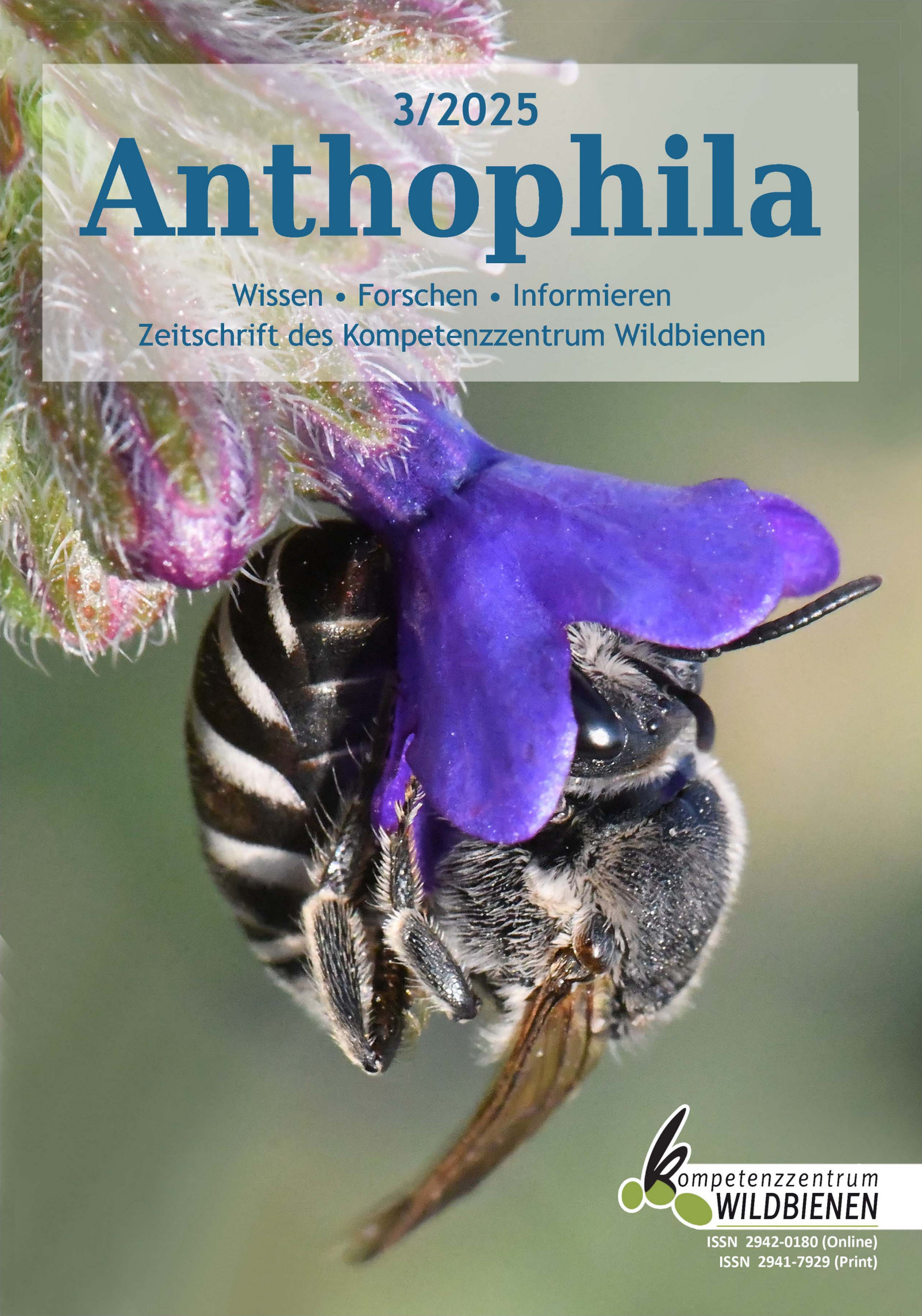

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info@wildbienenzentrum.de
https://www.wildbienenzentrum.de/

Redaktion / Editorial board

Ronald Burger, Christoph Saure, Erwin Scheuchl, Hans Richard Schwenninger, Noel Silló, Karin Wolf-Schwenninger

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♀ von *Colletes nasutus* SMITH, 1853 auf *Anchusa officinalis* L., © Dr. Hannes Petrischak

Rückseite / Back cover

oben: *Colletes halophilus* (VERHOEFF, 1944) ♀ auf Strand-Aster (*Tripolium pannonicum*), © Dr. Hannes Petrischak

unten: Salzwiesen an der Eidermündung bei Vollerwiek, Lebensraum der Strandaster-Seidenbiene (*Colletes halophilus*), © Dr. Hannes Petrischak

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Vorwort

Liebe Lesende,

das Kompetenzzentrum Wildbienen freut sich, Ihnen mit der dritten Ausgabe von **Anthophila** einen Sonderband präsentieren zu dürfen!

Er widmet sich den *Colletes*-Arten Nord- und Mitteleuropas und bietet mit einem umfassend bebilderten Bestimmungsschlüssel ein aktuelles Werkzeug zur Bestimmung dieser taxonomisch schwierigen Bienengattung. Damit wird ein wichtiger Baustein zur Förderung und Verbreitung von Grundlagenwissen der Seidenbienen gelegt.

Die Förderung von Artenkenntnissen stellt eine wichtige Aufgabe für die Zukunft dar. Die Bestimmung von Arten bildet hierbei die Grundlage jedes weiterführenden Forschungsansatzes: von ökologischen, taxonomischen und evolutionsbiologischen Studien über Biodiversitätsmonitoring bis hin zur Entwicklung von Schutzkonzepten. In einer Zeit, in der sich Artengemeinschaften durch Umweltveränderungen rasch wandeln, kommt der präzisen Bestimmung und taxonomischen Einordnung eine wachsende Bedeutung zu. Mit diesem Band leistet das Kompetenzzentrum Wildbienen einen wichtigen Beitrag dazu, dass taxonomisches Wissen zugänglich, überprüfbar und anwendbar bleibt.

Wie immer ist **Anthophila** als kostenlose Online-Version frei verfügbar und kann bei Bedarf auch als gedruckter Band bestellt werden. Der Sonderband bietet einen Transfer von Spezialwissen in die Breite der Gesellschaft und trägt so dazu bei, das Verständnis für die Vielfalt und ökologische Bedeutung der Seidenbienen zu vertiefen.

Das Kompetenzzentrum Wildbienen sieht in der Publikation dieses Bestimmungsschlüssels eine besondere Aufgabe: Sie verbindet wissenschaftliche Präzision mit dem Ziel der Wissensvermittlung und stärkt damit die Basis für zukünftige Forschung an der Gattung *Colletes* sowie an Wildbienen insgesamt.

Wir danken unserem Gesellschafter Prof. Michael Kuhlmann für seine herausragende Arbeit und sein Engagement in der Gattung *Colletes*, wodurch dieses grundlegende Werk für die wissenschaftliche und angewandte Wildbienenforschung zugänglich wird.

Kompetenzzentrum Wildbienen, gGmbH
Neustadt an der Weinstraße, den 15.11.2025

Preface

Dear readers,

the Wild Bee Competence Center is pleased to present the third issue of **Anthophila** as a special volume!

This issue is dedicated to the *Colletes* species of Northern and Central Europe and provides an up-to-date, richly illustrated identification key as a practical tool for identifying this taxonomically difficult bee genus. In doing so, it lays an important foundation for promoting and disseminating basic knowledge about plasterer bees (Colletidae).

Fostering taxonomic expertise represents a crucial task for the future. Accurate species identification forms the basis of all subsequent research — from ecological, taxonomic, and evolutionary studies to biodiversity monitoring and the development of conservation strategies. At a time when species communities are rapidly changing due to environmental transformations, precise identification and taxonomic classification are gaining increasing importance. With this volume, the Wild Bee Competence Center contributes to ensuring that taxonomic knowledge remains accessible, verifiable, and applicable.

As always, **Anthophila** is freely available online as an open-access publication and can also be ordered as a printed edition. This special issue transfers specialized scientific knowledge to a broader audience, thereby helping to deepen understanding of the diversity and ecological importance of plasterer bees.

The publication of this identification key represents a special mission for the Wild Bee Competence Center: it combines scientific precision with the goal of knowledge dissemination, thereby strengthening the foundation for future research on the genus *Colletes* and wild bees in general.

We would like to express our sincere gratitude to our founding member, Prof. Michael Kuhlmann, for his outstanding work and dedication to the genus Colletes, through which this fundamental reference has been made available to both scientific and applied wild bee research.

Wild Bee Competence Center (non-profit organization)
Neustadt an der Weinstraße, 15 November 2024

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Illustrated key to the Central and Northwest European species of the bee genus *Colletes* LATREILLE, 1802 (Hymenoptera: Colletidae)

Illustrierter Bestimmungsschlüssel für die mittel- und nordwesteuropäischen Arten der Gattung *Colletes* LATREILLE, 1802 (Hymenoptera: Colletidae)

Michael Kuhlmann[1], Lea Neiner[2]

[1] Zoological Museum, Kiel University, Hegewischstr. 3, D-24105 Kiel, Germany, mkuhlmann@zoolmuseum.uni-kiel.de
[2] Zoological Museum, Kiel University, Hegewischstr. 3, D-24105 Kiel, Germany, stu233159@mail.uni-kiel.de

Abstract

Keys are provided for the identification of females and males of the 30 *Colletes* species occurring in Central and Northwest Europe. They are comprehensively illustrated with photographs of structures that are relevant to identification in order to facilitate species identification in this difficult genus.

Zusammenfassung

Für die 30 in Mittel- und Nordwesteuropa vorkommenden *Colletes*-Arten werden Bestimmungsschlüssel für die Weibchen und Männchen vorgelegt. Sie sind umfassend mit Fotos von bestimmungsrelevanten Strukturen illustriert, um die Artbestimmung in dieser schwierigen Gattung zu erleichtern.

Introduction

Colletes are solitary bees that build nests in the ground. Most species are specialised (oligolectic) pollen collectors, which in extreme cases even visit only a single plant genus or species (MÜLLER & KUHLMANN 2008). As a genus, *Colletes* is easily recognisable in the Central European fauna by its bilobed 'tongue' (proboscis) in combination with dense body pilosity in fresh specimens. A bilobed proboscis is otherwise only found in *Hylaeus*, which, in contrast to *Colletes*, are almost hairless and therefore superficially look more like wasps. A general distinct feature for identification of *Colletes* is the second recurrent vein of the fore wing, which is uniquely sigmoidally bent outward in the posterior part (MICHENER 2007).

Although *Colletes* is one of the ten most species-rich bee genera worldwide with over 524 described species (ASCHER & PICKERING 2020), it is less diverse in Europe with only 66 recorded species (GHISBAIN et al. 2023). In Central and Northwest Europe as defined here (Fig. 1) only 30 species are known (Table 1) (REVERTÉ et al. 2023). Despite this comparatively low number of species, a reliable identification of *Colletes* is still a problem even in the very well-studied Western and Central European fauna. However, a reliable identification is prerequisite to advance research into these interesting but comparatively little-studied bees, of which new species have even recently been discovered in Central and Southern Europe, such as *C. standfussi* KUHLMANN, 2003 (KUHLMANN 2003), *C. pannonicus* HÖLZLER & MAZZUCCO, 2011 (HÖLZLER & MAZZUCCO 2011) and *C. jansmiti* KUHLMANN, 2018 (KUHLMANN & SMIT 2018, KUHLMANN 2025).

The challenges of *Colletes* identification lie in the considerable taxonomic problems that some species groups

pose even for experienced bee taxonomists. This was already emphasised by NOSKIEWICZ (1936) and AMIET et al. (2014), who rightly mentioned that the sometimes very small species differences, overlapping characters and intraspecific (geographical) variation can make identification difficult. In these cases, character combinations need to be used for species determination and in some specimens identification is only feasible for an expert with a reference collection or even impossible in some cases. The *C. succinctus* group (ZENZ et al. 2021) and the females of *C. chengtehensis* YASUMATSU, 1935 and *C. marginatus* SMITH, 1846 (ZETTEL et al. 2019) are notorious in this respect, in particular when species occur in the same area. In some regions, the species pairs *C. eous* MORICE, 1904 / *C. nigricans* GISTEL, 1857, *C. carinatus* RADOSZKOWSKI, 1891 / *C. gallicus* RADOSZKOWSKI, 1891 and *C. daviesanus* SMITH, 1846 / *C. inexpectatus* NOSKIEWICZ, 1936 can also be problematic. At least in the *C. succinctus* group, genetic barcoding (sequence of the mitochondrial cytochrome oxidase 1 (COX1) gene), which is widely used for animal species identification, also reaches its limits. Within this group, there are hardly any or no diagnostic genetic differences between the species (KUHLMANN et al. 2007, ZENZ et al. 2021) that can be used for differentiation.

Another reason for the difficulties in identifying *Colletes* species is the absence of comprehensive keys for Central and Northwest Europe that include all taxa currently known from the region. The basic work by NOSKIEWICZ (1936; includes an overview of the keys published up to that point), which is still indispensable for the Palaearctic fauna, as well as the key for the Central European species by BLÜTHGEN (1930) are incomplete and outdated and therefore difficult to use even for bee taxonomists. A number of later described species are missing in both publications and there have been significant nomenclatural changes since then. *Colletes* is not covered by the series 'Illustrierte Bestimmungstabellen der Wildbienen Deutschlands und Österreichs' (SCHEUCHL 2000, 2006, SCHMID-EGGER & SCHEUCHL 1997, DATHE et al. 2016), but a key to the 15 Swiss *Colletes* species is available in the series 'Fauna Helvetica' (AMIET et al. 2014). Even less taxa are treated in the illustrated keys to the *Colletes* bees of the British Isles (ELSE & EDWARDS 2018) and the Netherlands (SMIT 2009), that consider only nine species each and are therefore only of limited use for most parts of the study area. Thus, there is a significant gap and a demand for an illustrated key for the identification of the Central and Northwest European *Colletes* species. The present work aims to fill this gap.

Use of the determination keys

This is the first modern and extensively illustrated identification key for *Colletes* that covers the 30 species that have been recorded in Central and Northwest Europe (Table 1). The aim is to enable a reliable determination of the species in this taxonomically difficult genus, as far as this is possible without reference material. However, in the case of aberrant individual specimens and especially in the difficult species groups mentioned above, there will always be problems where even an experienced taxonomist will encounter difficulties. Comprehensive illustrations aim to reduce these problems as far as possible.

Central and Northwest Europe is here defined as the region shown in Figure 1. The area comprises the entire territories of 23 states. The only exception is France, where the Mediterranean south of the country has been excluded because of the additional Mediterranean species found there. Due to the relative small number of *Colletes* species in Central and Northwestern Europe, the reference area of this key was defined more broadly in order to appeal to a wider user group, like BOGUSCH & STRAKA (2012) did for *Sphecodes* LATREILLE, 1804. However, the use of this key should be limited to its geographical reference area, as closely related taxa occur in the neighbouring regions to the south and east, and some widespread species show considerable geographical variation outside the region.

As a general note it should be mentioned that photographs are usually not suitable for a reliable identification of most *Colletes* species. This applies in particular to live photos, which only in rare cases show sufficient detail. Exceptions are the few characteristic species (e.g. *C. cunicularius* (LINNAEUS, 1761), *C. nasutus* SMITH, 1853, *C. punctatus* MOCSÁRY, 1877), provided that the relevant features are clearly visible in the images.

For a verifiable and reliable identification usually pinned and professionally prepared specimens are required. Only with experience and knowledge of the regional bee

fauna, some species can be identified in the field by experts. Detailed instructions and information on the preparation of wild bees can be found, for example, in EBMER (2010), ELSE & EDWARDS (2018) and HOPFENMÜLLER & MAYR (2023). For the identification of *Colletes* species it is crucial that the relevant morphological characters are clearly visible and ideally fresh specimens with well-preserved pilosity should be used. It can be difficult or impossible to identify specimens that are worn out, have faded and rubbed off hairs or are dirty. The terminology for morphological structures and measurement sections (Fig. 2) used in the key follows MICHENER (2007). Puncture density is expressed as the relationship between puncture diameter (d) and the space between them (i), such as i = 1.5d or i < d. The following abbreviations are used: BL = body length; F = flagellar segment of the antenna; S = metasomal sternum; T = metasomal tergum.

Fig. 1 Delimitation of the reference area of the identification key (orange with red boundary line). Countries are labelled with two-digit ISO country codes.

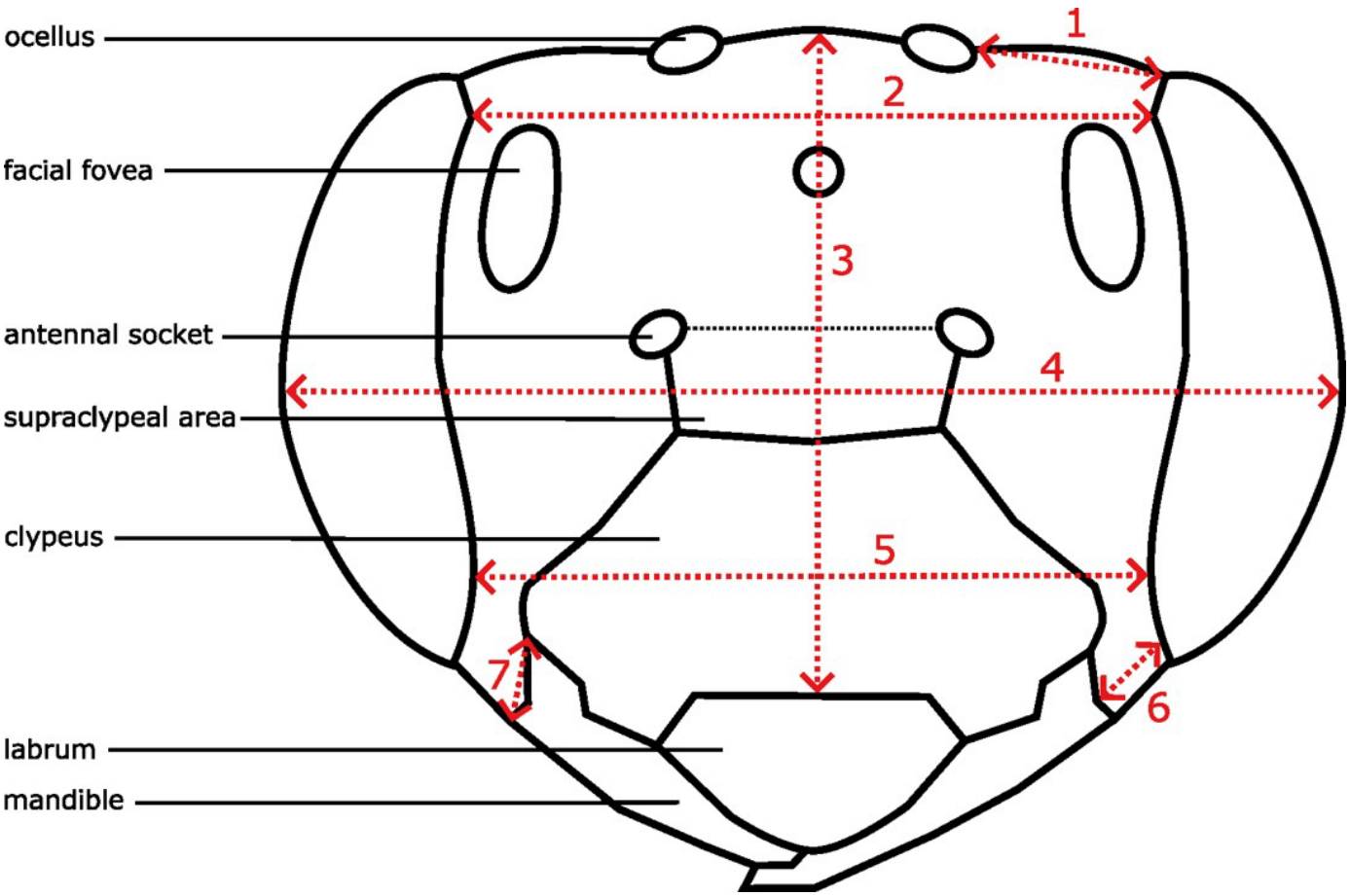

Fig. 2 Schematic frontal view of the head of a bee with measurement sections (adapted from MICHENER 2007: 46): (1) ocellocular distance, (2) upper interocular distance, (3) length of head, (4) width of head, (5) lower interocular distance, (6) malar area, (7) base of mandible.

Specimens are easiest to examine when the wings are positioned at a slight back- and upward angle and the legs and antennae are spread out. In this way, all relevant structures of the head (e.g. clypeus, malar area, facial fovea, vertex) and mesosoma (e.g. scutum, scutellum, propodeum, legs) can be easily examined. The metasoma should be slightly hanging downward so that both the propodeum and the dorsal and ventral sides of the metasoma are easily accessible. It is advisable to extract the proboscis in both sexes because the fine sculpture of the galea provide valuable specific characters in some taxa. In males, S7 and the genitalia should always be pulled out, as both are often diagnostically decisive. The male S7 is the most reliable and often simplest character for the identification of many species. To facilitate identification, S7 are illustrated in dorsal view on an identical scale and grouped together in overview figures for direct comparison (Supplemental Fig. 1a, 1b). It should be taken into account that the S7 of some species are delicate three-dimensional, bilaterally symmetrical structures that can easily stick together during preparation, potentially resulting in (one-sided) artefacts (e.g. by bending, folds).

In some cases, supporting information on distribution and flower visitation are given as additional criteria for identification in the key. These should be used with caution and only in combination with morphological characters. Reasons for this are that due to global warming, distributional patterns have shifted considerably and individuals can sometimes be found far outside the main distribution area. In addition, even the females of oligolectic species sometimes use a wider range of flowers (e.g. for nectar drinking instead of pollen collection). Males are generally not specialised on flowers, but can

be found near the host plants of females, where they are frequently looking for mating partners. Furthermore, individual bees can show divergent and untypical flower visitation behaviour that might result in misidentifications if determination is solely or largely based on flower visitation.

Table 1 *Colletes* species of the study area. Detailed information on their occurrence at country level can be found in REVERTÉ et al. (2023). The categorisation into species groups follows the concepts of NOSKIEWICZ (1936) and KUHLMANN et al. (2009). ***** = species rarely found, only in the extreme south or southeast of the study area.

***nigricans* group**	***anchusae* group**
* *eous* MORICE, 1904	* *anchusae* NOSKIEWICZ, 1924
nigricans GISTEL, 1857	***clypearis* group**
***carinatus* group**	*floralis* EVERSMANN, 1852
carinatus RADOSZKOWSKI, 1891	*impunctatus* NYLANDER, 1852
gallicus RADOSZKOWSKI, 1891	***marginatus* group**
***hylaeiformis* group**	*chengtehensis* YASUMATSU, 1935
hylaeiformis EVERSMANN, 1852	*marginatus* SMITH, 1846
***caspicus* group**	*sierrensis* FREY-GESSNER, 1903
caspicus MORAWITZ, 1874	***succinctus* group**
* *maidli* NOSKIEWICZ, 1936	*brevigena* NOSKIEWICZ, 1936
***fodiens* group**	*collaris* DOURS, 1872
daviesanus SMITH, 1846	*halophilus* VERHOEFF, 1944
fodiens (GEOFFROY, 1785)	*hederae* SCHMIDT & WESTRICH, 1993
inexpectatus NOSKIEWICZ, 1936	*pannonicus* HÖLZLER & MAZZUCCO, 2011
similis SCHENCK, 1853	*succinctus* (LINNAEUS, 1758)
***senilis* group**	***graeffei* group**
mlokossewiczi RADOSZKOWSKI, 1891	*graeffei* ALFKEN, 1900
***foveolaris* group**	***albomaculatus* group**
* *foveolaris* PÉREZ, 1903	*albomaculatus* (LUCAS, 1849)
***cunicularius* group**	*punctatus* MOCSÁRY, 1877
cunicularius (LINNAEUS, 1761)	***nasutus* group**
	nasutus SMITH, 1853

Key to *Colletes* species

Due to the sexual dimorphism in bees, separate keys are provided for females and males. Female *Colletes* can be recognized by the scopa on the hind legs (hairy structure for pollen transport), 6 externally visible metasomal terga and 12 antennal segments while males have no scopa, 7 metasomal terga and 13 antennal segments.

Females

1a Scutellum on each side with large backward curved tooth (Fig. 1a-1) (BL 11–12 mm) ..... ***C. graeffei***

1b Scutellum without teeth **2**

Fig. 1a-1 *Colletes graeffei*, scutellum with lateral tooth

2a(1) Head distinctly elongate, malar area about twice as long as width of base of mandible (Fig. 2a-1) (BL 12–15 mm) ..... ***C. nasutus***

2b Head not conspicuously elongate, malar area at most about as long as width of base of mandible **3**

Fig. 2a-1 *Colletes nasutus*, malar area

3a(2) Metanotum strongly curved, medially raised, with an apical drop almost overhanging the horizontal part of the propodeum (e.g. Fig. 3a-1); punctation on disc of T1 very coarse (Figs 4a-1, 4b-1) **4**

3b Metanotum even or only slightly curved, in about the same level as the horizontal part of the propodeum (e.g. Fig. 3b-1); punctation on disc of T1 much finer **5**

Fig. 3a-1 *Colletes punctatus*, metanotum in lateral view

Fig. 3b-1 *Colletes impunctatus*, metanotum in lateral view

4a(3) T1 very coarsely punctate, marginal zone strongly depressed, with very clear truncate premarginal line (Fig. 4a-1) (BL 9–11 mm) ..... ***C. punctatus***

4b T1 moderately coarsely punctate, marginal zone only slightly depressed, without distinct premarginal line (Fig. 4b-1) (BL 11–15 mm) ..... ***C. albomaculatus***

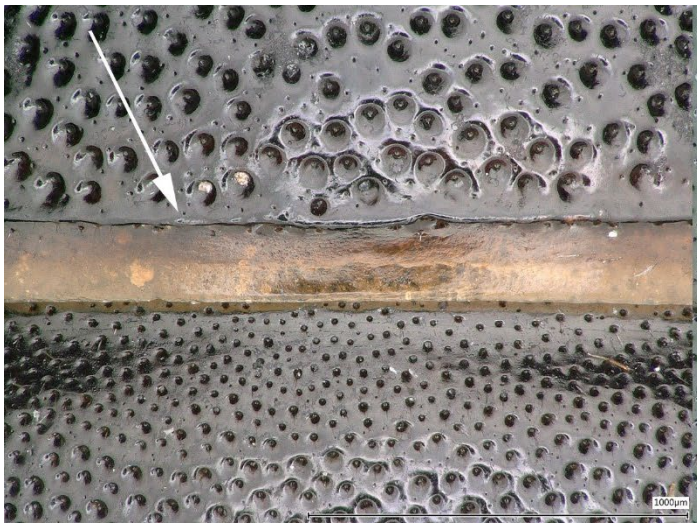

Fig. 4a-1 *Colletes punctatus*, marginal zone of T1

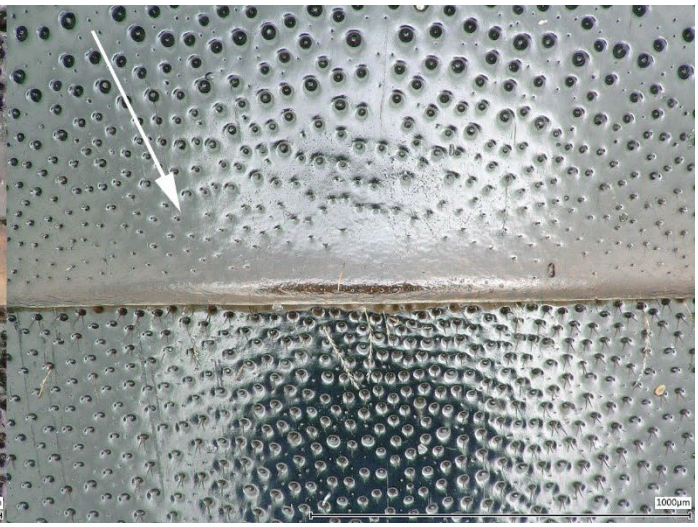

Fig. 4b-1 *Colletes albomaculatus*, marginal zone of T1

5a(3) Metasomal terga without distinct apical hair bands, consisting at most of single protruding hairs (Fig. 5a-1); facial fovea broad, about 3-4 times as wide as width of antennal flagellum (Fig. 5a-2) (BL 13–14 mm) ..... ***C. cunicularius***

5b Metasomal terga with distinct apical hair bands, consisting of short appressed hairs (e.g. Fig. 5b-1); facial fovea narrower, at most 1.5 times as wide as width of antennal flagellum (e.g. Fig. 5b-2) **6**

Fig. 5a-1 *Colletes cunicularius*, metasoma in dorsal view

Fig. 5b-1 *Colletes hederae*, metasoma in dorsal view

Fig. 5a-2 *Colletes cunicularius*, facial fovea

Fig. 5b-2 *Colletes halophilus*, facial fovea

6a(5) Front tibia curved, outward-facing surface concave, glabrous and polished (Fig. 6a-1); tarsal claws without tooth (Fig. 6a-2) (BL 10–12 mm) ..... ***C. anchusae***

6b Front tibia ± straight, outward-facing surface unmodified (e.g. Fig. 6b-1); tarsal claws with tooth (e.g. Fig. 6b-2) **7**

Fig. 6a-1 *Colletes anchusae*, front tibia

Fig. 6b-1 *Colletes similis*, front tibia

Fig. 6a-2 *Colletes anchusae*, tarsal claws

Fig. 6b-2 *Colletes cunicularius*, tarsal claws

7a(6) Apical hair band of T1 (less so on T2 and following terga) medially consisting of very short and broad, scale-like hairs (Fig. 7a-1) (BL 9–12 mm) ..... ***C. hylaeiformis***

7b Apical hair band of T1 and following terga consisting of longer and more slender hairs (e.g. Fig. 7b-1) **8**

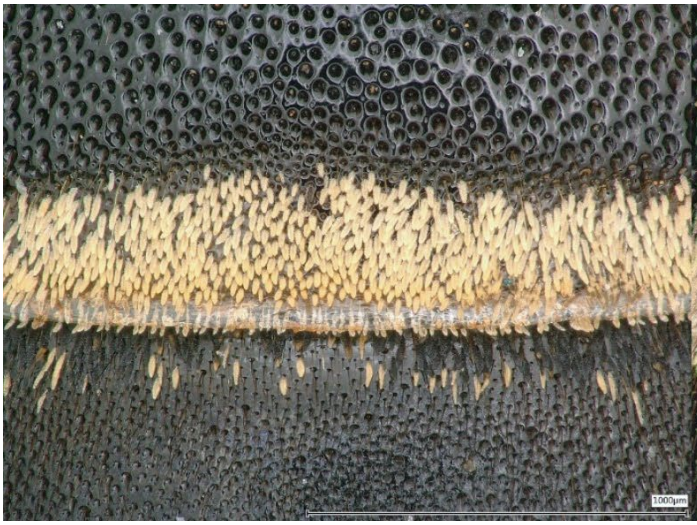

Fig. 7a-1 *Colletes hylaeiformis*, apical hair band of T1

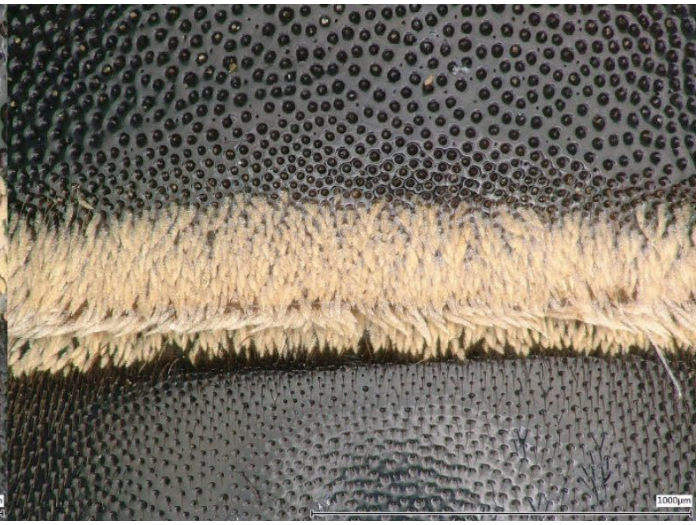

Fig. 7b-1 *Colletes nigricans*, apical hair band of T1

8a(7) Marginal zone of T1 in its posterior, slightly raised half broadly yellowish translucent (Fig. 8a-1, arrow), in the anterior half deeply depressed and dark reddish to blackish-brown (e.g. Fig. 8a-1) **9**

8b Marginal zone of T1 at most narrowly and much darker translucent (Fig. 8b-1, arrow) or only with a slightly raised narrow yellow margin (Fig. 8b-2, arrow) **10**

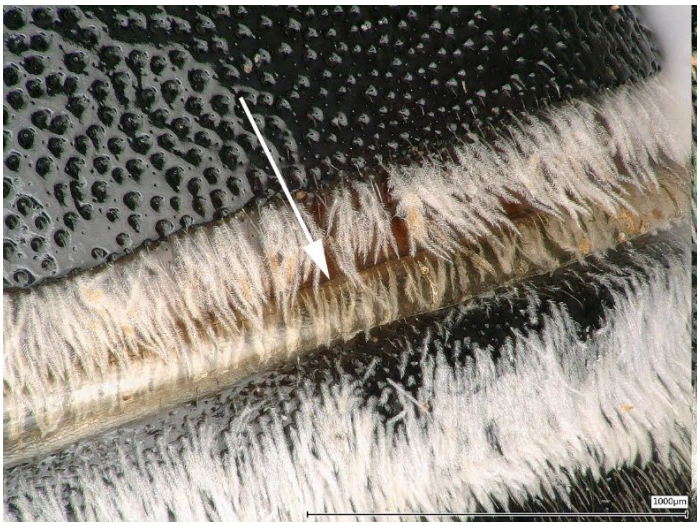

Fig. 8a-1 *Colletes carinatus*, marginal zone

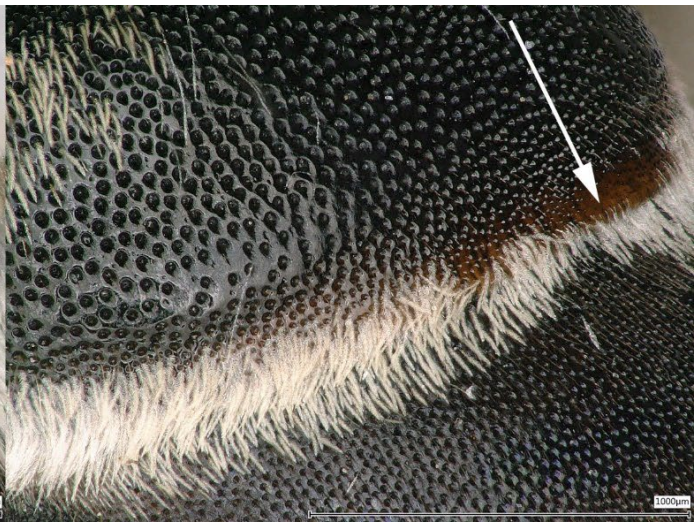

Fig. 8b-1 *Colletes sierrensis*, marginal zone

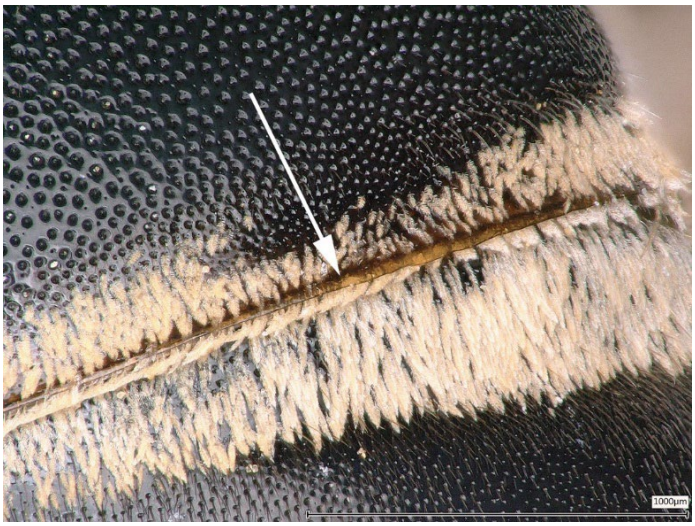

Fig. 8b-2 *Colletes eous*, marginal zone

Note: Differences between the females of the following two species are subtle.

9a(8) Premarginal line of T1 medially distinct and well defined, transition from disc to depression abrupt, almost truncated (Fig. 9a-1, arrow); punctation on disc of T1 slightly coarser and more dispersed (Fig. 9a-2); punctation on disc of T2 distinctly more dispersed (i > d) (Fig. 9a-3). In SE Central Europe (BL 10–12 mm) ..... ***C. carinatus***

9b Premarginal line of T1 medially indistinct, transition from disc to depression gently curved (Fig. 9b-1, arrow); punctation on disc of T1 slightly finer and denser (Fig. 9b-2); punctation on disc of T2 distinctly denser (i < d) (Fig. 9b-3). In SW Central Europe (BL 10–12 mm) ..... ***C. gallicus***

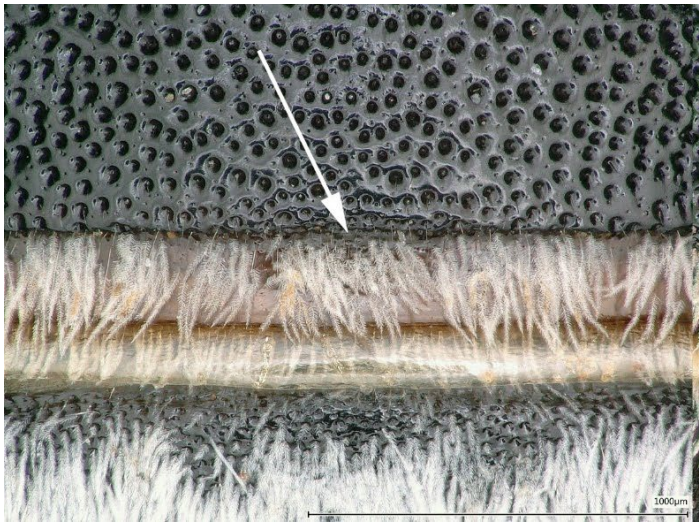

Fig. 9a-1 *Colletes carinatus*, premarginal line of T1

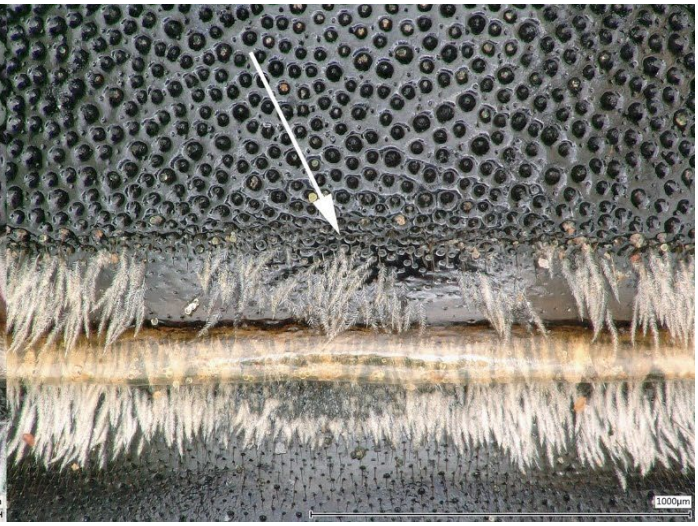

Fig. 9b-1 *Colletes gallicus*, premarginal line of T1

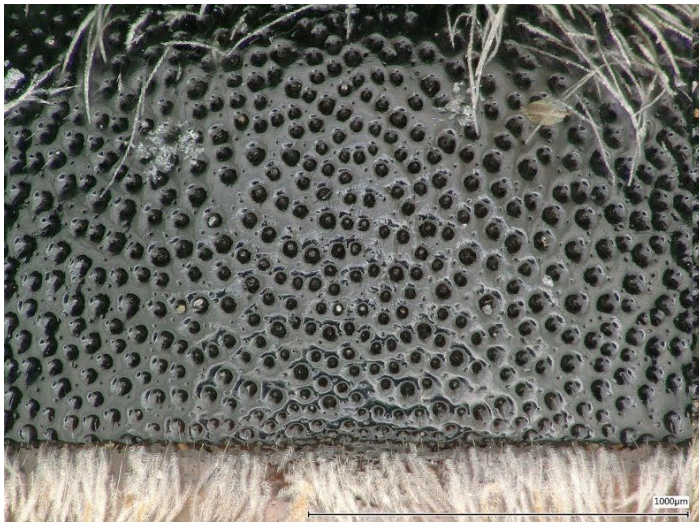

Fig. 9a-2 *Colletes carinatus*, disc of T1

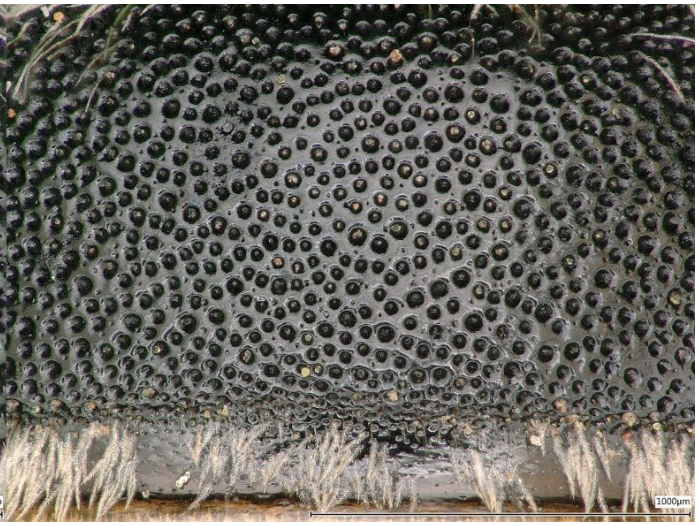

Fig. 9b-2 *Colletes gallicus*, disc of T1

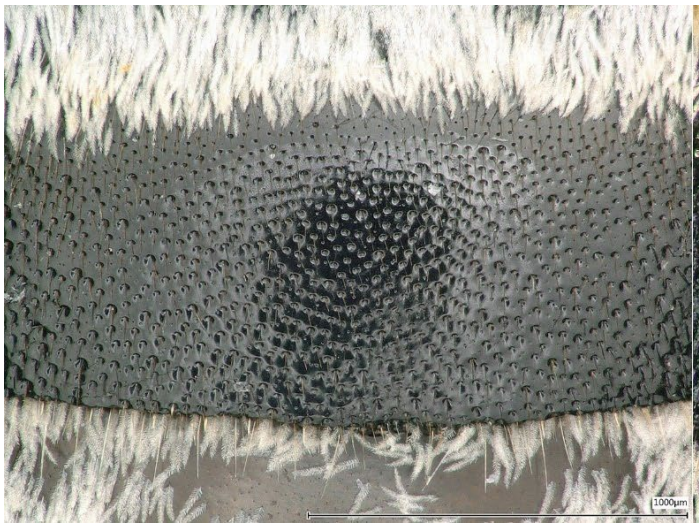

Fig. 9a-3 *Colletes carinatus*, disc of T2

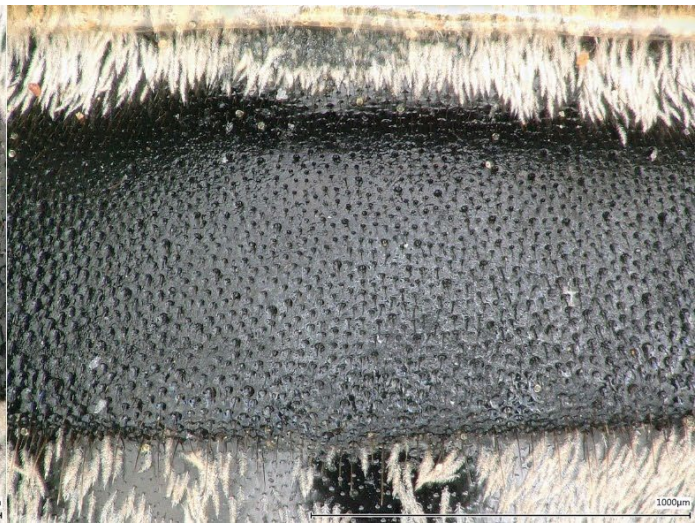

Fig. 9b-3 *Colletes gallicus*, disc of T2

10a(8) Preoccipital ridge sharp edged behind the upper part of the eye (Fig. 10a-1) **11**

10b Preoccipital ridge ± evenly rounded (e.g. Fig. 10b-1) **13**

Fig. 10a-1 *Colletes chengtehensis*, preoccipital ridge behind eye

Fig. 10b-1 *Colletes hylaeiformis*, without preoccipital ridge behind eye

11a(10) Clypeus with transverse wrinkles bending towards the middle (Fig. 11a-1). Oligolectic on *Odontites*; in SW Central Europe (BL 8–10 mm) ..... ***C. sierrensis***

11b Clypeus with ± longitudinal wrinkles (e.g. Fig. 11b-1). Polylectic or presumably polylectic species **12**

Fig. 11a-1 *Colletes sierrensis*, clypeus

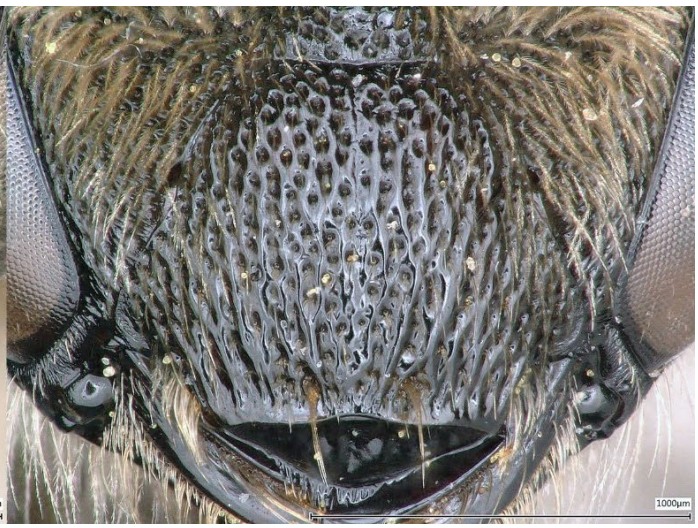

Fig. 11b-1 *Colletes marginatus*, clypeus

Note: Distinguishing the females of the following two species is very difficult and, in some cases, not possible with certainty, as *C. chengtehensis* in Central Europe (western edge of its range) looks very similar to *C. marginatus*.

12a(11) Disc of scutum usually at least with a few scattered dark (brown to blackish) erect hairs (Fig. 12a-1). If the hairs of older specimens are rubbed off, faded or, in rare cases, only light-coloured hair is present, a combination of other, partially with *C. chengtehensis* overlapping characters need to be used for identification and, if necessary, weighed against each other in the case of conflicting results: Scutum only in the very middle of the disc occasionally with more scattered punctation (i = d) (Fig. 12a-2); discs of T1 and T2 with slightly coarser and more scattered punctation (Figs 12a-3, 12a-4); lateral hair patches on the basal declivous part of T1 smaller, medially separated, not forming a transverse band (Fig. 12a-5). Widespread in Central and NW Europe (BL 8–10 mm) ..... ***C. marginatus***

12b Scutum without dark hairs (Fig. 12b-1). The following characters are partly overlapping with *C. marginatus* but they can be used to support the determination: Scutum on the disc a larger area with more scattered punctation (i = d) (Fig. 12b-2); discs of T1 and T2 with slightly finer and denser punctation (Figs 12b-3, 12b-4); lateral hair patches on the basal declivous part of T1 larger, forming a transverse band (Fig. 12b-5). Only in steppe regions of SE Central Europe (BL 8–10 mm) ..... ***C. chengtehensis***

Fig. 12a-1 *Colletes marginatus*, scutum in lateral view

Fig. 12b-1 *Colletes chengtehensis*, scutum in lateral view

Fig. 12a-2 *Colletes marginatus*, scutum in dorsal view

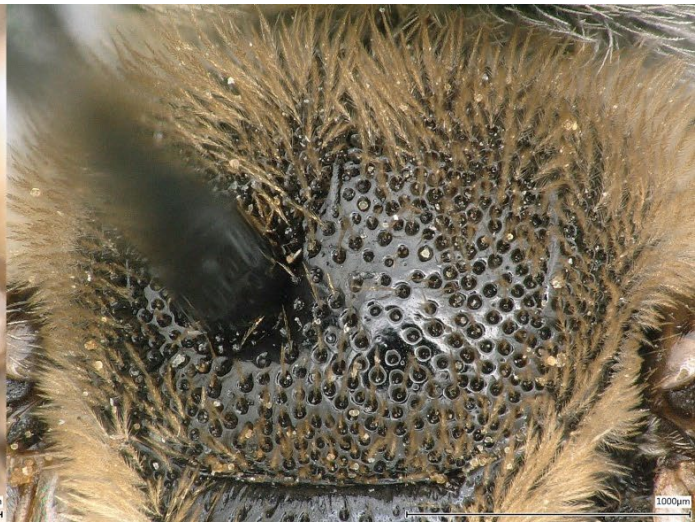

Fig. 12b-2 *Colletes chengtehensis*, scutum in dorsal view

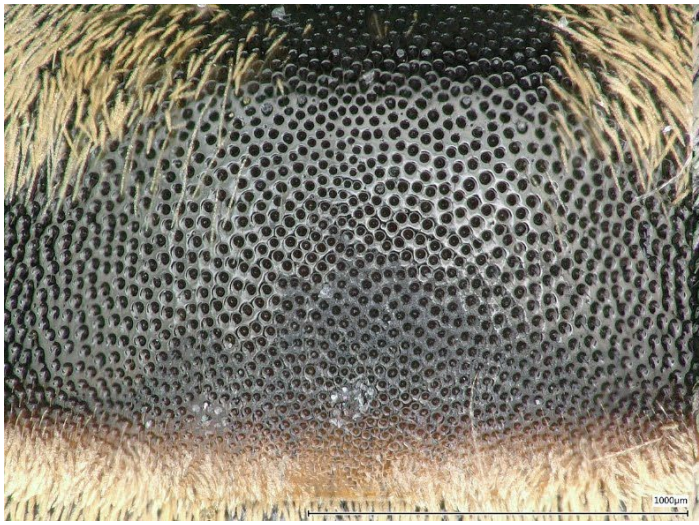

Fig. 12a-3 *Colletes marginatus*, disc of T1

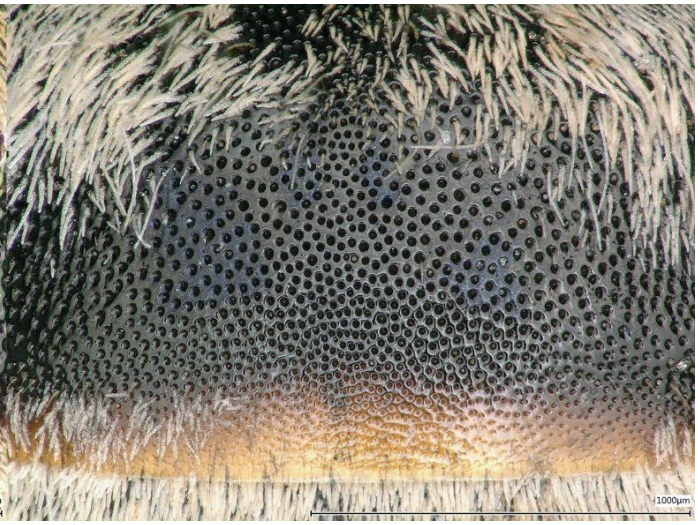

Fig. 12b-3 *Colletes chengtehensis*, disc of T1

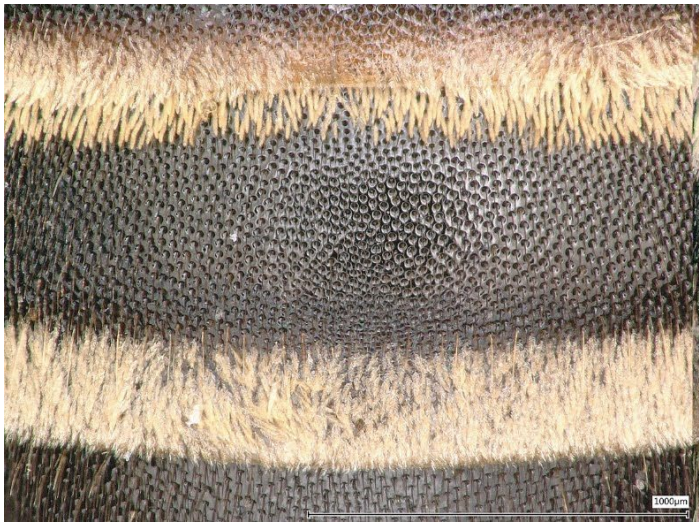

Fig. 12a-4 *Colletes marginatus*, T2

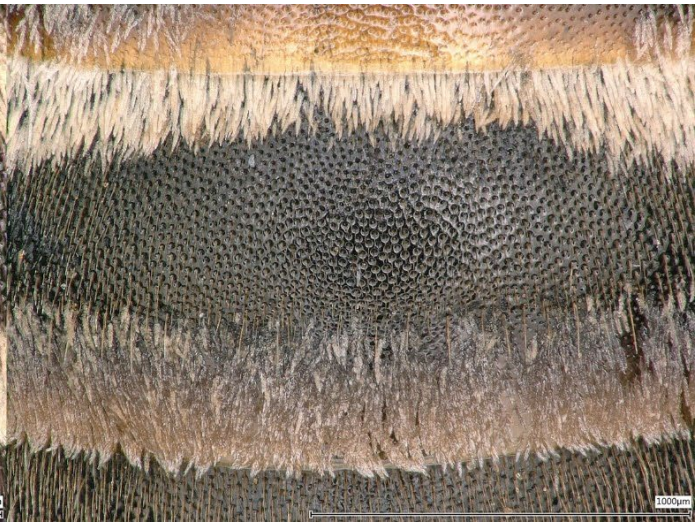

Fig. 12b-4 Colletes chengetehensis, T2

Fig. 12a-5 *Colletes marginatus*, pilosity pattern of T1

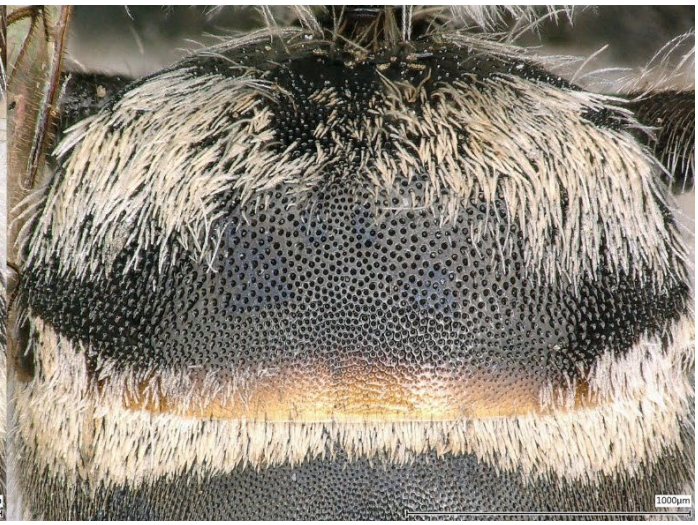

Fig. 12b-5 *Colletes chengtehensis*, pilosity pattern of T1

13a(10) Clypeus laterally with transverse wrinkles bending towards the middle (Fig. 13a-1) (BL 7–9 mm) .... ***C. mlokossewiczi***

13b Clypeus only with ± longitudinal wrinkles (e.g. Fig. 13b-1) **14**

Fig. 13a-1 *Colletes mlokossewiczi*, clypeus

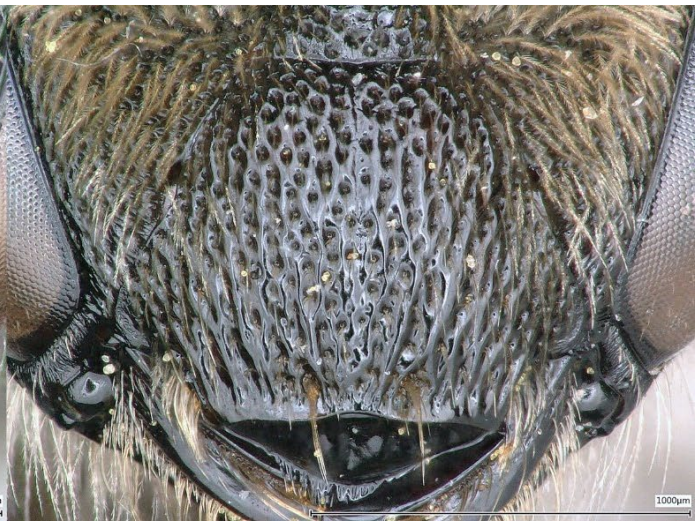

Fig. 13b-1 *Colletes marginatus*, clypeus

14a(13) Propodeum laterally, sometimes only in the lower half, densely covered with short appressed hairs that at least partly hide the sculpture of integument (e.g. Fig. 14a-1) **15**

14b Propodeum laterally sparsely covered with long erect hairs and usually without any short appressed hairs, sculpture of integument visible (Fig. 14b-1); in rare cases with a few scattered single short appressed hairs but integumental sculpture never hidden **18**

Fig. 14a-1 *Colletes maidli*, propodeum in lateral view

Fig. 14b-1 *Colletes chengtehensis*, propodeum in lateral view

15a(14) Basal declivous part of T1 with slender, long, erect hairs, rarely mixed with a few very short, appressed hairs; integumental sculpture visible between the hairs (e.g. Fig. 15a-1) **16**

15b Basal declivous part of T1 with thick, mostly appressed and partly erect hairs of variable lengths; integumental sculpture mostly covered by hairs and invisible (e.g. Fig. 15b-1) **17**

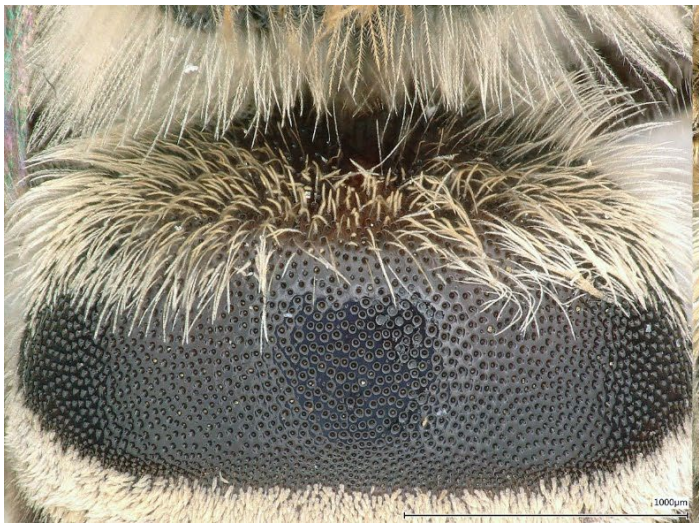

Fig. 15a-1 *Colletes nigricans*, pilosity pattern of T1

Fig. 15b-1 *Colletes caspicus*, pilosity pattern of T1

Note: The following two species show considerable geographical variation and differences between females can be subtle.

16a(15) Marginal zone of T1 medially slightly depressed and concave, apically with a raised, narrow yellowish translucent margin (Fig. 16a-1). In SW Central Europe (BL 10–12 mm) ..... ***C. eous***

16b Marginal zone of T1 medially almost flat, at most slightly apically raised and margin always dark brownish to blackish (Fig. 16b-1). In S Central Europe (BL 10–12 mm) ..... ***C. nigricans***

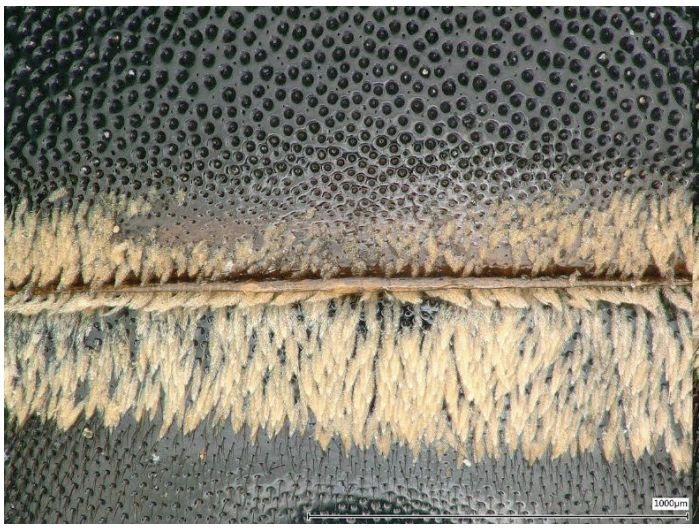

Fig. 16a-1 *Colletes eous*, marginal zone of T1

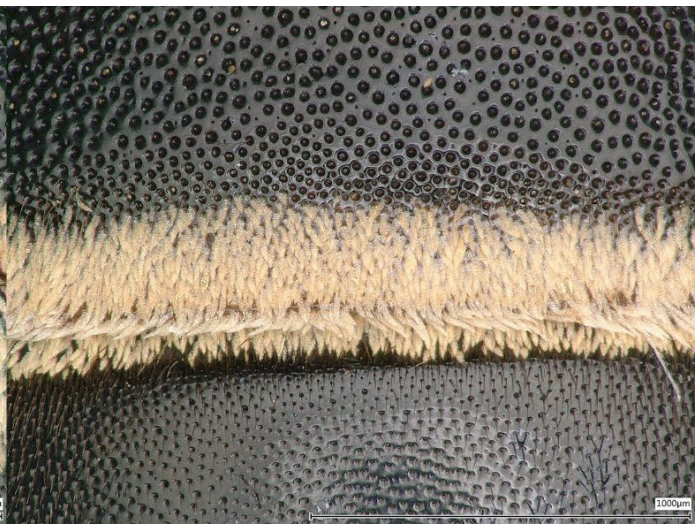

Fig. 16b-1 *Colletes nigricans*, marginal zone of T1

17a(15) Disc of T1 more sparsely punctate (i = 1-1.5d) (Fig. 17a-1). In E Central Europe (extinct in W Central Europe) (BL 11–14 mm) ..... ***C. caspicus***

17b Disc of T1 more densely punctate (i < d) (Fig. 17b-1), density and size of punctures can vary considerably between individuals. In S Central Europe (BL 10–12 mm) ..... ***C. maidli***

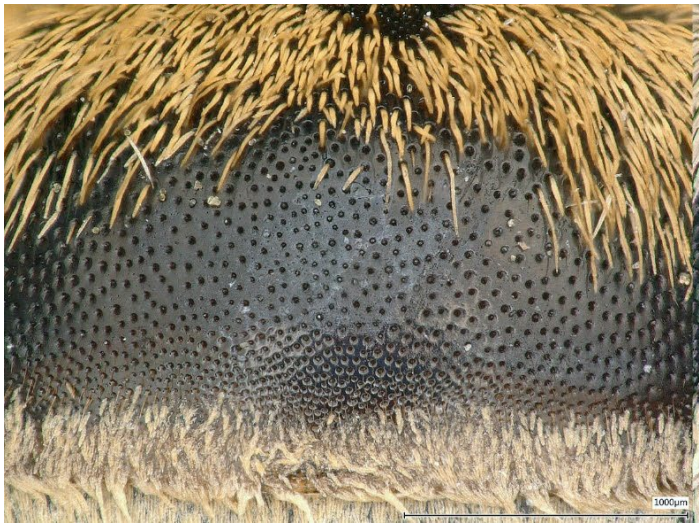

Fig. 17a-1 *Colletes caspicus*, disc of T1

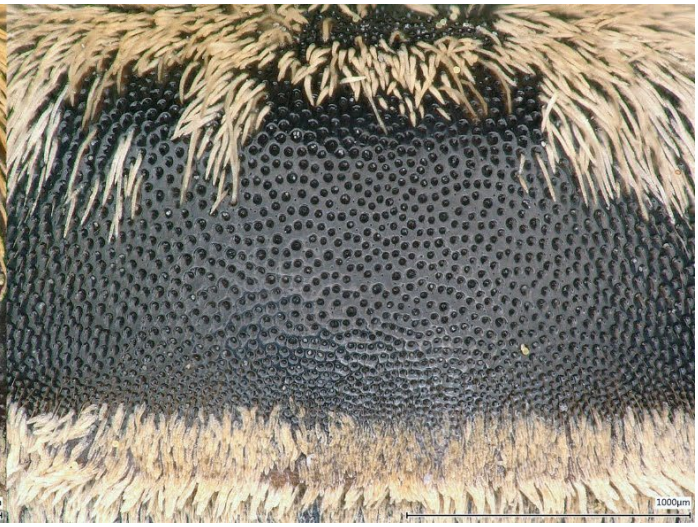

Fig. 17b-1 *Colletes maidli*, disc of T1

18a(14) Disc of T1 densely punctate (i ≤ d) and glabrous (e.g. Figs 18a-1, 18a-2, 18a-3) (**exception**: long erect hairs in fresh *C. fodiens*; Fig. 18a-4); marginal zone of T1 translucent orange to light brown (e.g. Figs 18a-1, 18a-2, 18a-4) (**exception**: blackish-brown in *C. similis*; Fig. 18a-3) **19**

18b Disc of T1 at least slightly more sparsely punctate (i = 1-1.5d or sparser) and with some long erect hairs (e.g. Figs 18b-1, 18b-2, 18b-3) marginal zone of T1 variable, from translucent orangish-brown to blackish (e.g. Figs 18b-1, 18b-3) **26**

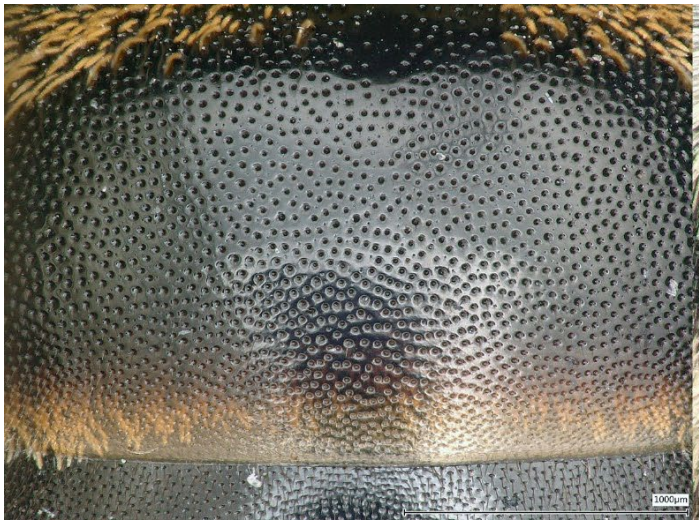

Fig. 18a-1 *Colletes collaris*, disc of T1

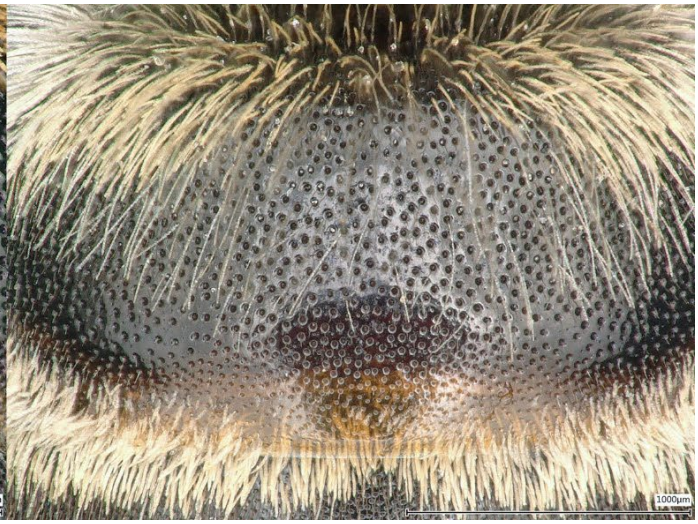

Fig. 18b-1 *Colletes inexpectatus*, disc of T1

Fig. 18a-2 *Colletes succinctus*, disc of T1

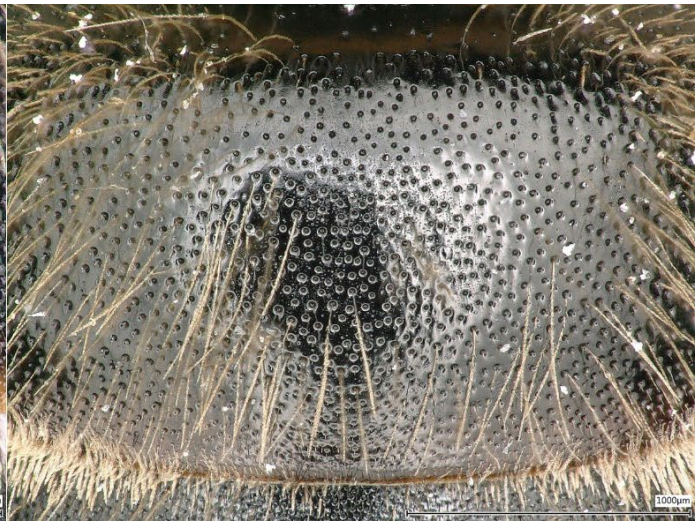

Fig. 18b-2 *Colletes floralis*, disc of T1

Fig. 18a-3 *Colletes similis*, disc of T1

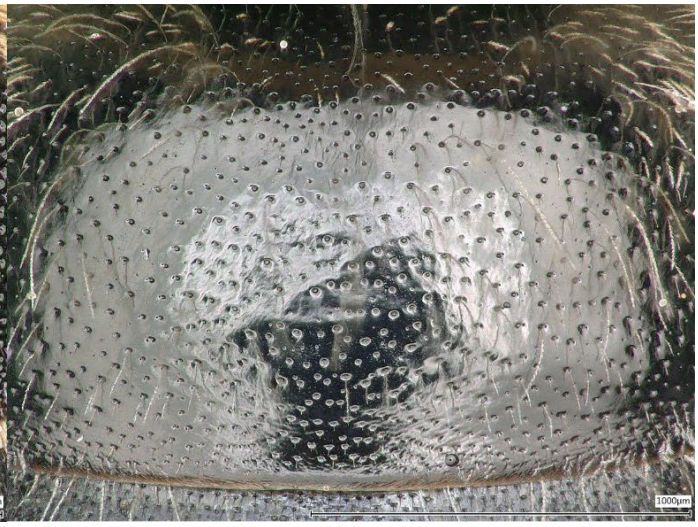

Fig. 18b-3 *Colletes impunctatus*, disc of T1

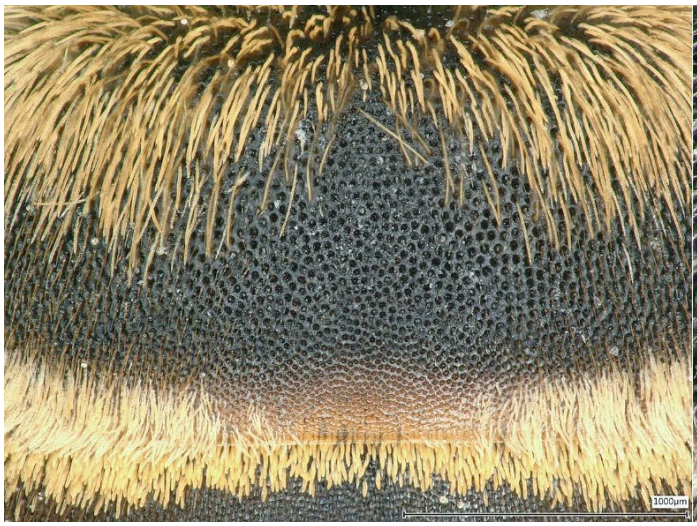

Fig. 18a-4 *Colletes fodiens*, disc of T1

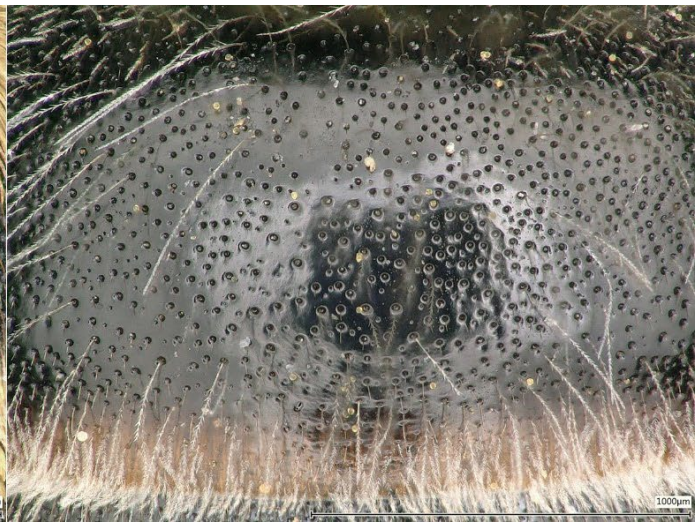

Fig. 18b-4 *Colletes foveolaris*, disc of T1

19a(18) Marginal zone of T1 apically opaque dark brown to black (Fig. 19a-1) (BL 9–11 mm) ..... ***C. similis***

19b Marginal zone of T1 apically translucent orange to brown (e.g. Figs 19b-1, 19b-2) **20**

Fig. 19a-1 *Colletes similis*, marginal zone of T1

Fig. 19b-1 *Colletes collaris*, marginal zone of T1

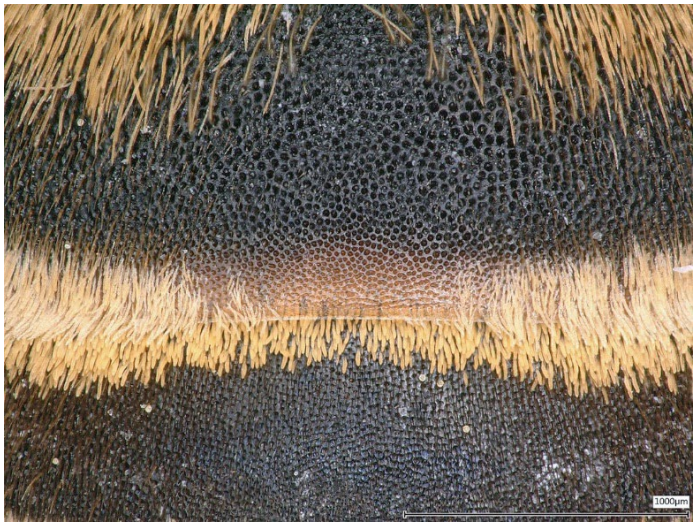

Fig. 19b-2 *Colletes fodiens*, marginal zone of T1

20a(19) Punctation on disc of T1 coarser and extremely dense, appearing matt due to the almost complete lack of interspaces (Fig. 20a-1) (BL 9–11 mm) ..... ***C. fodiens***

20b Punctation on disc of T1 finer and sparser, interspaces larger, polished and shiny (e.g. Figs 20b-1, 20b-2, 20b-3) **21**

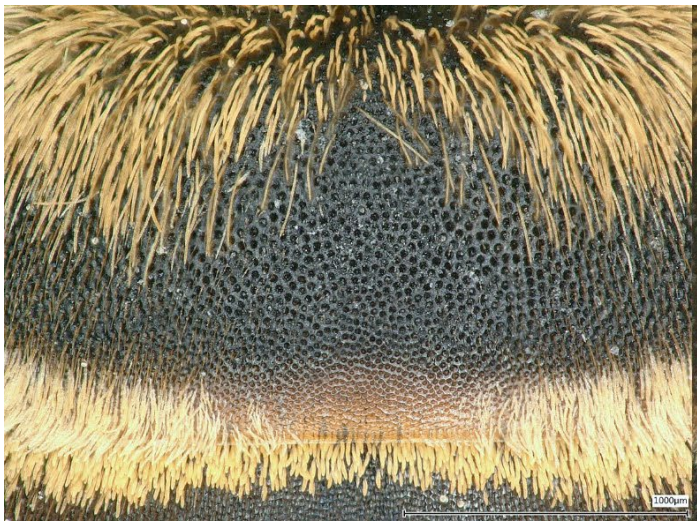

Fig. 20a-1 *Colletes fodiens*, disc of T1

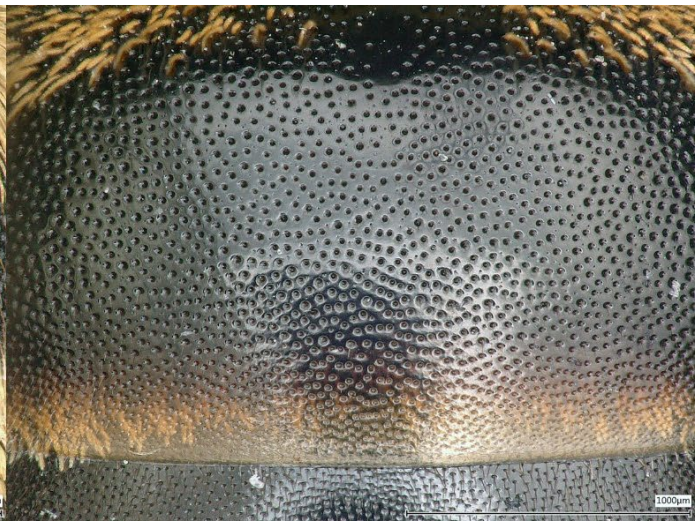

Fig. 20b-1 *Colletes collaris*, disc of T1

Fig. 20b-2 *Colletes succinctus*, disc of T1

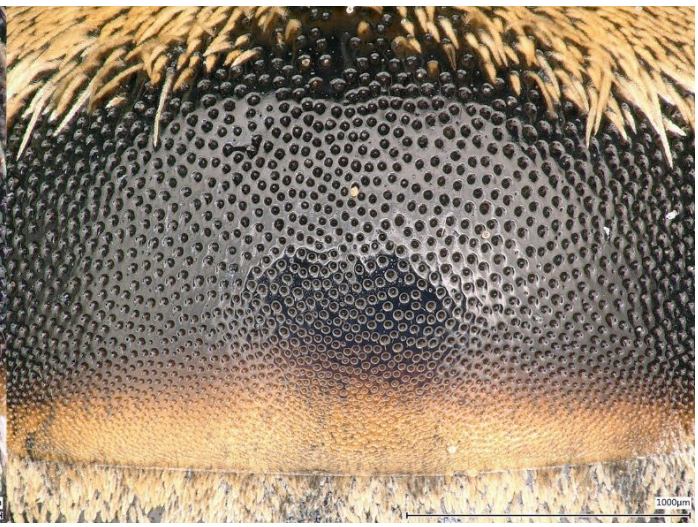

Fig. 20b-3 *Colletes brevigena*, disc of T1

Note: Even with experience and the help of reference specimens, most species of the *C. succinctus* group are very difficult to identify on the basis of morphological characters alone. The most reliably identifiable species are (in this order as in the key) *C. collaris*, *C. succinctus* and *C. hederae*. Observations of flower visitation or information on distribution can facilitate identification.

21a(20) Apical tergal hair bands narrower (Fig. 21a-1); basal region of the propodeum without a clearly defined horizontal surface, more rounded in profile (Fig. 21a-2); propodeal triangle clearly visible, not hidden by long protruding hairs, its declivous apicolateral part glabrous (Fig. 21a-2). Oligolectic on Asteraceae; in S Central Europe (BL 11–13 mm) ..... ***C. collaris***

21b Apical tergal hair bands broader (e.g. Figs 21b-1, 21b-2); basal region of the propodeum ± horizontal, carinate and sharply defined posteriorly (angled in profile) (e.g. Fig. 21b-3); propodeal triangle partly hidden by long protruding hairs, its declivous apicolateral part lined with long hairs (e.g. Fig. 21b-3) **22**

Fig. 21a-1 *Colletes collaris*, metasoma in dorsal view

Fig. 21b-1 *Colletes succinctus*, metasoma in dorsal view

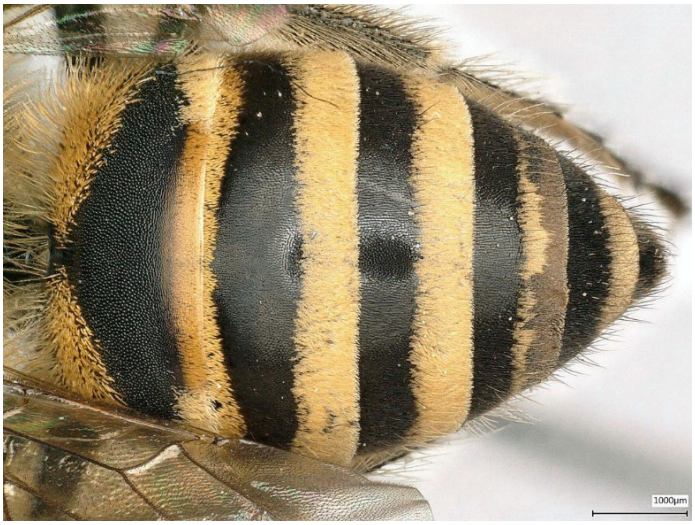

Fig. 21b-2 *Colletes hederae*, metasoma in dorsal view

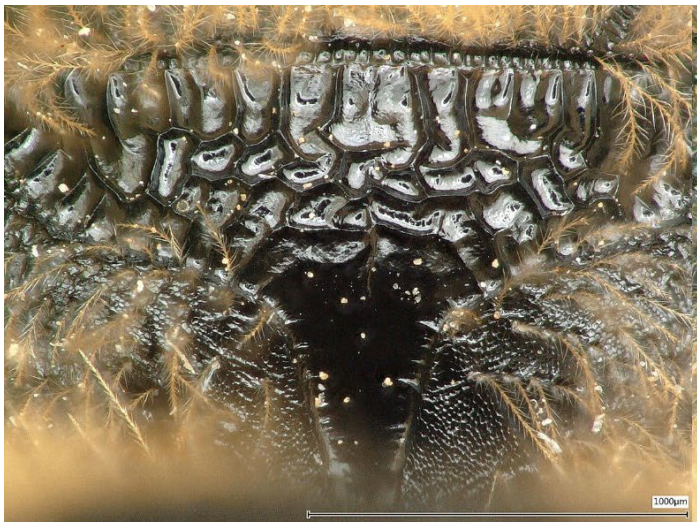

Fig. 21a-2 *Colletes collaris*, propodeum

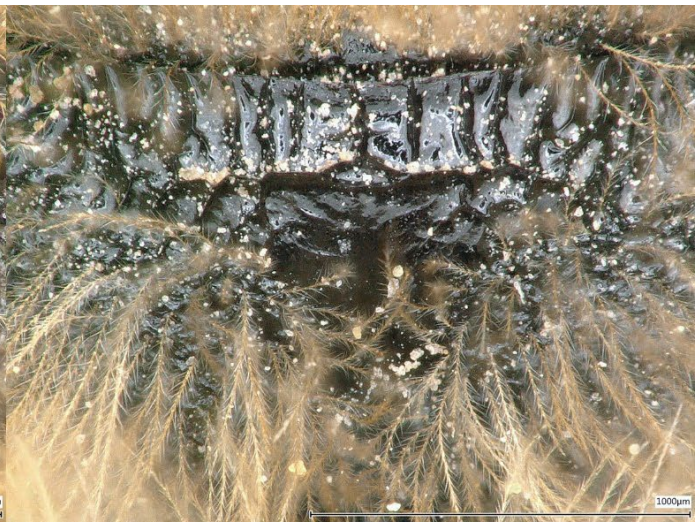

Fig. 21b-3 *Colletes succinctus*, propodeum

22a(21) Galea on the outer, more strongly chitinised portion polished and shiny, without very fine reticulation (except at extreme apex) (Fig. 22a-1); apical tergal hair bands slightly narrower (Fig. 22a-2). **Note:** Length / proportions of the maxillary palps (usually short and stout in *C. succinctus*, longer and slender in other species) and sculpture of the clypeus are of limited use as characters, as they show some intra- and inter-specific (geographical) variation. Strong preference for *Calluna* and *Erica*; widespread in Central and NW Europe (BL 10–12 mm) ..... ***C. succinctus***

22b Galea on the outer, more strongly chitinised portion entirely or at least predominantly with very fine reticulation and matt (sometimes galea in basal half partly polished and shiny) (e.g. Fig. 22b-1); apical tergal hair bands broader (e.g. Fig. 22b-2) **23**

Fig. 22a-1 *Colletes succinctus*, galea

Fig. 22b-1 *Colletes hederae*, galea

Fig. 22a-2 *Colletes succinctus*, metasoma in dorsal view

Fig. 22b-2 *Colletes hederae*, metasoma in dorsal view

23a(22) Clypeus with outer, longitudinal ridge(s) curved towards mid-line and connected apically (Fig. 23a-1); apical tergal hair bands in freshly emerged specimens pale yellowish- to orangish-brown (Fig. 23a-2). Strong preference for *Hedera*; widespread in Central and NW Europe (BL 10–14 mm) ..... ***C. hederae***

23b Clypeus with outer, longitudinal ridge(s) barely curved towards mid-line and not connected apically (e.g. Fig. 23b-1); apical tergal hair bands in freshly emerged specimens white to cream-white (e.g. Fig. 23b-2) **24**

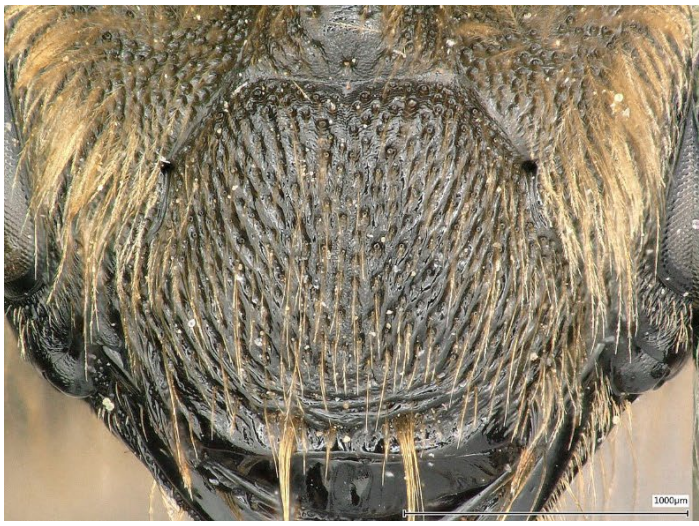

Fig. 23a-1 *Colletes hederae*, clypeus

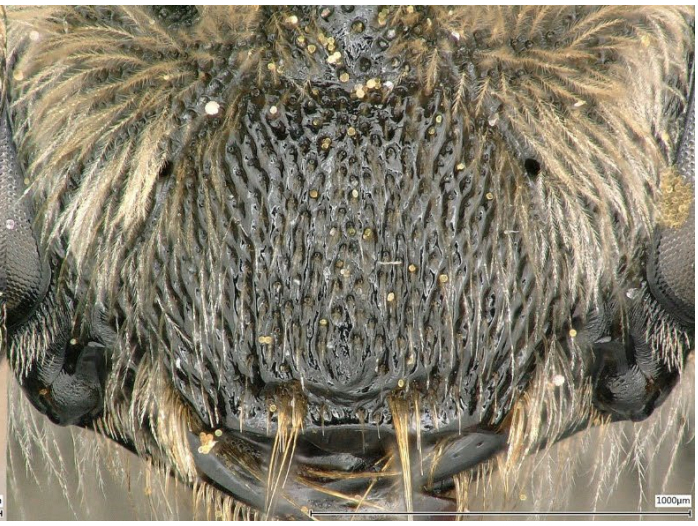

Fig. 23b-1 *Colletes brevigena*, clypeus

Fig. 23a-2 *Colletes hederae*, metasoma in dorsal view

Fig. 23b-2 *Colletes brevigena*, metasoma in dorsal view

24a(23) Facial fovea broader; ocellocular distance less than twice as wide as facial fovea at its broadest point (Fig. 24a-1); usually supraclypeal area medially with larger punctures that are ± twice the size of those on the clypeus (Fig. 24a-2). Presumably oligolectic on Asteraceae, with strong preference for *Tripolium pannonicum*; endemic to the surroundings of Lake Neusiedl (E Austria) (BL 10–11 mm) ..... ***C. pannonicus***

24b Facial fovea narrower; ocellocular distance more than twice as wide as facial fovea at its broadest point (e.g. Fig. 24b-1); usually supraclypeal area medially with smaller punctures that are ± the same size of those on the clypeus (e.g. Fig. 24b-2) **25**

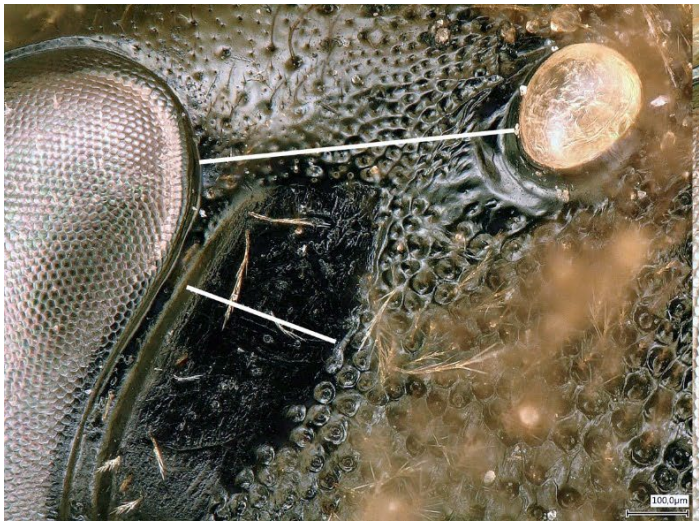

Fig. 24a-1 *Colletes pannonicus*, head in dorsolateral view

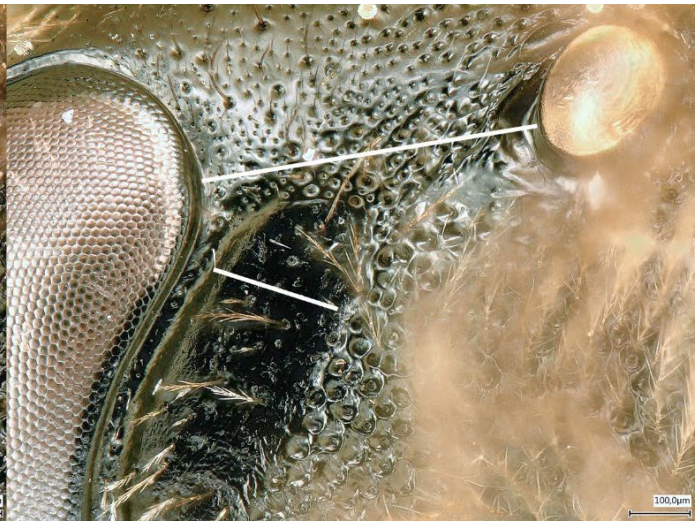

Fig. 24b-1 *Colletes halophilus*, head in dorsolateral view

Fig. 24a-2 *Colletes pannonicus*, supraclypeal area

Fig. 24b-2 *Colletes brevigena*, supraclypeal area

25a(24) Punctation on T2 slightly denser, deeper and coarser, overall more distinct (Fig. 25a-1). Oligolectic on Asteraceae, with strong preference for *Tripolium pannonicum*; only in coastal regions with salt marshes, from the Atlantic coast of France to S North Sea and SW Baltic Sea (BL 10–14 mm) ..... ***C. halophilus***

25b Punctation on T2 slightly sparser, flatter and finer, overall less distinct (Fig. 25b-1). Polylectic; in S Central Europe (BL 10–13 mm) ..... ***C. brevigena***

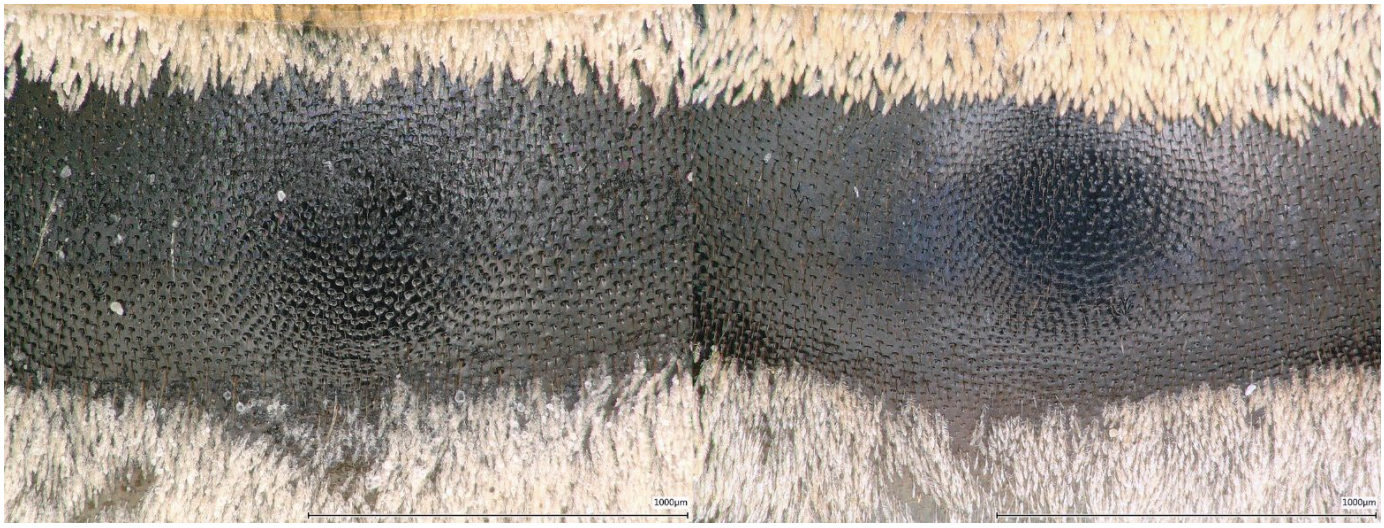

Fig. 25a-1 *Colletes halophilus*, disc of T2

Fig. 25b-1 *Colletes brevigena*, disc of T2

26a(18) Vertex and scutellum with abundant dark brown to blackish long erect hairs (Fig. 26a-1); punctation and pilosity of T1 as in Fig. 26a-2 (BL 8–10 mm) ..... ***C. foveolaris***

26b Vertex and scutellum either without dark brown to blackish hairs or dark hairs confined to disc of scutum (Fig. 26b-1); punctation and pilosity of T1 as in Figs 26b-2 to 26b-5) **27**

Fig. 26a-1 *Colletes foveolaris*, head and mesosoma in lateral view

Fig. 26b-1 *Colletes floralis*, scutum in lateral view

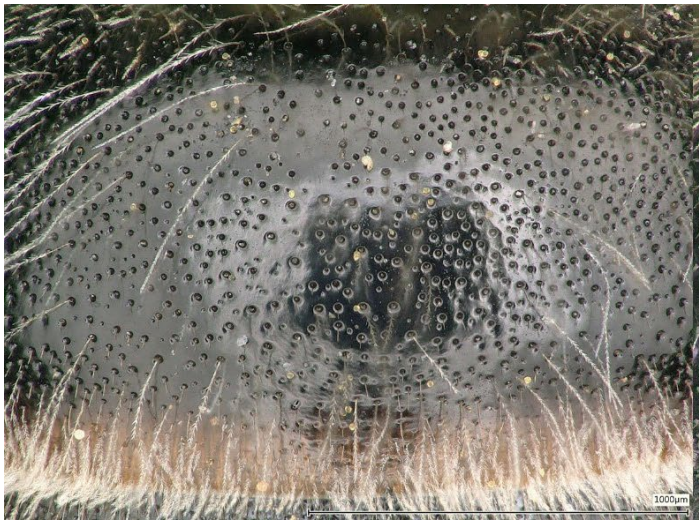

Fig. 26a-2 *Colletes foveolaris*, disc of T1

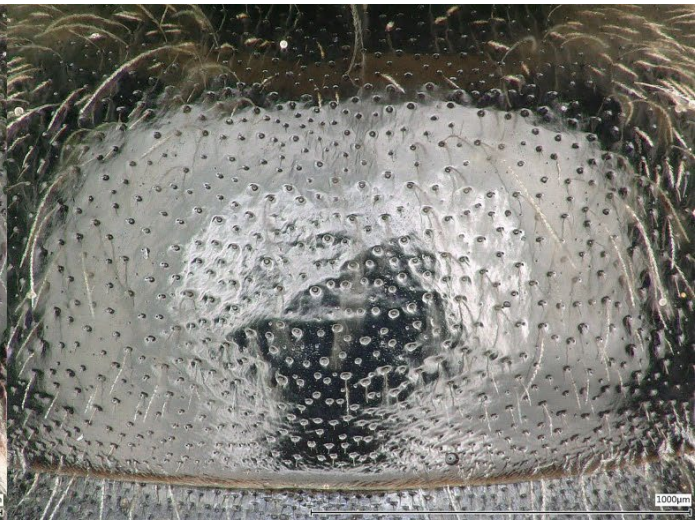

Fig. 26b-2 *Colletes impunctatus*, disc of T1

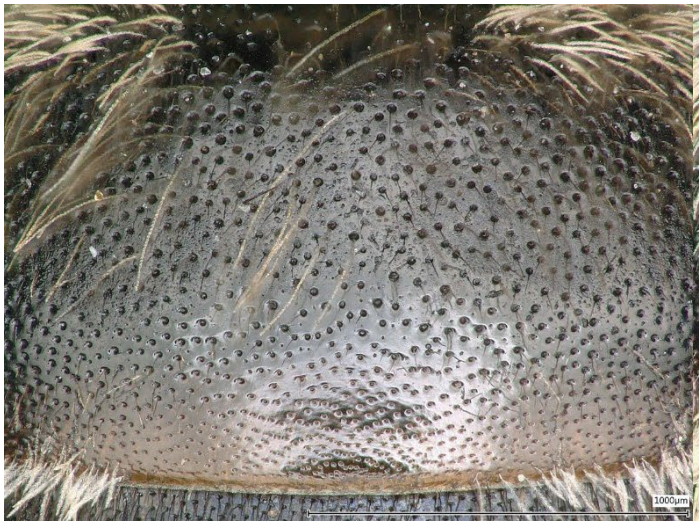

Fig. 26b-3 *Colletes daviesanus*, disc of T1

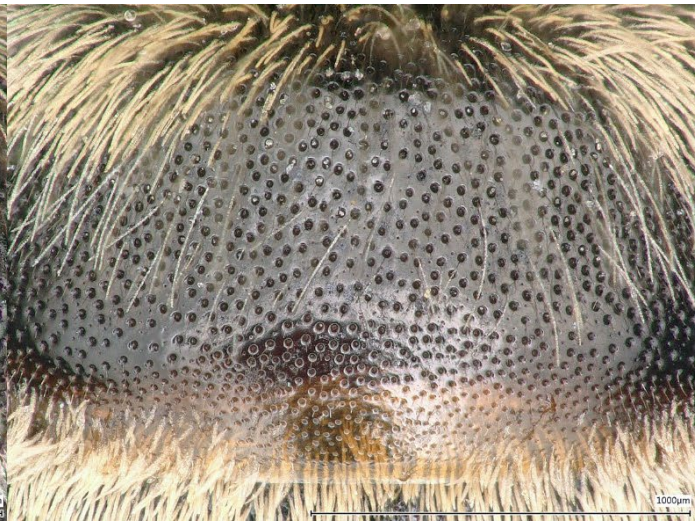

Fig. 26b-4 *Colletes inexpectatus*, disc of T1

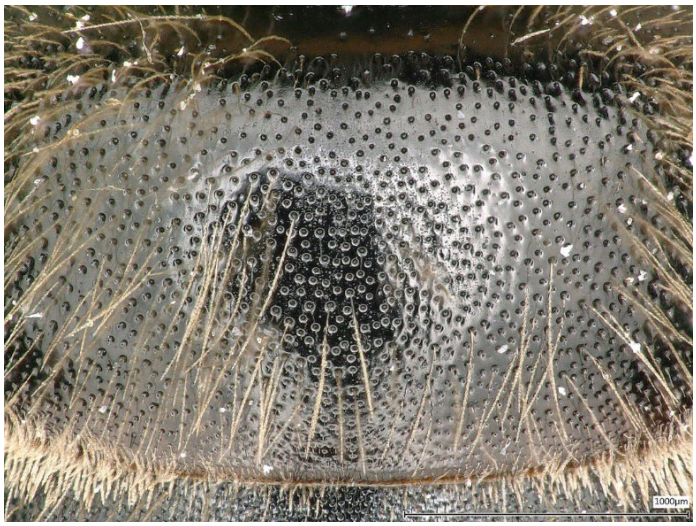

Fig. 26b-5 *Colletes floralis*, disc of T1

27a(26) Malar area much shorter than 1/2 width of the base of mandible (Fig. 27a-1); head distinctly broader than long (width of head about 1.4-1.5 times as length of head), oval shaped (Fig. 27a-2) **28**

27b Malar area about 1/2 as long as width of base of mandible (Fig. 27b-1); head slightly broader than long (width of head about 1.2-1.3 times as length of head), more triangular shaped (Fig. 27b-2) **29**

Fig. 27a-1 *Colletes daviesanus*, malar area

Fig. 27b-1 *Colletes impunctatus*, malar area

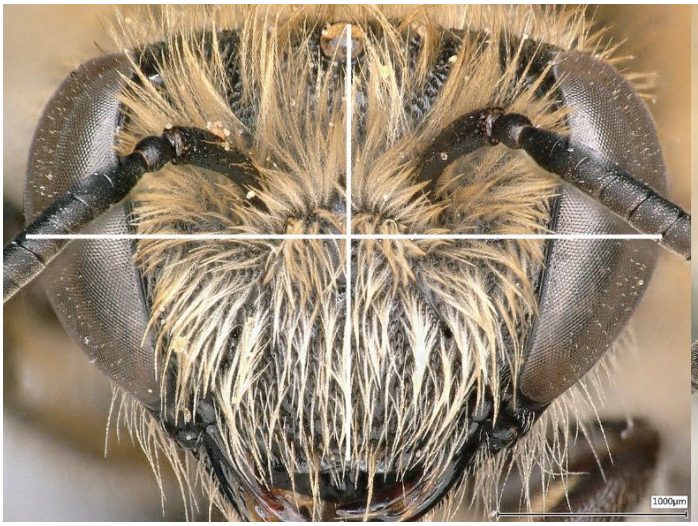

Fig. 27a-2 *Colletes daviesanus*, head

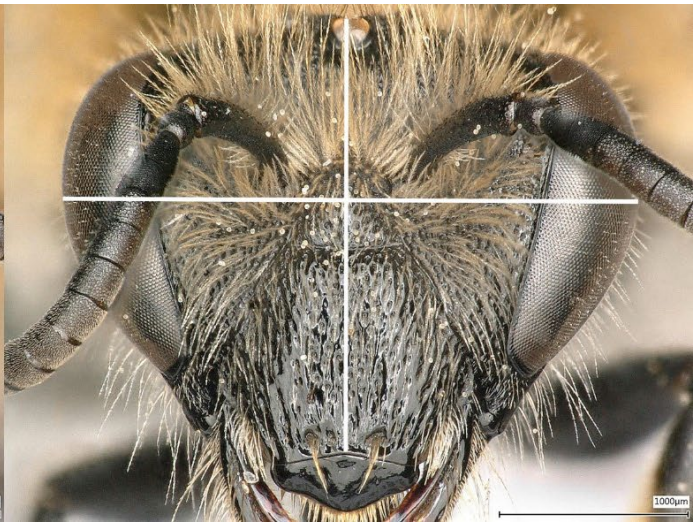

Fig. 27b-2 *Colletes impunctatus*, head

Note: Differences between the females of the following two species are subtle.

28a(27) Erect hairs on disc of T1 extend further posteriorly, medially often up to the marginal zone (Fig. 28a-1, arrow); punctation on disc of T1 slightly finer and sparser (i > 1.5d) (Fig. 28a-2). Widespread in Central and NW Europe (BL 9–11 mm) ..... ***C. daviesanus***

28b Erect hairs on disc of T1 usually only on anterior half (Fig. 28b-1); punctation on disc of T1 slightly coarser and denser (i = 1-1.5d) (Fig. 28b-2). Only in SE Central Europe (BL 9–11 mm) ..... ***C. inexpectatus***

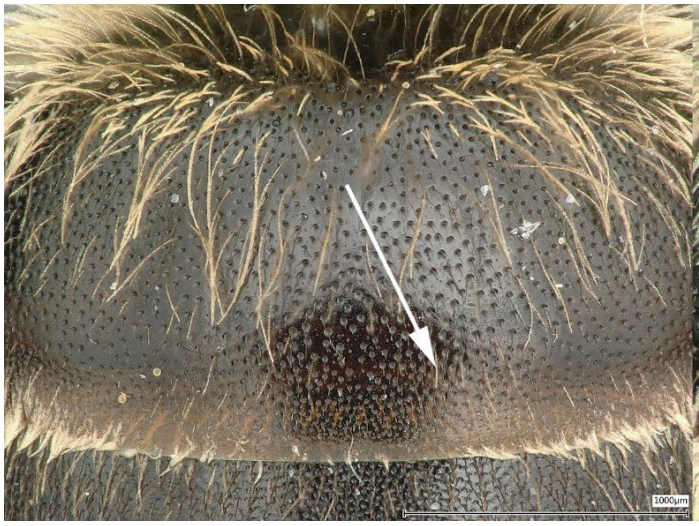

Fig. 28a-1 *Colletes daviesanus*, pilosity of T1

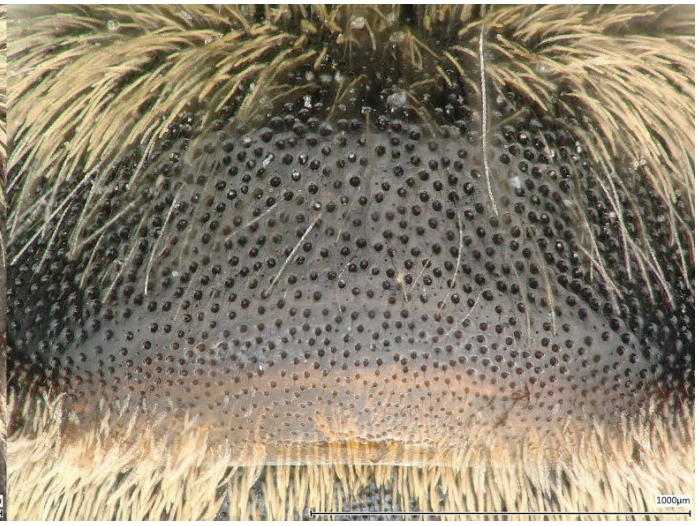

Fig. 28b-1 *Colletes inexpectatus*, pilosity of T1

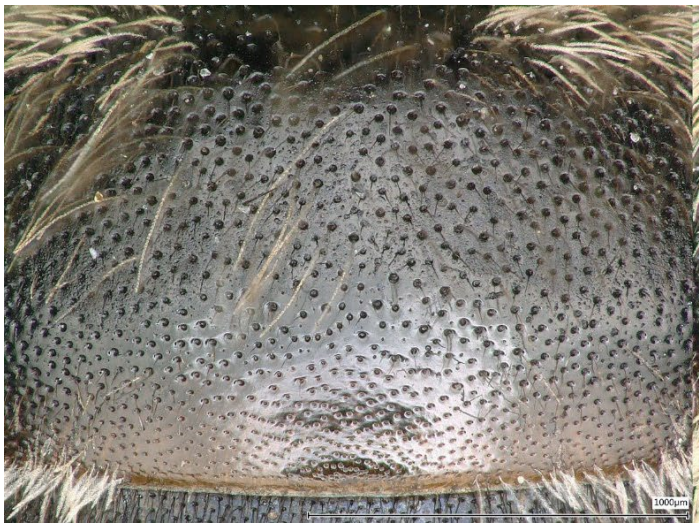

Fig. 28a-2 *Colletes daviesanus*, disc of T1

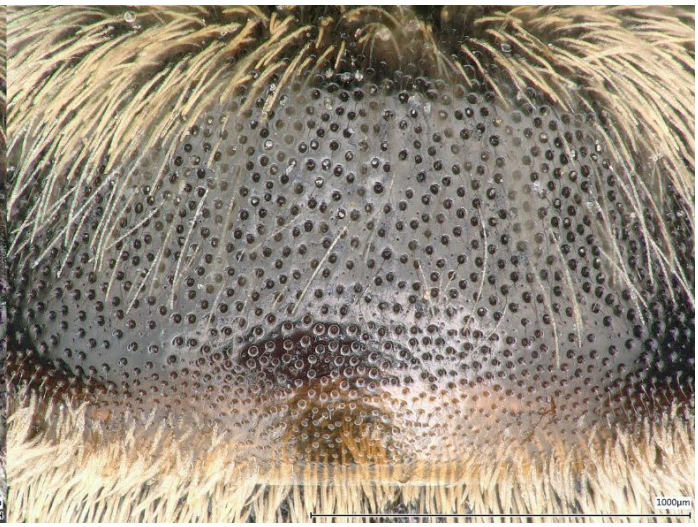

Fig. 28b-2 *Colletes inexpectatus*, disc of T1

29a(27) Disc of scutum with numerous black hairs (Fig. 29a-1); clypeus at apical margin with a pair of large pits (Fig. 29a-2, arrow); T1 with denser and coarser punctation (Fig. 29a-3) (BL 10–12 mm) ..... ***C. floralis***

29b Scutum without dark brownish to black hairs (Fig. 29b-1); clypeus at apical margin with a pair of small pits (Fig. 29b-2, arrow); T1 usually with sparser and finer punctation (Fig. 29b-3), but punctation geographically highly variable (BL 9–11 mm) ..... ***C. impunctatus***

Fig. 29a-1 *Colletes floralis*, scutum in lateral view

Fig. 29b-1 *Colletes impunctatus*, scutum in lateral view

Fig. 29a-2 *Colletes floralis*, apical margin of clypeus

Fig. 29b-2 *Colletes impunctatus*, apical margin of clypeus

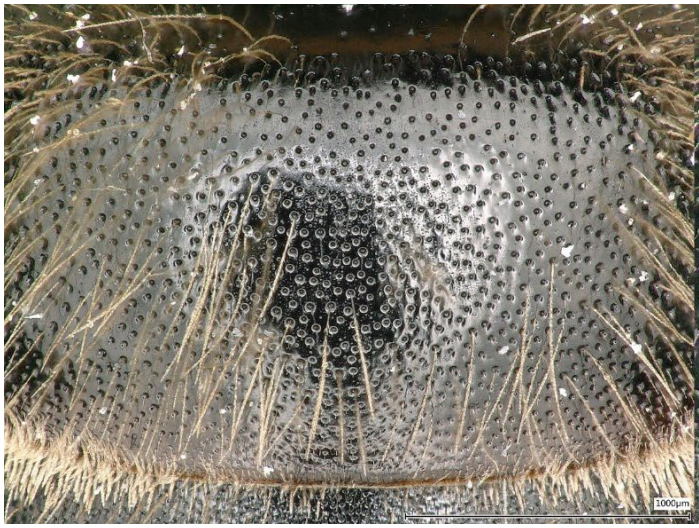

Fig. 29a-3 *Colletes floralis*, disc of T1

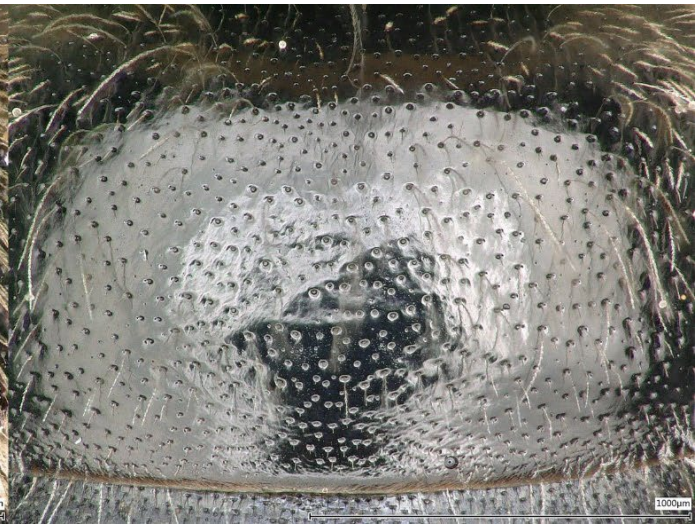

Fig. 29b-3 *Colletes impunctatus*, disc of T1

Males

For males it is highly recommended to dissect S7 that is associated with the genitalia. In most species of the reference area shape and structure of S7 are species-specific and often the easiest and most reliable way of identification. To facilitate species identification, the S7 of all 30 *Colletes* species are summarised in two overview figures (Supplemental Figs 1a, 1b), sorted by similarity for direct comparison.

1a Scutellum on each side with large backward curved tooth (Fig. 1a-1); S7 as in Fig. 1a-2 (BL 10–12 mm) .... ***C. graeffei***

1b Scutellum without teeth **2**

Fig. 1a-1 *Colletes graeffei*, scutellum with lateral tooth

Fig. 1a-2 *Colletes graeffei*, S7

2a(1) Head distinctly elongate, malar area about twice as long as width of base of mandible (Fig. 2a-1); S7 as in Fig. 2a-2 (BL 12–14 mm) ..... ***C. nasutus***

2b Head not conspicuously elongate, malar area at most about as long as width of base of mandible **3**

Fig. 2a-1 *Colletes nasutus*, malar area

Fig. 2a-2 *Colletes nasutus*, S7

3a(2) Metanotum strongly curved, medially raised, with an apical drop almost overhanging the horizontal part of the propodeum (e.g. Fig. 3a-1); punctation on disc of T1 very coarse (Figs 4a-1, 4b-1) **4**

3b Metanotum even or only slightly curved, in about the same level as the horizontal part of the propodeum (e.g. Fig. 3b-1); punctation on T1 much finer **5**

Fig. 3a-1 *Colletes punctatus*, metanotum in lateral view

Fig. 3b-1 *Colletes impunctatus*, metanotum in lateral view

4a(3) Marginal zone of T1 strongly depressed, with very clear truncate premarginal line (Fig. 4a-1); S7 as in Fig. 4a-2 (BL 8–11 mm) ..... ***C. punctatus***

4b Marginal zone of T1 slightly depressed, without distinct premarginal line (Fig. 4b-1); S7 as in Fig. 4b-2 (BL 10–14 mm) ..... ***C. albomaculatus***

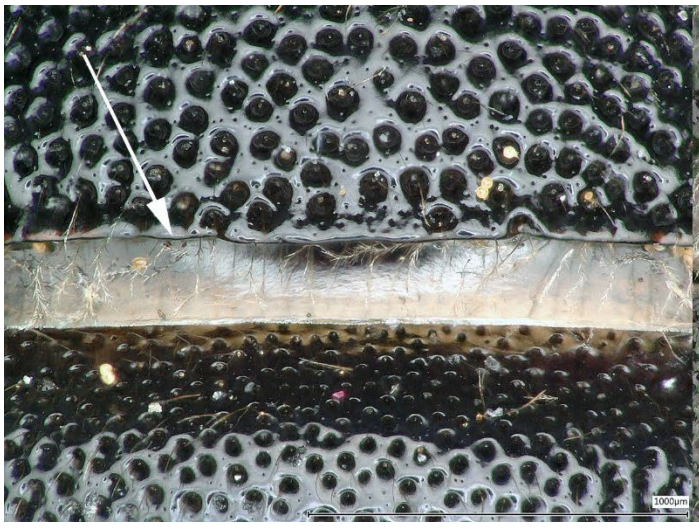

Fig. 4a-1 *Colletes punctatus*, marginal zone of T1

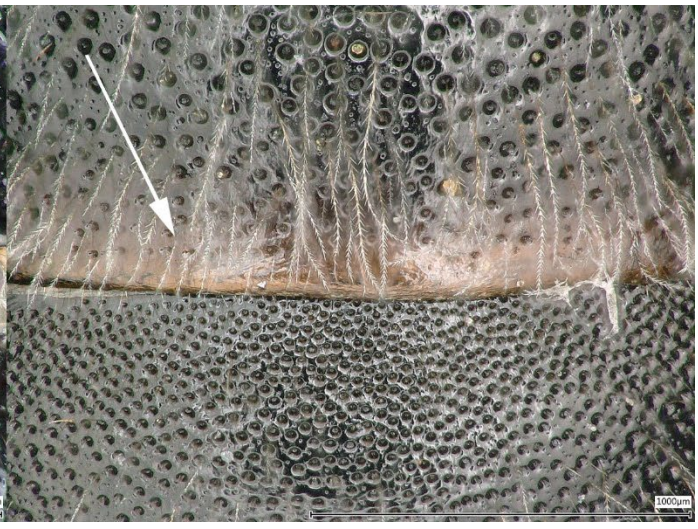

Fig. 4b-1 *Colletes albomaculatus*, marginal zone of T1

Fig. 4a-2 *Colletes punctatus*, S7

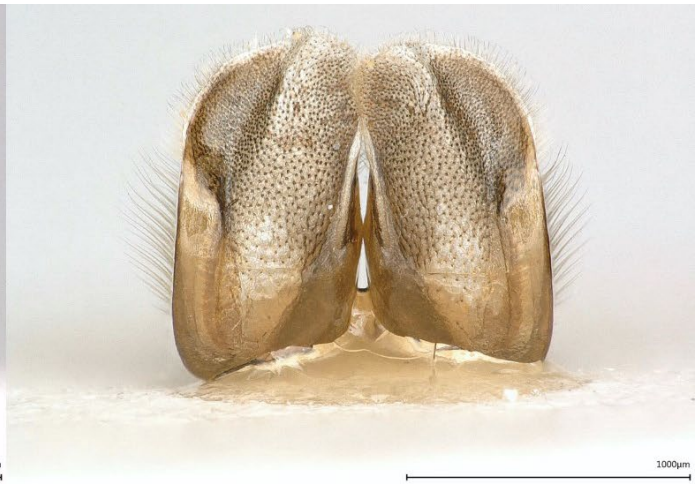

Fig. 4b-2 *Colletes albomaculatus*, S7

5a(3) Metasomal terga without distinct apical hair bands, consisting at most of single protruding hairs (Fig. 5a-1); S7 as in Fig. 5a-2 (BL 12–14 mm) ..... ***C. cunicularius***

5b Metasomal terga with distinct apical hair bands, consisting of short appressed hairs (e.g. Fig. 5b-1) **6**

Fig. 5a-1 *Colletes cunicularius*, metasoma in dorsal view

Fig. 5b-1 *Colletes halophilus*, metasoma in dorsal view

Fig. 5a-2 *Colletes cunicularius*, S7

6a(5) Apical hair fringe of S5 medially with hairs more than twice as long than laterally (e.g. Fig. 6a-1) **7**

6b Apical hair fringe of S5 medially without distinctly longer hairs **8**

Fig. 6a-1 *Colletes maidli*, apical hair fringe of S5

7a(6) Elongate part of apical hair fringe of S5 narrow and hairs longer medially (Fig. 7a-1); punctation on discs of T1-2 sparser (i = 1.5d) (Figs 7a-2, 7a-3); disc of T2 with long erect hairs (Fig. 7a-3); S7 broader as in Fig. 7a-4. In E Central Europe (extinct in W Central Europe) (BL 9–12 mm) ..... ***C. caspicus***

7b Elongate part of apical hair fringe of S5 broad and hairs shorter medially (Fig. 7b-1); punctation on discs of T1-2 denser (i = d) (Figs 7b-2, 7b-3); disc of T2 without or only with few long erect hairs (Fig. 7b-3); S7 narrower as in Fig. 7b-4. In S Central Europe (BL 9–11 mm) ..... ***C. maidli***

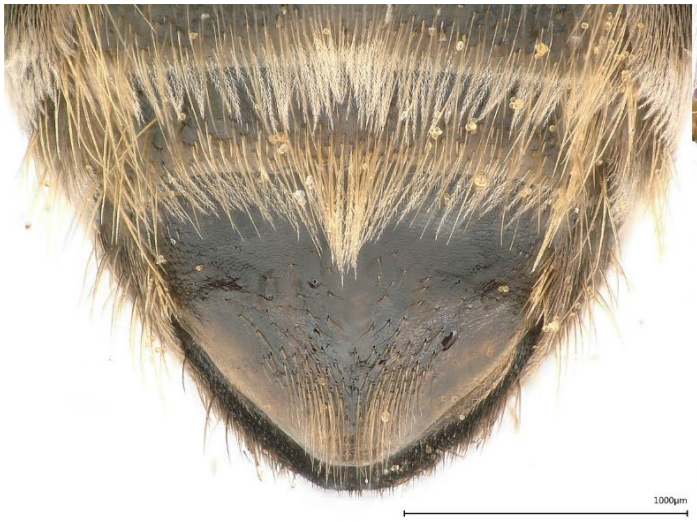

Fig. 7a-1 *Colletes caspicus*, apical hair fringe of S5

Fig. 7b-1 *Colletes maidli*, apical hair fringe of S5

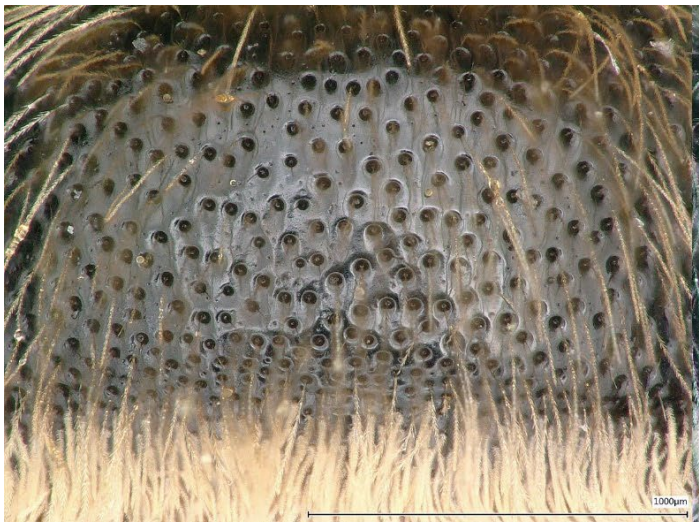

Fig. 7a-2 *Colletes caspicus*, disc of T1

Fig. 7b-2 *Colletes maidli*, disc of T1

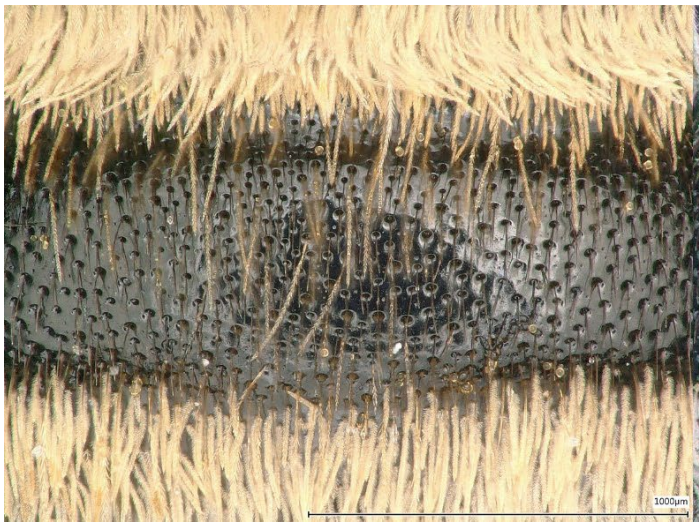

Fig. 7a-3 *Colletes caspicus*, disc of T2

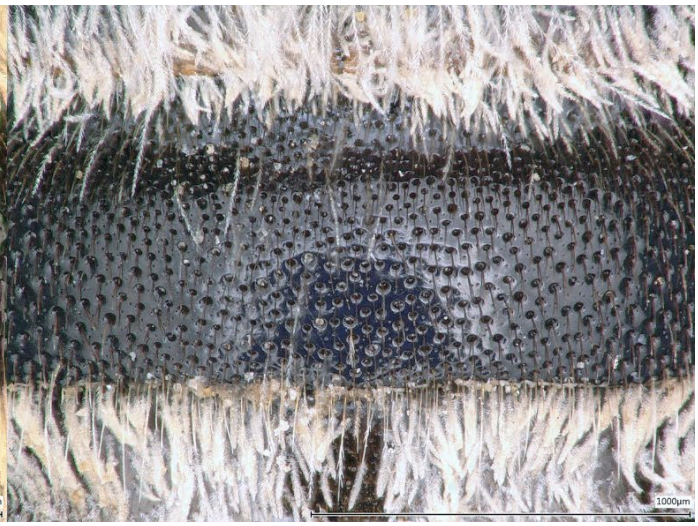

Fig. 7b-3 *Colletes maidli*, disc of T2

Fig. 7a-4 *Colletes caspicus*, S7

Fig. 7b-4 *Colletes maidli*, S7

8a(6) S6 laterally with a pair of large and dense patches of short erect hair (e.g. Figs 8a-1, 8a-2 arrows); marginal zone of T1 in its posterior, slightly raised part broadly yellowish translucent, in the anterior half deeply depressed and dark reddish to blackish-brown (e.g. Fig. 8a-3, arrow) **9**

8b S6 laterally without such patches, some species with small tufts of hair on either side (e.g. Fig. 8b-1) or with a pair of deep, posterolateral pits (e.g. Fig. 11a-1); marginal zone of T1 at most narrowly and much darker translucent or only with a slightly raised narrow yellow margin (e.g. Figs 8b-2, 8b-3, arrows) **10**

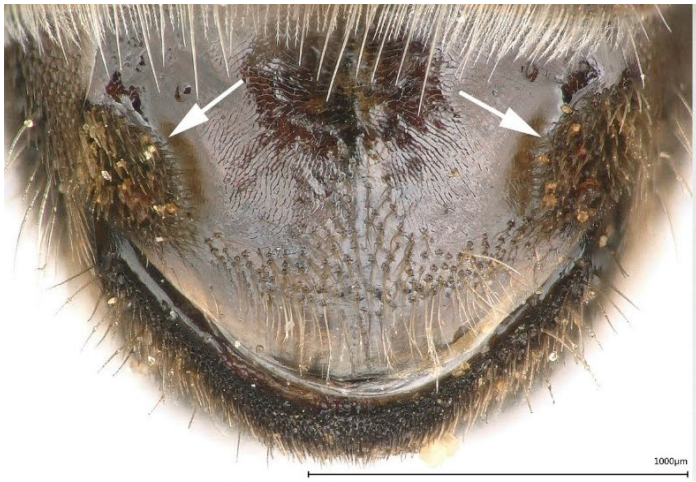

Fig. 8a-1 *Colletes gallicus*, S6 with lateral hair patches

Fig. 8b-1 *Colletes floralis*, S6 without lateral hair patches

Fig. 8a-2 *Colletes gallicus*, S6 with lateral hair patch

Fig. 8b-2 *Colletes eous*, marginal zone of T1

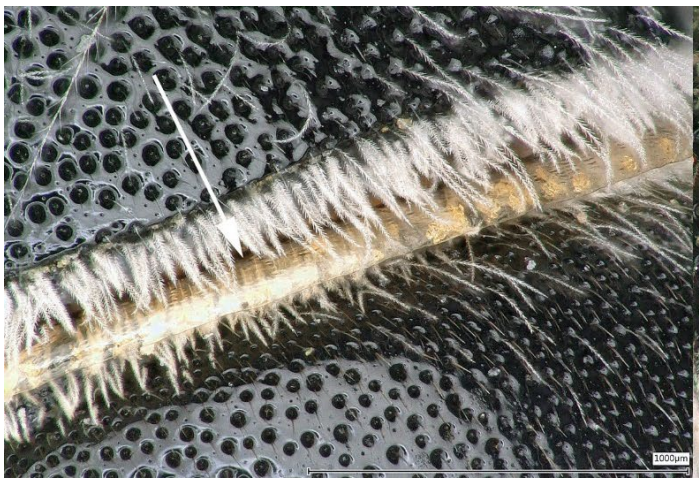

Fig. 8a-3 *Colletes carinatus*, marginal zone of T1

Fig. 8b-3 *Colletes sierrensis*, marginal zone of T1

Note: Differences between the males of the following two species are subtle.

9a(8) Premarginal lines of T1 and T2 medially distinct and well defined, transition from disc to depression abrupt, truncated to overhanging (Fig. 9a-1, arrow); S7 as in Fig. 9a-2. In SE Central Europe (BL 9–11 mm) ..... ***C. carinatus***

9b Premarginal line of T1 medially indistinct, transition from disc to depression gently curved (Fig. 9b-1, arrow); S7 as in Fig. 9b-2. In SW Central Europe (BL 9–11 mm) ..... ***C. gallicus***

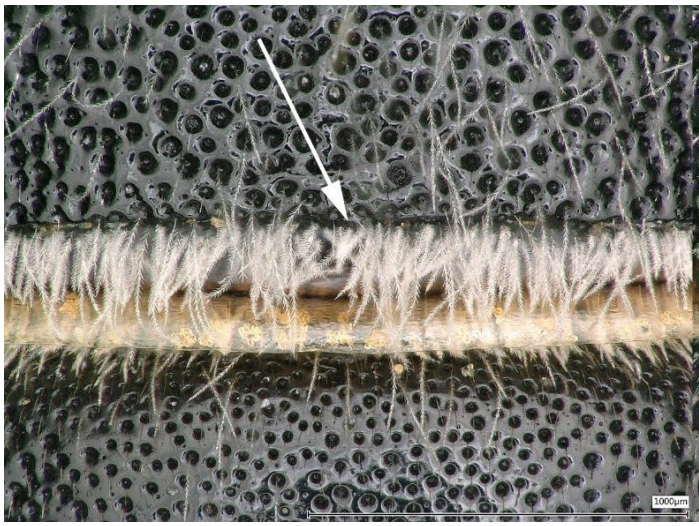

Fig. 9a-1 *Colletes carinatus*, premarginal line of T1

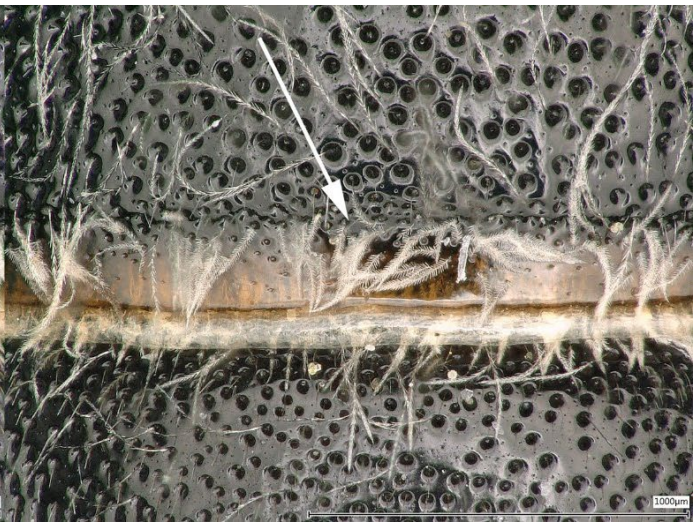

Fig. 9b-1 *Colletes gallicus*, premarginal line of T1

Fig. 9a-2 *Colletes carinatus*, S7

Fig. 9b-2 *Colletes gallicus*, S7

10a(8) Marginal zone of T2 deeply depressed (Figs 10a-1, 10a-2), apical hair bands of T2-T3 medially broader than the disc, consisting of scale-like hairs (Fig. 10a-2); premarginal lines of T2 and T3 truncated or overhanging (Fig. 10a-2); S7 as in Fig. 10a-3 (BL 9–11 mm) ..... ***C. hylaeiformis***

10b Marginal zone of T2 less depressed, apical hair bands of T2-T3 medially narrower than the disc, consisting of slender appressed hairs; premarginal lines of T2 and T3 at most medially truncated; S7 different **11**

Fig. 10a-1 *Colletes hylaeiformis*, T1 and T2

Fig. 10a-2 *Colletes hylaeiformis*, marginal zones of T2 and T3 in lateral view

Fig. 10a-3 *Colletes hylaeiformis*, S7

11a(10) S6 with a pair of deep, posterolateral pits (e.g. Fig. 11a-1, arrows) **12**

11b S6 without a pair of deep, posterolateral pits **17**

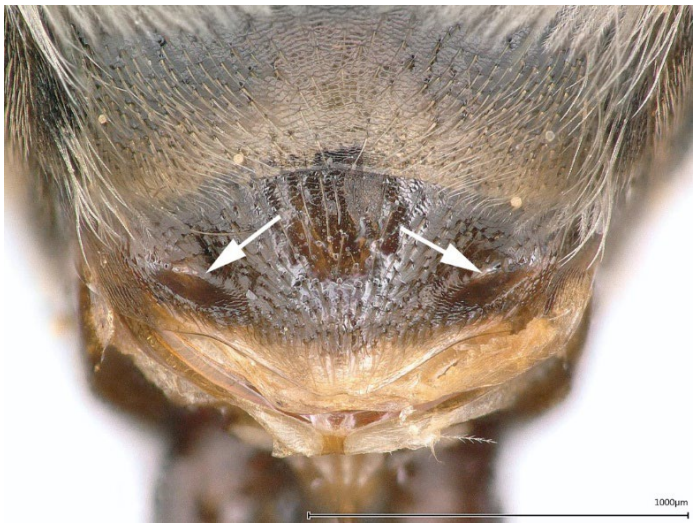

Fig. 11a-1 *Colletes succinctus*, S6

Note: Even with experience and the help of reference specimens, most species of the *C. succinctus* group are very difficult to identify on the basis of morphological characters alone. The most reliably identifiable species are *C. collaris* and *C. succinctus*. Observations of flower visitation or information on distribution can facilitate identification.

12a(11) S7 very small, apical processes roughly transversely oval (Fig. 12a-1); apical tergal hair bands narrower (Fig. 12a-2); propodeal triangle clearly visible, not hidden by long protruding hairs, its declivous apicolateral part glabrous (Fig. 12a-3). Oligolectic on Asteraceae; in S Central Europe (BL 11–12 mm) ..... ***C. collaris***

12b S7 distinctly larger, apical processes roughly triangular in shape (e.g. Figs 12b-1, 12b-2); apical tergal hair bands broader (e.g. Figs 12b-3, 12b-4); propodeal triangle partly hidden by long protruding hairs, its declivous apicolateral part lined with long hairs (e.g. Fig. 12b-5) **13**

Fig. 12a-1 *Colletes collaris*, S7

Fig. 12b-1 *Colletes halophilus*, S7

Fig. 12b-2 *Colletes succinctus*, S7

Fig. 12a-2 *Colletes collaris*, metasoma in dorsal view

Fig. 12b-3 *Colletes halophilus*, metasoma in dorsal view

Fig. 12b-4 *Colletes hederae*, metasoma in dorsal view

Fig. 12a-3 *Colletes collaris*, propodeum

Fig. 12b-5 *Colletes halophilus*, propodeum

13a(12) Galea on the outer, more strongly chitinised portion polished and shiny, without very fine reticulation (except at extreme apex) (Fig. 13a-1); S7 as in Fig. 13a-2. **Note:** Length / proportions of the maxillary palps (usually short and stout in *C. succinctus*, longer and slender in other species) are of limited use as characters, as they show some intra- and inter-specific (geographical) variation. Strong preference for *Calluna* and *Erica*; widespread in Central and NW Europe (BL 8–11 mm) ..... ***C. succinctus***

13b Galea on the outer, more strongly chitinised portion entirely or at least predominantly with very fine reticulation and matt (sometimes galea in basal half partly polished and shiny) (e.g. Fig. 13b-1) **14**

Fig. 13a-1 *Colletes succinctus*, galea

Fig. 13b-1 *Colletes hederae*, galea

Fig. 13a-2 *Colletes succinctus*, S7

14a(13) Membrane of S7 medially longer, apical edge ± straight (e.g. Fig. 14a-1) **15**

14b Membrane of S7 medially shorter, apical edge ± concave (e.g. Fig. 14b-1) **16**

Fig. 14a-1 *Colletes halophilus*, S7

Fig. 14b-1 *Colletes brevigena*, S7

15a(14) Punctation of T1 and T2 coarser and deeper, on the disc of T1 punctures partly elongate, as if pierced obliquely from behind (Figs 15a-1, 15a-2); apical tergal hair bands in freshly emerged specimens white to cream-white (Fig. 15a-3); S7 as in Fig. 15a-4. Oligolectic on Asteraceae, with strong preference for *Tripolium pannonicum*; only in coastal regions with salt marshes, from the Atlantic coast of France to S North Sea and SW Baltic Sea (BL 9–13 mm) ..... ***C. halophilus***

15b Punctation of T1 and T2 finer and flatter, punctures roundish (Figs 15b-1, 15b-2); apical tergal hair bands in freshly emerged specimens pale yellowish- to orangish-brown (Fig. 15b-3); S7 as in Fig. 15b-4. Strong preference for *Hedera*; widespread in Central and NW Europe (BL 9–13 mm) ..... ***C. hederae***

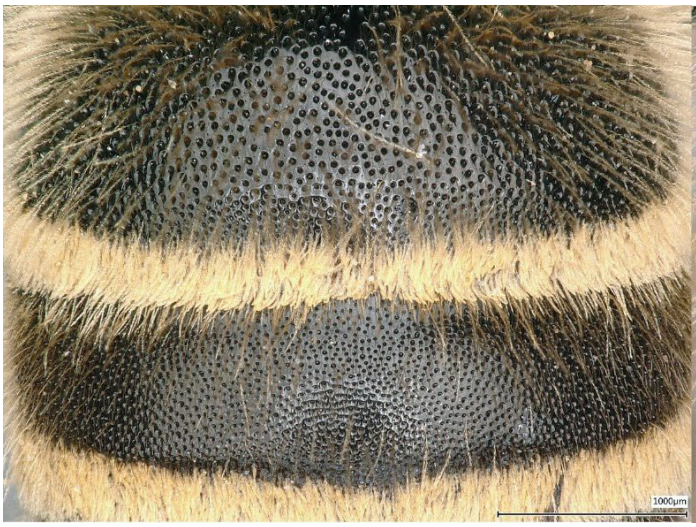

Fig. 15a-1 *Colletes halophilus*, T1 and T2 in dorsal view

Fig. 15b-1 *Colletes hederae*, T1 and T2 in dorsal view

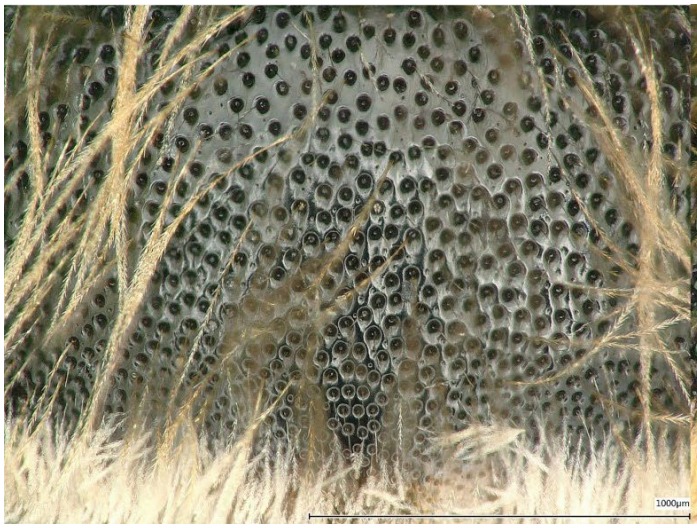

Fig. 15a-2 *Colletes halophilus*, disc of T1

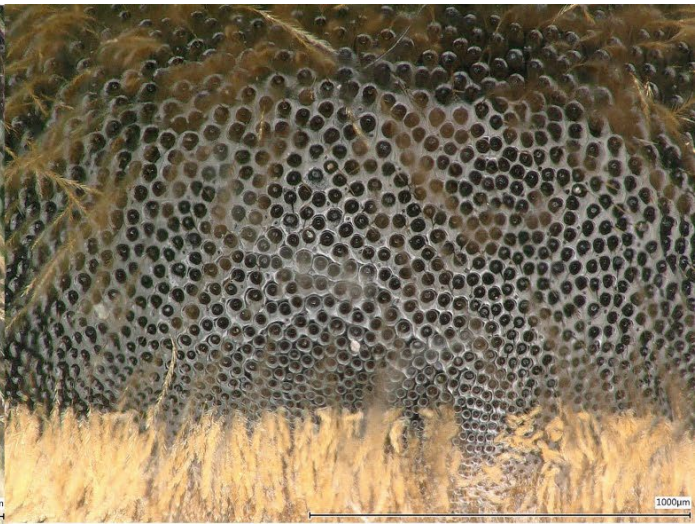

Fig. 15b-2 *Colletes hederae*, disc of T1

Fig. 15a-3 *Colletes halophilus*, metasoma in dorsal view

Fig. 15b-3 *Colletes hederae*, metasoma in dorsal view

Fig. 15a-4 *Colletes halophilus*, S7

Fig. 15b-4 *Colletes hederae*, S7

16a(14) Punctation of T1 and T2 coarser and denser, terga have a less shiny appearance (Fig. 16a-1); S7 as in Fig. 16a-2. Polylectic; in S Central Europe (BL 10–13 mm) ..... ***C. brevigena***

16b Punctation of T1 and T2 finer and sparser, terga have a shinier appearance (Fig. 16b-1); S7 as in Fig. 16b-2. Presumably oligolectic on Asteraceae, with strong preference for *Tripolium pannonicum*; endemic to the surroundings of Lake Neusiedl (E Austria) (BL 10–11 mm) ..... ***C. pannonicus***

Fig. 16a-1 *Colletes brevigena*, T1 and T2 in dorsal view

Fig. 16b-1 *Colletes pannonicus*, T1 and T2 in dorsal view

Fig. 16a-2 *Colletes brevigena*, S7

Fig. 16b-2 *Colletes pannonicus*, S7

17a(11) Head about as broad as long (width of head about the same as length of head) (Fig. 17a-1), in dorsal view narrower than mesosoma; S7 as in Fig. 17a-2 (BL 8–10 mm) ..... ***C. anchusae***

17b Head broader than long (width of head bigger than length of head), in dorsal view as broad or broader than mesosoma; S7 different **18**

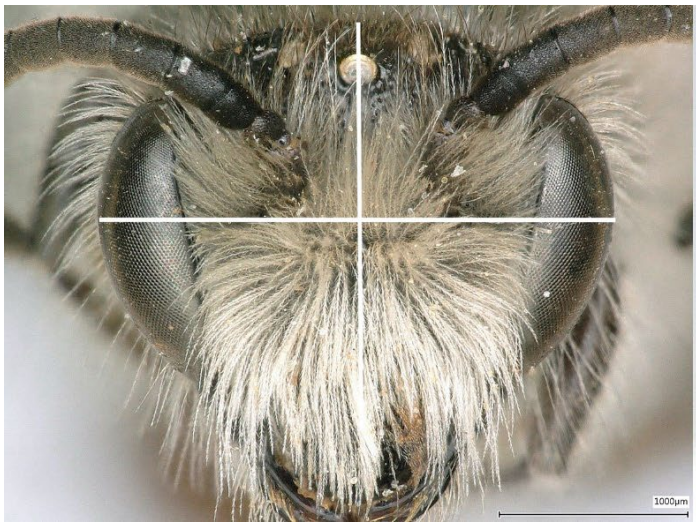

Fig. 17a-1 *Colletes anchusae*, head

Fig. 17a-2 *Colletes anchusae*, S7

18a(17) Disc of T2 without long erect hairs (rarely medially with a few single hairs (arrow)) (e.g. Figs 18a-1, 18a-2) **19**

18b Disc of T2 abundantly covered with long erect hairs (e.g. Figs 18b-1, 18b-2, arrows) **23**

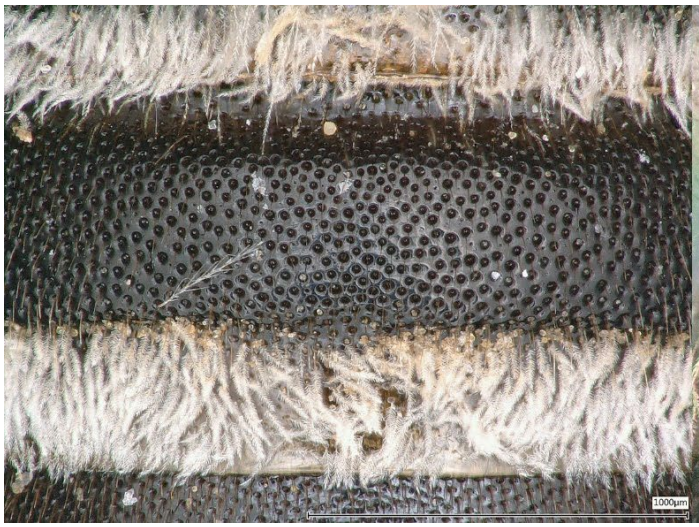

Fig. 18a-1 *Colletes nigricans*, disc of T2

Fig. 18b-1 *Colletes similis*, disc of T2

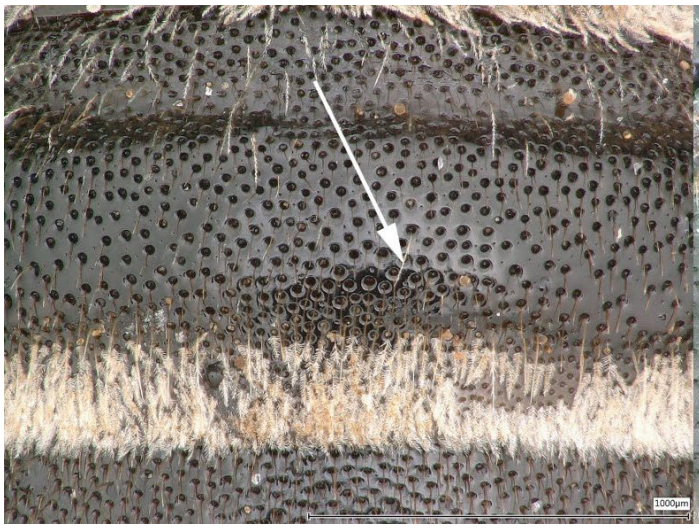

Fig. 18a-2 *Colletes sierrensis*, disc of T2

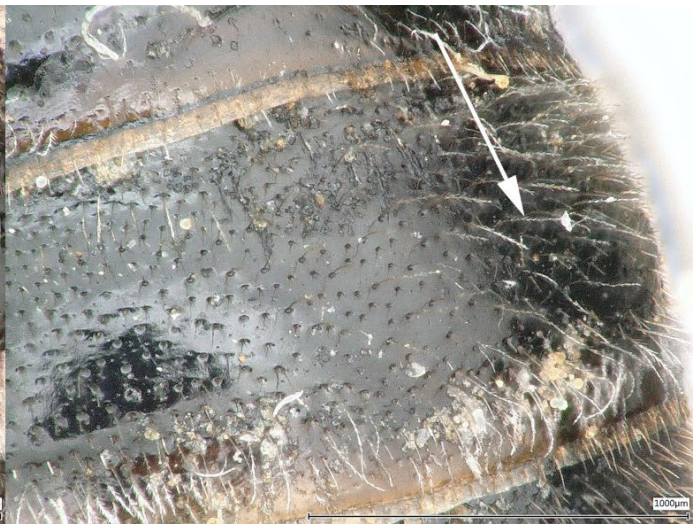

Fig. 18b-2 *Colletes impunctatus*, disc of T2

19a(18) S7 longer, three times as long as apical width **20**

19b S7 shorter, about as wide as long or broader than long **21**

20a(19) S7 ventrally without fringe of long hairs along its longitudinal axis (visible in lateral view) (Fig. 20a-1); marginal zone of T1 strongly concave, apically raised with narrow yellowish translucent margin (Fig. 20a-2); S7 as in Fig. 20a-3. In SW Central Europe (BL 9–11 mm) ..... ***C. eous***

20b S7 ventrally with fringe of long hairs along its longitudinal axis (visible in lateral view, arrow) (Fig. 20b-1); marginal zone of T1 almost flat or just slightly concave, apically either not or only slightly raised, without yellowish translucent margin (Fig. 20b-2); S7 as in Fig. 20b-3. In S Central Europe (BL 9–11 mm) ..... ***C. nigricans***

Fig. 20a-1 *Colletes eous*, S7 in lateral view

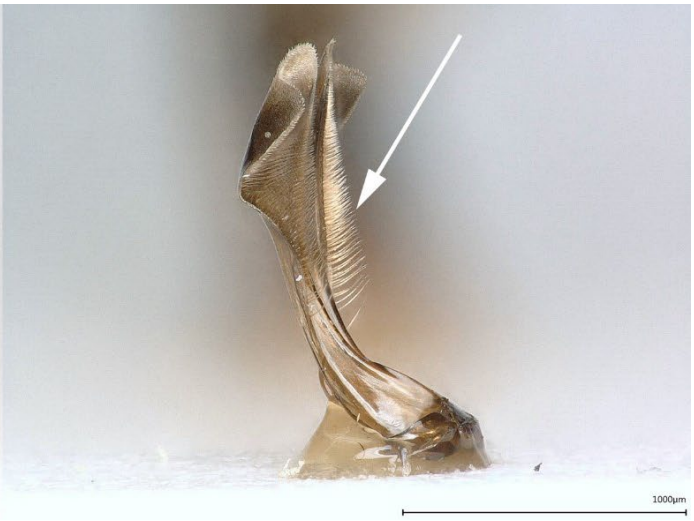

Fig. 20b-1 *Colletes nigricans*, S7 in lateral view

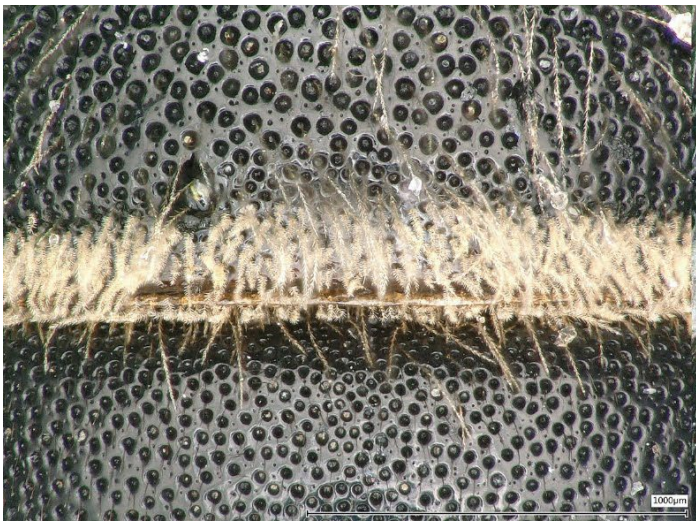

Fig. 20a-2 *Colletes eous*, marginal zone of T1

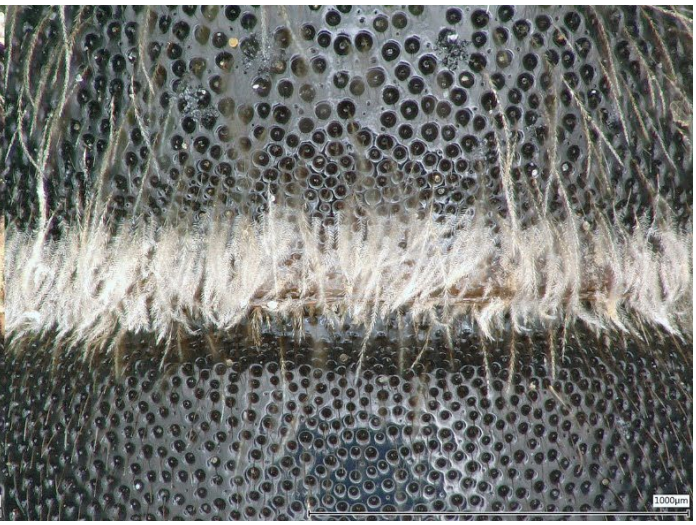

Fig. 20b-2 *Colletes nigricans*, marginal zone of T1

Fig. 20a-3 *Colletes eous*, S7

Fig. 20b-3 *Colletes nigricans*, S7

21a(19) S7 apically broader, almost 2 times as wide as long (Fig. 21a-1). Oligolectic on *Odontites*; in SW Central Europe (BL 8–10 mm) ..... ***C. sierrensis***

21b S7 apically narrower, maximum about 1.5 times as wide as long (Figs 22a-1, 22b-1). Polylectic or presumably polylectic species **22**

Fig. 21a-1 *Colletes sierrensis*, S7

22a(21) S7 apically broader, about 1.5 times as wide as long (Fig. 22a-1). Widespread in Central and NW Europe (BL 8–10 mm) ..... ***C. marginatus***

22b S7 apically narrower, about as wide as long (Fig. 22b-1). Only in steppe regions of SE Central Europe (BL 8–10 mm) ..... ***C. chengtehensis***

Fig. 22a-1 *Colletes marginatus*, S7

Fig. 22b-1 *Colletes chengtehensis*, S7

23a(18) S7 of roundish oval shape (Fig. 23a-1) (BL 7–9 mm) ..... ***C. foveolaris***

23b S7 of different shape, not roundish oval (e.g. Figs 23b-1, 23b-2, 23b-3) **24**

Fig. 23a-1 *Colletes foveolaris*, S7

Fig. 23b-1 *Colletes inexpectatus*, S7

Fig. 23b-2 *Colletes daviesanus*, S7

Fig. 23b-3 *Colletes mlokossewiczi*, S7

24a(23) S6 laterally with small tooth or bulge, covered with a hair brush or hair patch that is usually pointing backwards (e.g. Figs 24a-1, 24a-2, 24a-3, arrows) **25**

24b S6 ± flat, without lateral tooth or bulge, pilosity different (in *C. floralis* with a simple brush) (Figs 24b-1, 24b-2) **29**

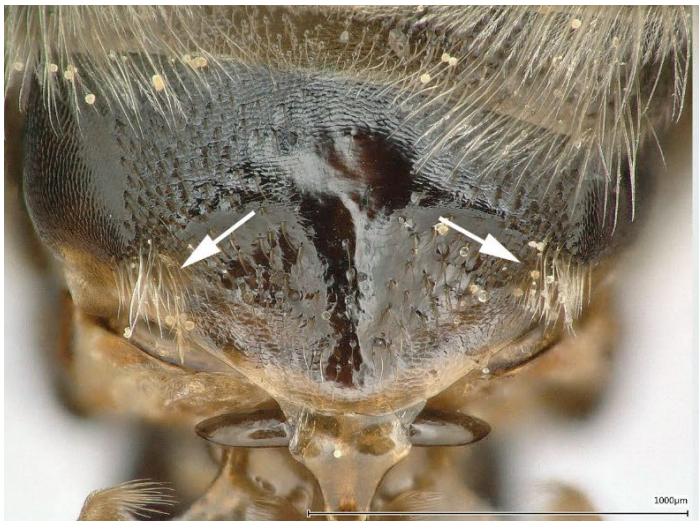

Fig. 24a-1 *Colletes similis*, S6

Fig. 24b-1 *Colletes floralis*, S6

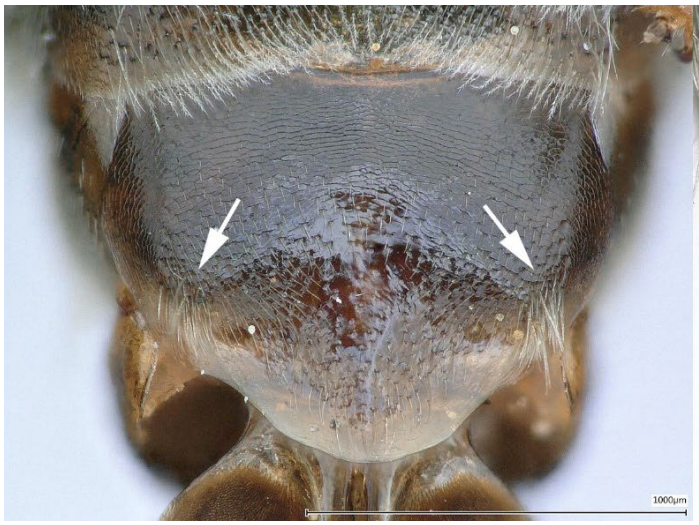

Fig. 24a-2 *Colletes mlokossewiczi*, S6

Fig. 24b-2 *Colletes impunctatus*, S6

Fig. 24a-3 *Colletes daviesanus*, S6 in lateral view

25a(24) Hind basitarsus clearly broadened apically, 2.5-3 times as long as wide (Fig. 25a-1); S7 as in Fig. 25a-2. Only in SE Central Europe (BL 7–10 mm) ..... ***C. inexpectatus***

25b Hind basitarsus not clearly broadened apically, ± parallel-sided and about 3.5 times as long as wide (e.g. Fig. 25b-1); S7 of different shape (Figs 26a-3, 27a-4, 28a-3, 28b-3). These species (except *C. mlokossewiczi*) are widespread and common in Central and NW Europe **26**

Fig. 25a-1 *Colletes inexpectatus*, hind basitarsus

Fig. 25b-1 *Colletes daviesanus*, hind basitarsus

Fig. 25a-2 *Colletes inexpectatus*, S7

26a(25) Malar area very short, medially almost linear (Fig. 26a-1); in dorsal view F2 about as long or slightly longer than F1 (Fig. 26a-2); S7 small, shape as in Fig. 26a-3 (BL 7–9 mm) ..... ***C. mlokossewiczi***

26b Malar area longer, its lengths medially about 1/3 to 1/2 the width of base of mandible (e.g. Fig. 26b-1); in dorsal view F2 about 1.3-1.5 times longer than F1 (e.g. Fig. 26b-2); S7 larger and of different shape (Figs 27a-4, 28a-3, 28b-3) **27**

Fig. 26a-1 *Colletes mlokossewiczi*, malar area

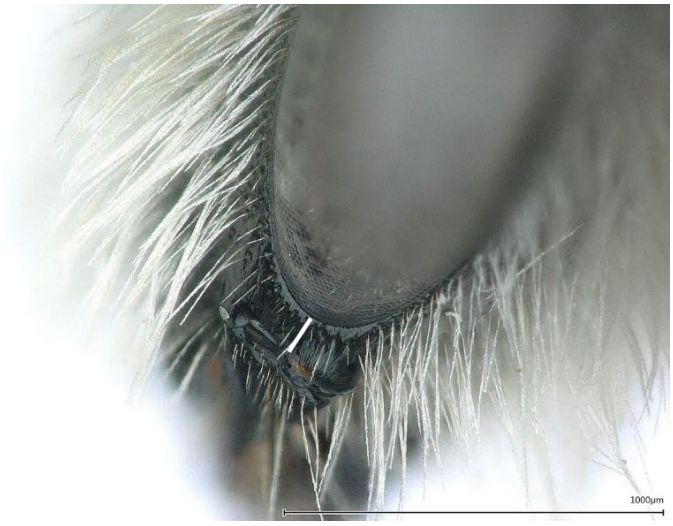

Fig. 26b-1 *Colletes daviesanus*, malar area

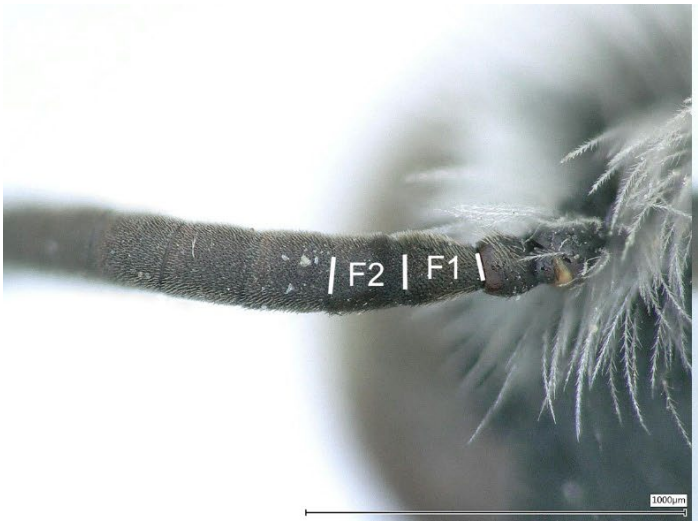

Fig. 26a-2 *Colletes mlokossewiczi*, F1 and F2

Fig. 26b-2 *Colletes fodiens*, F1 and F2

Fig. 26a-3 *Colletes mlokossewiczi*, S7

Note: The following three species are common and widespread oligoleges of Asteraceae. They are most easily and reliably identified by their S7.

27a(26) S2 medially without distinct apical hair fringe (Fig. 27a-1); S6 laterally with a small tooth covered with a hair brush that is pointing backwards (Fig. 27a-2); T1 and T2 more sparsely punctate (i = 0.5-1.5d) and therefore shinier in appearance (Fig. 27a-3); S7 as in Fig. 27a-4 (BL 7–10 mm) ..... ***C. daviesanus***

27b S2 medially with distinct apical hair fringe (e.g. Fig. 27b-1); S6 laterally with a small bulge, covered with a hair patch (e.g. Fig. 27b-2); T1 and T2 more densely punctate (i < d) and therefore duller in appearance (Figs 27b-3, 27b-4); S7 different (Figs 28a-3, 28b-3) **28**

Fig. 27a-1 *Colletes daviesanus*, metasoma in ventral view

Fig. 27b-1 *Colletes fodiens*, metasoma in ventral view

Fig. 27a-2 *Colletes daviesanus*, S6 in lateral view

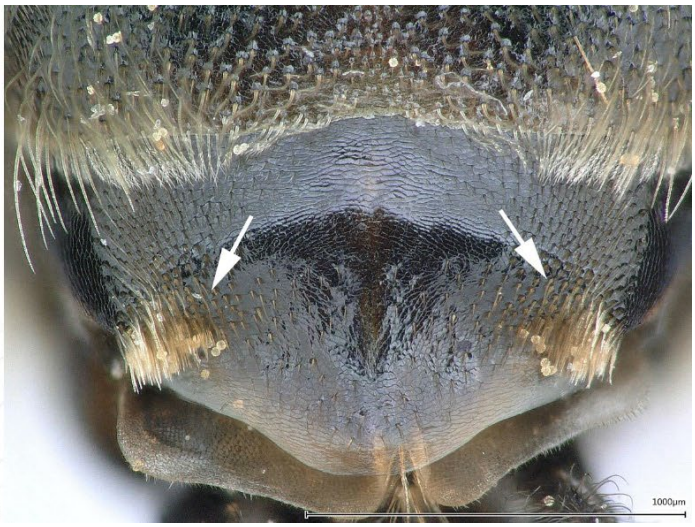

Fig. 27b-2 *Colletes fodiens*, S6

Fig. 27a-3 *Colletes daviesanus*, T1 and T2

Fig. 27b-3 *Colletes fodiens*, T1 and T2

Fig. 27a-4 *Colletes daviesanus*, S7

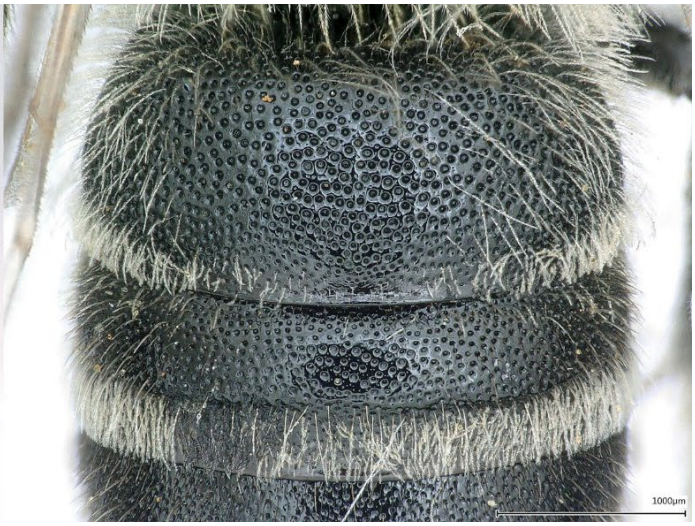

Fig. 27b-4 *Colletes similis*, T1 and T2

28a(27) T1 and T2 with finer punctation (Fig. 28a-1); hind trochanter ventrally with significant swelling (Fig. 28a-2); S7 as in Fig. 28a-3 (BL 8–10 mm) ..... ***C. fodiens***

28b T1 and T2 with coarser punctation (Fig. 28b-1); hind trochanter unmodified, ventrally without swelling (Fig. 28b-2); S7 as in Fig. 28b-3 (BL 7–10 mm) ..... ***C. similis***

Fig. 28a-1 *Colletes fodiens*, T1 and T2

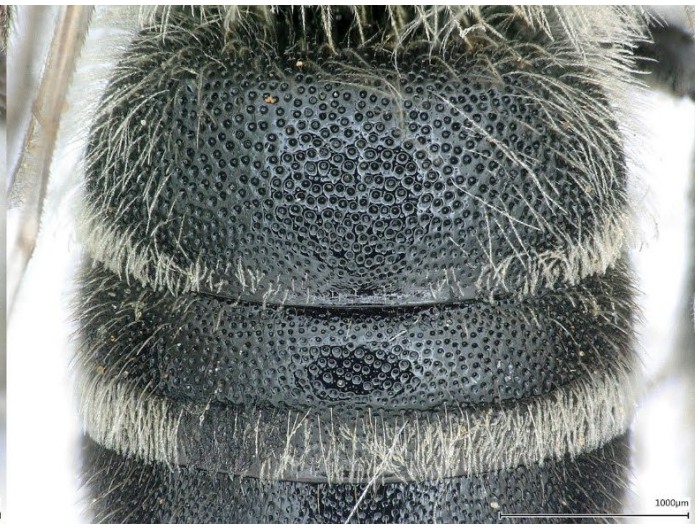

Fig. 28b-1 *Colletes similis*, T1 and T2

Fig. 28a-1 *Colletes fodiens*, hind trochanter viewed from behind

Fig. 28b-2 *Colletes similis*, hind trochanter viewed from behind

Fig. 28a-3 *Colletes similis*, S7

Fig. 28b-3 *Colletes similis*, S7

29a(24) Disc of T1 with coarser and denser (i = 0.5-1.5 d) punctation (Fig. 29a-1); S7 as in Fig. 29a-2 (BL 9–11 mm) ... . ***C. floralis***

29b Disc of T1 with finer and sparser (i = 2-4 d) punctation (Fig. 29b-1); S7 as in Fig. 29b-2 (BL 8–10 mm) ... ***C. impunctatus***

Fig. 29a-1 *Colletes floralis*, disc of T1

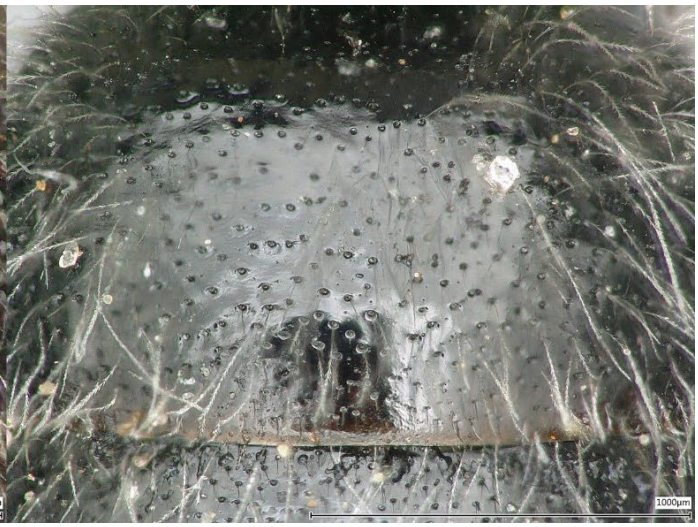

Fig. 29b-1 *Colletes impunctatus*, disc of T1

Fig. 29a-2 *Colletes floralis*, S7

Fig. 29b-2 *Colletes impunctatus*, S7

Acknowledgements

Special thanks go to the colleagues at the Kompetenzzentrum Wildbienen, especially CHRISTOPH SAURE and NOEL SILLÓ, for their critical review of the key and helpful suggestions for its improvement.

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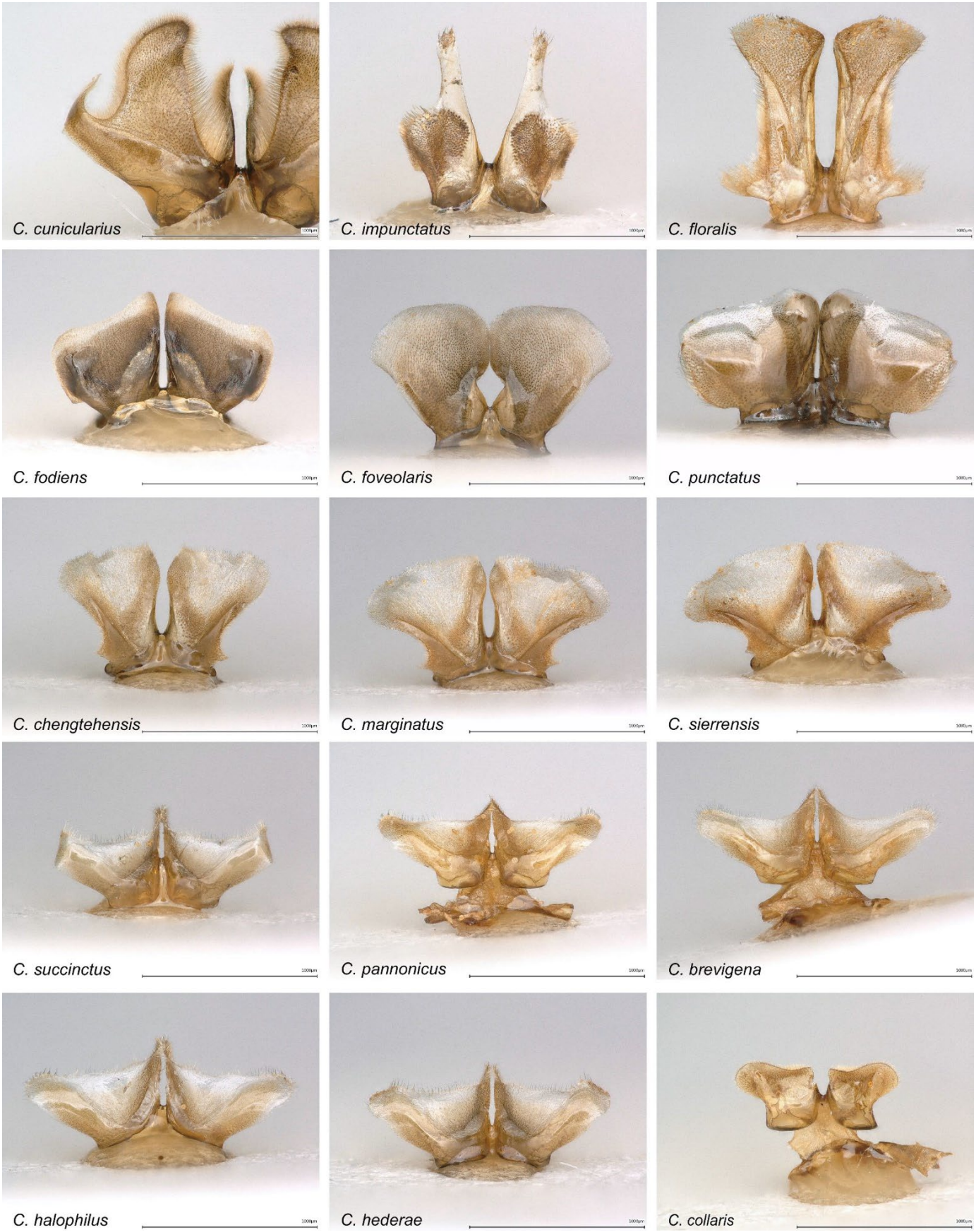
Supplements

Supplemental Fig. 1a Overview of the male S7 of 15 *Colletes* species sorted by similarity in shape. Illustrations are on the same scale to facilitate direct comparison of size and shape.



Supplemental Fig. 1b Overview of the male S7 of 15 *Colletes* species sorted by similarity in shape. Illustrations are on the same scale to facilitate direct comparison of size and shape.

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In-text citations should fully name up to two authors. For three or more authors, only the first author is named, followed by "et al."

Bei gleichzeitiger Nennung mehrerer Artikel im Text werden diese nach chronologischer Reihenfolge geordnet und beim gleichen Erscheinungsjahr zusätzlich alphabetisch.

Beispiele im Text:

„[…] (ZURBUCHEN & MÜLLER 2012, RADCHENKO et al. 2020, MÜLLER 2023, SILLO 2023).“

„Laut MÜLLER (2023) gibt es Pollenpräferenzen [...]“

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MÜLLER A. (2023): The hidden diet - examination of crop content reveals distinct patterns of pollen host use by Central European bees of the genus *Hylaeus* (Hymenoptera, Colletidae). — Alpine Entomology 7: 21-35. https://doi.org/10.3897/alpento.7.102639

RADCHENKO V.G., TOMOZII B., GHISBAIN G. & MICHEZ D. (2020): New data on the morphology and distribution of the cryptic species *Dasypoda morawitzi* RADCHENKO, 2016 (Hymenoptera: Melittidae) with corrections to the diagnosis of

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Examples in the text:

„[…] (ZURBUCHEN & MÜLLER 2012, RADCHENKO et al. 2020, MÜLLER 2023, SILLÓ 2023).“

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- The last author's name is separated from the second-to-last author's name by an ampersand (“&”).
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- The title is separated from the journal name by an em dash.
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LOEFFEL K., STREICH S., WESTRICH P. & ZETTEL J. (1999): Auensukzession und Zonation im Rottensand (Pfynwald Kt. VS). II. Wiederbesiedlung einer Überschwemmungsfläche durch Wildbienen (Hymenoptera, Apidae). — Mitteilungen der Schweizerischen entomologischen Gesellschaft 72: 139-151.

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SILLÓ N. (2023): Erstnachweis von *Stelis simillima* MORAWITZ, 1875 in Deutschland mit Hinweisen zur Unterscheidung von *Stelis punctulatissima* (KIRBY, 1802) - First records of *Stelis simillima* MORAWITZ, 1875 in Germany with notes on the separation from *Stelis punctulatissima* (KIRBY, 1802). — Anthophila 1(1): 7-17.

ZURBUCHEN A. & MÜLLER A. (2012): Wildbienenschutz - von der Wissenschaft zur Praxis. Haupt, Bern: 162 S.

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Für jeden Autor sollten zu Beginn des Manuskripts eine aktuelle Anschrift und E-Mail-Adresse angegeben werden sowie institutionelle Information (wenn vorhanden).

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Figures

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Author Information

For each author, current address and email should be provided at the beginning of the manuscript as well as institutional information (if available).