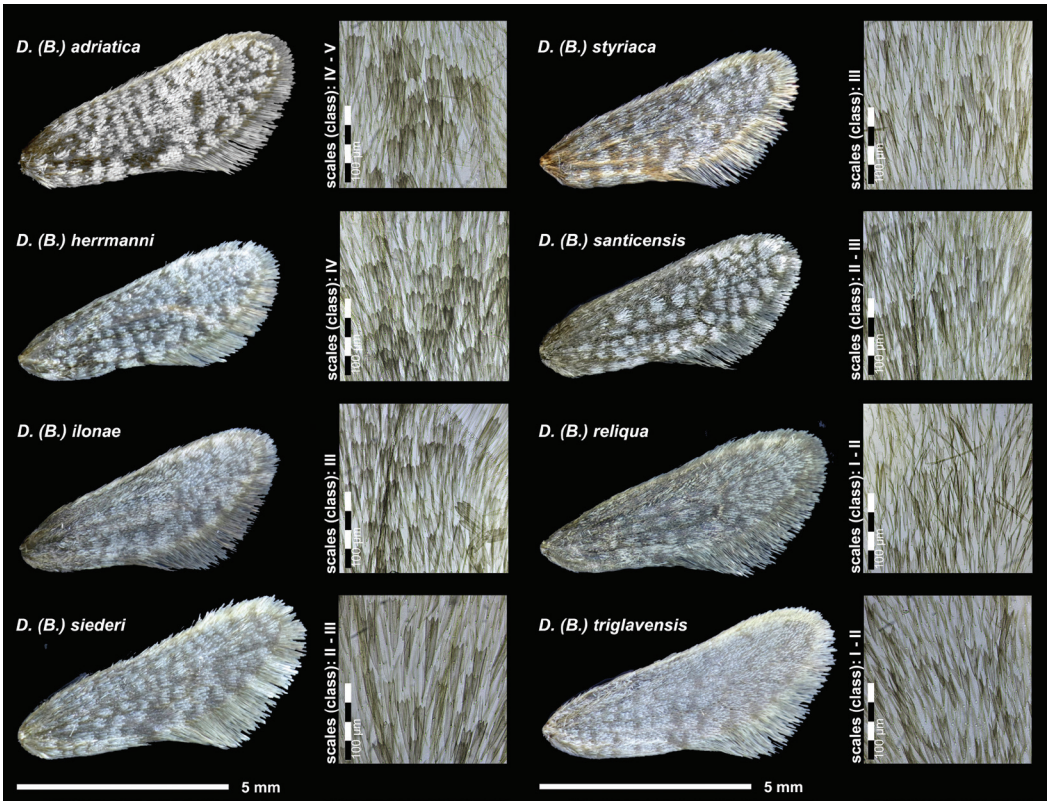

Figure 10. Comparison of patterns and cloaking scales of male forewings: Slovenian and surrounding subgenus *Brevantennia* species.

DNA barcoding analysis

We DNA barcoded 52 specimens belonging to eight named *Dahlica* species of the subgenus *Brevantennia* (Table 1). The sequences formed nine different BINs seven of which were new to BOLD (Table 1) with a genetic intraspecific variability ranging from 0–2.51% with a mean of 0.91% (Table 1). The minimum nearest-neighbour distance varies from 2.4–4.97% (Table 1). Out of the eight named species barcoded, five had their own unique BIN (Table 1; Fig. 12), since *D. triglavensis* shows two different BINs which are 2.4% divergent (Table 1) and *D. santicensis and D. siederi* share a BIN. Indeed, *D. santicensis* shows a high level of intraspecific variability with a maximum intraspecific genetic distance of 2.57% (Table 1). According to BOLD, the nearest neighbour of the latter is a *Dahlica* species at 4.97% (p-distance) (Table 1). All 19 specimens of *D. santicensis* share the same BIN (BOLD:AAQ1227) (Fig. 12, Table 1). In addition, we DNA barcoded an Italian specimen of *D. siederi* (STG 216) which shares the same BIN (BOLD:AAQ1227) as *D. santicensis* (Table 1, Fig. 12 , Suppl. material 1: Table S1).

One specimen from Crimea (TLMF Lep 07217) forms its own BIN (BOLD:ACM5956) and shows a high genetic divergence of 4.33% to a *Dahlica* species (Suppl. material 1: Table S1). We need more specimens to assess its status and it is therefore treated here as an unconfirmed candidate species (sensu Lopez-Vaamonde et al. 2021).

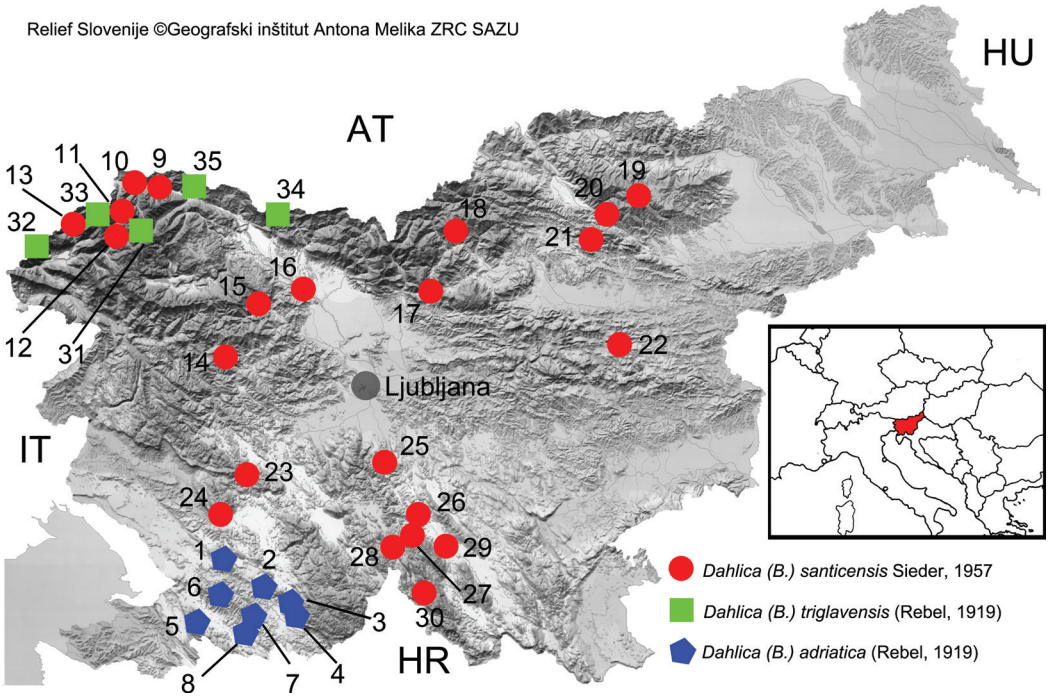

Figure 11. Distribution map of subgenus *Brevantennia* species in Slovenia. **1.** Prelovce, Vremščica; **2.** Potok Mrzlek, Ribnica; **3.** Žlebovi, Koritnice; **4.** Devin, Županica; **5.** Slavnik; **6.** Misliče, Brkini; **7.** Pregarje, Huje; **8.** Obrov, Brkini (Weidlich 2012); **9.** Gozd Martuljek; **10.** Rateče, Gorenjska; **11.** Mala Mojstrovka; **12.** Mlinarica, Zg. Trenta; **13.** Strmec na Predelu; **14.** Kladje, Cerkno; **15.** Zgornja Sorica; **16.** Gradišče, Naklo; **17.** Črnivec pod Plešivcem; **18.** Strmec, Raduha; **19.** Cezlak, Oplotnica; **20.** Tolsti vrh, Mislinja; **21.** Paški Kozjak; **22.** Mrzlo Polje, Gračnica; **23.** Laniše, Hrušica; **24.** Nanos; **25.** Kurešček, Želimlje; **26.** Mala Slevica, Velike Lašče; **27.** Ravni vrh, Sodražica; **28.** Retje, Ribnica; **29.** Breg pri Ribnici na Dolenjskem; **30.** Trava, Podplanina; **31.** Triglav, Julijske Alpe; **32.** Kanin, Julijske Alpe; **33.** Mangart, Julijske Alpe; **34.** Stol, Karavanke; **35.** Belca, Karavanke.

Discussion

Here we studied the Dahlicini, a very challenging group in terms of species delimitation and identification. We focused primarily on the species from Slovenia, but we briefly touched also on problems of related species from neighbouring countries. Due to its rich geological development, Slovenia has a remarkable species diversity in a relatively small geographical area, and this is reflected in the subgenus *Brevantennia*. Accurate identification of *Dahlica* species is challenging and can only be successful done based on all listed external features in combination with the genital indices (Arnscheid and Weidlich 2017: 39). In our study group, the genital index method proved to be the most useful approach which, in combination with the distinguishing shape of cloaking scales, allowed us to identify all Slovenian species. Here we updated the known values of these indices as a result of our analysis of a larger number of specimens from different localities. We found that wing venation is an unreliable diagnostic character at species level.

Table 1. Summary statistics for specimens included in this study. Dmin_NN heterospecific = minimum distance to nearest neighbour; NN= nearest neighbour; BIN Dmax= maximum intraspecific distance within a BIN.

Species	No. in dataset	BIN name	BIN geography	BIN Average (P-distance)	BIN Dmax (P-distance)	Dmin_NN heterospecific (P-distance)	NN heterospecific BIN	NN heterospecific Identification
Dahlica (*Brevantennia*) *adriatica* (Rebel, 1919)	8	BOLD:ACX7360	Slovenia, Austria, Bosnia and Herzegovina	0.35	1.22	4.33	BOLD:ACS2709	*Siederia*
Dahlica (*Brevantennia*) *ilonae* Weidlich, 2014	7	BOLD:ACJ3876	Slovakia, Hungary, Romania, Ukraine	0.84	1.44	4.01	BOLD:ACC7077	*Brevantennia styriaca*
Dahlica (*Brevantennia*) *pinkeri* Sieder, 1964	1	BOLD:ACX7360	Spain	NA	NA	4.51	BOLD:ADD5884	*Dahlica nickerlii*
Dahlica (*Brevantennia*) *reliqua* (Sieder, 1953)	2	BOLD:ACC7257	Austria	0	0	4.81	BOLD:ADQ8354	*Dahlica exulans*
Dahlica (*Brevantennia*) *santicensis* (Sieder, 1957)	19	BOLD:AAQ1227	Austria, Slovenia, Croatia, Romania	1.25	2.57	4.97	BOLD:AED7194	*Dahlica sp.*
Dahlica (*Brevantennia*) *siederi* (Sauter, 1954)	1	BOLD:AAQ1227	Italy					
Dahlica (*Brevantennia*) *sp.*	1	BOLD:ACM5956	Crimea	NA	NA	4.33	BOLD:ADQ8354	*Dahlica exulans*
Dahlica (*Brevantennia*) *styriaca* (Meier, 1957)	2	BOLD:ACC7077	Austria	0	0	4.01	BOLD:ACJ3876	*Dahlica triquetrella*
Dahlica (*Brevantennia*) *triglavensis* (Rebel, 1919)	3	BOLD:ABU8640	Slovenia	0	0	2.4	BOLD:ABU8641	*Brevantennia triglavensis*
Dahlica (*Brevantennia*) *triglavensis* (Rebel, 1919)	8	BOLD:ABU8641	Slovenia	0.23	0.92	2.4	BOLD:ABU8640	*Brevantennia triglavensis*
TOTAL	**52**							

Our results have confirmed the presence of both *D. adriatica* and *D. triglavensis* in Slovenia. *D. triglavensis* shows two different BINS separated geographically by the Sava valley: BOLD:ABU8640 occurs in Julijske Alpe and BOLD:ABU8641 occurs in Karavanke mountains. We have not found any morphological differentiation between both allopatric populations representing another European Lepidoptera species with multiple BINs (Lopez-Vaamonde et al. 2021). It would be interesting to see whether there are any areas where representatives of both BINS enter into contact.

Both morphological and DNA barcoding results confirmed the differentiation between *D. styriaca* and *D. santicensis*. Indeed, we have obtained DNA barcode data of *D. styriaca* from the type locality in Austria and DNA barcodes of *D. santicensis* from populations distributed from Austrian Carinthia, East Tyrol, Slovenia, Romania and Croatia. Our morphological analysis confirmed that *D. santicensis* is a good species and the recently described *D. gorskikotarica* is a new synonym of this species.

D. styriaca does not occur in Slovenia, but further field work is needed in the less studied areas of Slovenia, such as the mountain range of Kozjak, located north of the Drava River in the border with Austria, an area which lies on the Eurasian plate.

Two species, *D. siederi* and *D. santicensis*, share the same BIN. These two species are morphologically very similar having almost the same genital index and type of cloaking scales (Weidlich 2015). However, these two species can be separated clearly by the ground colour of the forewings which is much lighter in *D. siederi* than in *D. santicensis*. Furthermore, the forewing pattern is creamy white, unlike that of *D. santicensis*, which is light grey. The forewing apex in the area of the stigma is noticeably lighter in *D. siederi*, creamy silver in ground colour, unlike *D. santicensis* which has this area silvery grey, the same colour as the ground colour or fringes. There are also strong differences in the choice of biotope. *D. siederi* prefers sunny subalpine slopes above the

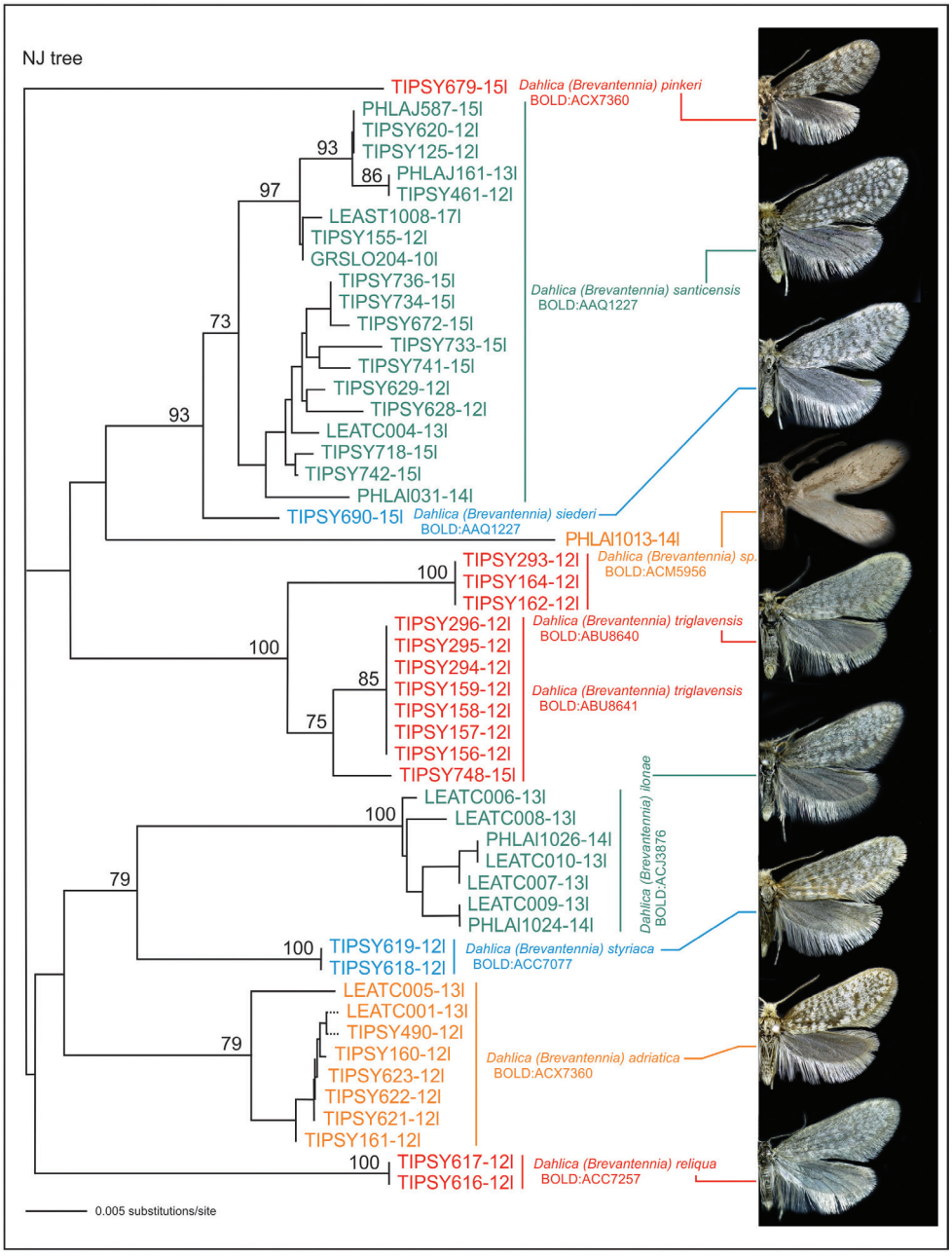

Figure 12. Neighbor-Joining tree (uncorrected p-distance) of subgenus *Brevantennia* COI (DNA barcode) sequences. Each specimen is identified by its ProcessID code (see Suppl. material 1: Table S1). Values above branches are bootstrap supports above 70. Collecting data of the corresponding specimens, from top to bottom as follows: *D. pinkeri* - Spain, Portbou, Colera; *D. santicensis* - Slovenia, Gozd Martuljek; *D. siederi* - Schweiz, Monte Generoso; *D.* sp. - Ukraine, Crimea, Sample ID: TLMF Lep 07217, BIN: BOLD:ACM5956; *D. triglavensis* - Slovenia, Kanin; *D. ilonae* - Slovakia, Malužiná; *D. styriaca* - Austria, Häuslberg bei Leoben; *D. adriatica* - Slovenia, Vremščica; *D. reliqua* - Austria, Launsdorf.

tree line, where larval cases are found on cliffs, walls and rocks at elevations from 1600–1700 m, whereas *D. santicensis* is a highly eurytopic species. The latter inhabits shaded humid areas of mixed forest dominated by conifers, mostly *Pinus sylvestris* and *Picea abies*, from the lowlands to the subalpine zone, between 400–1600 m. Unfortunately, we only DNA barcoded one specimen of *D. siederi* from a single locality (Italy, Monte Baldo). More specimens of *D. siederi* are needed for DNA barcoding analysis, in particular from the type locality (Schweiz, Monte Generoso) to test the hypothesis that *D. santicensis* and *D. siederi* are species each with multiple BINs.

Acknowledgements

We would like to express our cordial thanks to Sabine Gaal (Austria) for giving access to study the curated collection in NHMW. We also express our sincere gratitude to Mojmir Lasan (Slovenia). His knowledge about Psychidae helped us to make the first steps in studying this interesting family. Our special thanks go to František Fiala (Czech Republic) for the possibility of study a collection of late Miloslav Petrů, which is now under his care. We are grateful to Stanislav Gomboc (Slovenia) for helpful comments on the manuscript and assistance in processing of DNA samples. Michael Weidlich (Germany) provided valuable material for DNA barcoding. Our sincere thanks also to the editor David Lees and both reviewers Christof Zeller and Thomas Sobczyk for insightful comments that helped to improve the manuscript. We thank Marijan Govedič (Slovenia) for providing valuable literature and Colin W. Plant, (UK), for linguistic improvements and some comments on the paper. DNA barcoding was funded by FEDER InFoBioS project (EX011185) to CLV, and by grants of the Promotion of Educational Policies, University and Research Department of the Autonomous Province of Bolzano - South Tyrol and the Austrian Federal Ministry of Science, Research and Economics to PH. The authors are grateful to the staff at the Centre for Biodiversity Genomics at Guelph for their assistance in particular Claudia Steinke, Ramya Manjunath, Miduna Rahulan, Evgeny V. Zakharov, Jeremy Deeward and Vanessa Bouwer.

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Supplementary material 1

Table S1

Authors: Jurij Rekelj, Željko Predovnik, Peter Huemer, Carlos Lopez-Vaamonde

Data type: Table.

Explanation note: Specimens used in this study, with Sample and Process ID, BIN and accession number. Additional collecting and specimen data are accessible in BOLD through the public dataset: DS-BREVANTE. (dx.doi.org/10.5883/DS-BREVANTE).

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Link: https://doi.org/10.3897/nl.45.81674.suppl1

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Digitale Literatur/Digital Literature

Zeitschrift/Journal: Nota lepidopterologica

Jahr/Year: 2022

Band/Volume: 45

Autor(en)/Author(s): Rekelj Jurij, Predovnik Zeljko, Huemer Peter, Lopez-Vaamonde Carlos

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