

Original article

## The propodeal corbicula of *Andrena proxima* and allied species (Hymenoptera, Andrenidae)

Andreas DUBITZKY, Klaus SCHÖNITZER\*

Zoologische Staatssammlung München, Münchhausenstr. 21, 81247 München, Germany

(Received 26 March 2001; revised 25 June 2001; accepted 28 June 2001)

**Abstract** – In the present study the external morphology of the lateral surface of the propodeum of females of *Andrena proxima* and *A. alutacea* – which is possibly a synonym of the former – is investigated by light- and scanning electron microscopy. Two different hair types and characteristic star-shaped structures of the cuticle at the bases of hairs in the central region of the lateral surface of the propodeum are described. Between the two taxonomic forms no differences could be found. Both, the different hair types as well as the star-shaped structures of the cuticle are possibly used for retention of the collected pollen. The described structures are probably autapomorphic characters which justify *A. proxima*-group as a separate species group not included in the subgenus *Micrandrena* as Warncke did.

**propodeum / pollen collecting / taxonomy / *Andrena proxima* / *Andrena alutacea***

### 1. INTRODUCTION

The univoltine sandbee *Andrena proxima* may be observed in Central Europe from May to July. This species is oligolectic on Apiaceae and can be recognized in the field because of its floral relationship as well as by its obvious white tergal hair bands and its small size, 8 to 10 mm (Müller et al., 1997; Westrich, 1989).

Like in other species of *Andrena*, in *A. proxima* the sides of the propodeum are

functional corbiculae for transporting pollen. These serve for the transport of pollen (Fig. 1) and are additional to the hairs of the tibia and the flocculus of the trochanter, both on the posterior legs. In several species with the propodeal corbiculae more pollen is transported there than on the posterior legs. The pollen collecting facilities of several species of sandbees were investigated by scanning electron microscopy (SEM) by Pasteels and Pasteels (1977). These authors, however, did not investigate the propodeum

---

\* Correspondence and reprints  
E-mail: andreas\_dubitzky@yahoo.de; schoenitzer@zsm.mwn.de



**Figure 1.** Female of *Andrena proxima* on the flower of *Aegopodium podagraria*. White arrows indicate the filled corbicula of the propodeum.

of *A. proxima* although it is characterized by special structures. They predominantly described the propodeal corbicula of several species of the subgenus *Andrena* and some reductions within the genus, for example in the American subgenus *Diandrena* and in *Andrena humilis*<sup>1</sup>.

In the present communication the lateral propodeal surface of *Andrena proxima* is investigated by SEM and the function of its structures is discussed. This is also of interest from the taxonomic view. Although this species can be recognized in the field rather easily, its taxonomic status is not yet clear. Some authors suggest that *Andrena proxima* is actually two species (i.e. *Andrena proxima* (Kirby, 1802) and *A. alutacea*: Stöckhert, 1942; Schmid-Egger and Scheuchl, 1997), whereas others state that *A. alutacea* is a synonym of *A. proxima* (e.g. Dylewska, 1987; Westrich, 1989; Schwarz et al., 1996). At any case *A. proxima* is a polymorphic species and some subspecies have been described (*A. proxima ampla* Warncke, 1967; *A. p. aspericollis* Pérez, 1895; *A. p. bernicla* Warncke, 1975).

## 2. MATERIALS AND METHODS

Although it is not clear whether they are synonyms, in the present paper the two forms are treated like two species: *A. proxima* and *A. alutacea* Stöckhert, 1942. The two taxa can be differentiated by the diagnosis of Schmid-Egger and Scheuchl (1997).

Three specimens of each, *A. alutacea* and *A. proxima*, were investigated by SEM. They were conventionally sputtered (*A. proxima*) or investigated unsputtered (*A. alutacea*). The pinned specimens were fixed on a conventional stubb by Leit-C-Plast (a plastic conductive carbon cement) and investigated with a Phillips XL-20 or LEO 1430 VP. Unsputtered material was examined with a special low voltage anode at 1.6 kV (XL-20) or with a variable pressure device (20–30 Pa, BSE detector, 15 kV, 1430 VP).

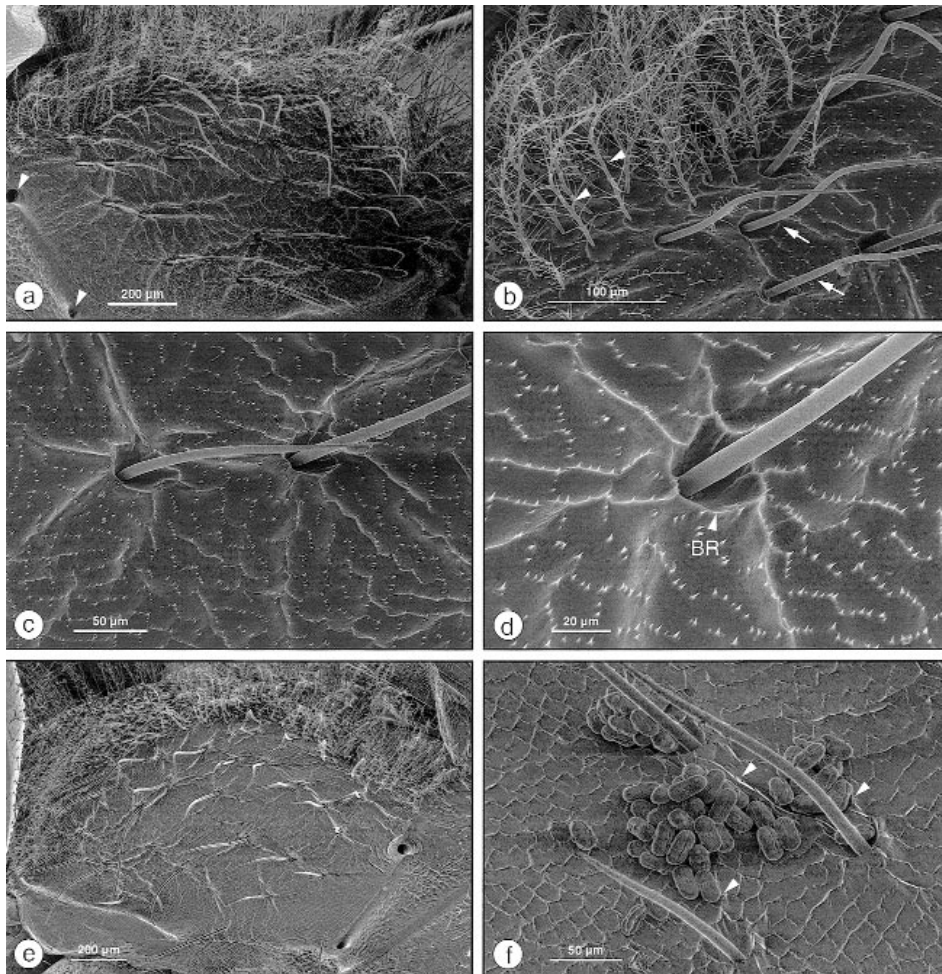
Furthermore, for comparison with light microscopy (LM) we investigated several specimens of the above mentioned species as well as material of the following species: *Andrena subproximana* Strand, 1913 (holotype, DEI Eberswalde); the *Andrena labialis*-group (subgen. *Holandrena*): *A. variabilis* Smith, 1853; *A. labialis* (Kirby, 1802); *A. forsterella* Osytshnjuk, 1978; *A. decipiens* Schenk, 1861; the *A. dorsata*-group (subgen. *Simandrena*): *A. dorsata* (Kirby, 1802); *A. propinqua* Schenk, 1853; and other species of the genus *Andrena*. Most specimens of *A. alutacea* investigated were either paratypes or determined by Stöckhert, we also investigated the holotype of *A. alutacea*. If not stated else, the investigated bees are from the stocks of the Zoological State Collection (= Zoologische Staatssammlung München).

<sup>1</sup> For the sake of correctness it should be mentioned that in their Figure 17 unbranched hairs are shown as scopal hairs of *Andrena humilis*, although this species is characterized by clearly branched hairs of the scopa.

### 3. RESULTS AND DISCUSSION

The sides (= corbiculae) of the propodeum of *A. proxima* and *A. alutacea* respectively, are shown in Figures 2a and 2e. The long hairs of the edge of the side of the propodeum constitute a fringe along the upper and posterior borders of the corbicula. The anterior

side of the corbicula is open. This corresponds to the general observation that pollen is transferred from anterior to posterior before it is deposited in any corbicula (Jander, 1976). In contrast to this, the species of the *A. dorsata*-group bear an additional fringe of hairs at the anterior end of the side of the propodeum (cf. Schmid-Egger and Scheuchl,



**Figure 2.** Corbiculua of the propodeum (= lateral side of the propodeum) of *A. proxima* (a–d) and of *A. alutacea* (e–f) respectively. (a) Overall view. Orientation: top: dorsal, left: anterior; (b) Detail of the dorsal part of the corbicula with setae (arrows) and branched hairs outside the corbicula (arrowheads); (c) Setae arising from the surface of the corbicula with starlike keels; (d) Base of a seta in the corbicula with starlike keels and rows of cuticular spicules (microtrichia). BR: basal ring of seta; (e) Overall view. orientation: top: dorsal, right: anterior; (f) Surface of propodeal corbicula with pollen. Arrowheads: cuticular keels.

1997). Furthermore in the species of the *A. dorsata*-group, the surface of the corbicula is completely bare. At the anterior edge of the corbicula in *A. proxima* and *A. alutacea* there are two apodemal holes (Figs. 2a and 2e) as in most but not all species of the genus.

A most remarkable feature are the numerous starlike wrinkles of the cuticle on the surface of the corbicula which may be seen by LM as well as by SEM. The centre of each of these starlike structures is formed by an elevated, irregularly round, basal ring of a hair or seta (Fig. 2). From each basal ring, stellate cuticular keels radiate with reducing height (Figs. 2c, 2d), like the root-stock of a tree. Altogether about 30 to 35 setae are inserted on the surface of each corbicula. As compared to the branched hairs of the fringe on the upper margin of the corbicula, the hairs of the surface of the corbicula are unbranched and two to three times as thick (Fig. 2b). Most, especially the longest of the setae of the surface of the corbicula are bent posteriorly nearly rectangularly at an altitude of about 100 µm (Figs. 2a, 2b and 2e). On the posterior part of the corbicula surface the setae are somewhat longer and not bent. Another special feature of the cuticle of the corbicula are rows of acute triangular spicules (microtricha) standing in zig-zag rows (Figs. 2c, 2d). These rows of microtricha probably correspond to epidermal cell borders. They can not be seen by LM and should be investigated by SEM if they are to be found in other species of *Andrena*. No significant difference in the morphology of the propodeal corbicula was found between *A. proxima* and *A. alutacea*.

Surprisingly the starlike cuticular structures were not observed by various previous authors (Dylewska, 1987; Stöckert, 1942) who investigated *Andrena proxima* and *A. alutacea*. On the other hand these are clear features for the recognition of the group of *A. proxima/alutacea* (cf. Schmid-Egger and Scheuchl, 1997).

*Andrena proxima* (and *A. alutacea*) was integrated into the subgenus *Micrandrena*

(= *A. minutula*-group) by Warncke (1968, see also later publications of Warncke). Dylewska (1987), however, transferred the species into a separate species group of its own (*Andrena proxima*-group) mainly because of the dense punctation of the mesopleura (= mesepisterna). The structures described in the present communication are possibly autapomorphic and justify considering the *Andrena proxima*-group as a separate species group. Furthermore the distinct tergal bands as well as the longer distance between the stigma and the ending of the cubital vein into the radial cell support separation of *A. proxima* and its allies from the subgenus *Micrandrena*.

In contrast to other species of *Andrena*, similar starlike structures are also found in species of the *A. labialis*-group (subgen. *Holandrena*): the starlike structures are quite clear in *A. variabilis* and *A. forsterella*, less clear in *A. labialis*, and not found in *A. decipiens*; they have not been mentioned previously (Schönitzer et al., 1995). They are, however, never spread over the whole surface of the propodeum and are much less clear than those of *A. proxima/A. alutacea*. Nevertheless they might be a hint (a putative synapomorphy) for a closer relationship of these two taxa; possibly the *A. labialis*-group and the *A. proxima*-group are sistergroups.

On the other hand the propodeum of *A. subproximana* is clearly different from that of *A. proxima*. Its floor is bare of any hairs and wrinkles; it is chagreened and surrounded by branched hairs which are similar to those of the *A. dorsata*-group. In contrast to its description (Strand, 1913), *A. subproximana* is unequivocally not related to *A. proxima*. By a distinct hair fringe at the anterior side of the propodeal corbicula, a clear keel between the middle and lateral part of the propodeum, a rather broad fovea facialis and the postscutellum with rather long hairs, *A. subproximana* is clearly characterized as a member of the *A. dorsata*-group (subgen. *Simandrena*).

The star shaped structures of the cuticle as well as the bent setae of the propodeal

corbicula are possibly an adaptation for the retention of pollen grains in the corbicula. These structures possibly cause an enlargement of the surface area and permit better adhesion of the pollen grains to the cuticular surface. This idea is supported by the observation of pollen grains lined up at the starlike wrinkles and keels in those cases with only small amounts of pollen in the corbicula (cf. Fig. 2f). Westrich and Schmidt (1989) show pollen grains of Apiaceae on the tibia of *A. proxima* in an SEM photo, they are similar to the pollen found in the present investigation which is obviously also from Apiaceae (see also Müller et al., 1997).

#### ACKNOWLEDGEMENTS

We thank Dr. W. Grünwaldt and Mr. J. Schubert for most valuable hints on the literature. Mr. S.M. Blank lent us the holotype of *Andrena subproximana* from the Deutsches Entomologisches Institut, Eberswalde. Dr. R. Melzer enabled us to use the SEM of the Zoological Institute of the Ludwig-Maximilians-Universität, Munich. To all those involved we want to express our sincere thanks.

**Résumé – Les corbicules propodéales d’*Andrena maxima* et espèces voisines (Hymenoptera, Andrenidae).** La morphologie externe de la surface latérale du propodeum des femelles d’*Andrena maxima* et d’*A. alutacea* – synonyme éventuel de l’espèce précédente – a été étudiée en microscopie optique et microscopie électronique à balayage. On décrit deux types différents de soies et des structures caractéristiques en forme d’étoile situées sur la cuticule à la base des soies dans la région centrale de la surface latérale du propodeum. Les différents types de soies comme les structures étoilées sont susceptibles d’être utilisés pour retenir le pollen récolté. Aucune différence n’a été trouvée entre les deux formes taxonomiques. Les structures décrites sont probablement des caractères autapomorphiques qui justifient que le groupe *A. proxima* soit un groupe d’espèces séparé non inclus dans le sous-genre *Micandrena*. On a trouvé des

structures semblables de la surface du propodeum latéral chez les espèces du groupe *A. labialis* (sous-genre *Holandrena*), qui est peut-être un groupe sœur de *A. proxima*/*A. alutacea*. Contrairement à sa description originelle, *A. subproxima* n’est pas reliée à *A. proxima* mais est nettement caractérisée comme un membre du groupe *A. dorsata* (sous-genre *Simandrena*).

#### *Andrena proxima* / *Andrena alutacea* / taxonomie / propodeum / corbicule

**Zusammenfassung – Das Körbchen am Propodeum von *Andrena proxima* und verwandten Arten (Hymenoptera, Andrenidae).** Von *Andrena proxima* und *A. alutacea*, wobei von letzterer nicht klar ist, ob es sich um ein Synonym der erstgenannten Art handelt, wurde die äußere Morphologie des Sammel-Körbchens an der Propodeumseite der Weibchen licht- und rasterelektronenmikroskopisch untersucht. Dabei konnten neben zwei verschiedenen Haartypen an Oberkante und Körbchenboden des Sammelkörbchens charakteristische, sternförmige Cuticula-Runzeln an der Basis der Körbchenbodenhaare dokumentiert werden. Sowohl die verschiedenen Haartypen als auch die sternförmigen Runzeln des Körbchenbodens dürften das Fixieren der Pollenkörner im Körbchen unterstützen. Zwischen den beiden Formen konnte kein Unterschied gefunden werden. An Hand dieser und anderer morphologischer Merkmale wurde diskutiert, dass *A. proxima*/*A. alutacea* als eigenständige Artengruppe anzusehen sind und nicht in die Untergattung *Micrandrena* gehören. Ähnliche Strukturen am Propodeumkörbchen wurden bei Arten der *A. labialis* Gruppe (subgen. *Holandrena*) festgestellt, die möglicherweise die Schwestergruppe von *A. proxima*/*A. alutacea* ist. *A. subproximana*, die gemäß ihrer Originalbeschreibung mit *A. proxima* verwandt sein sollte, ist der *A. dorsata*-Gruppe (subgen. *Simandrena*) zuzuordnen.

#### Propodeum / Pollen sammeln / Taxonomie / *Andrena proxima* / *Andrena alutacea*

## REFERENCES

- Dylewska M. (1987) Die Gattung *Andrena* Fabricius (Andrenidae, Apoidea) in Nord- und Mitteleuropa, Acta Zool. Cracov. 30, 359–708.
- Jander R. (1976) Grooming and pollen manipulation in bees (Apoidea): the nature and evolution of movements involving the foreleg, Physiol. Entomol. 1, 179–194.
- Müller A., Krebs A., Amiet F. (1997) Bienen, Mitteleuropäische Gattungen, Lebensweise, Beobachtung, Naturbuch Verlag, Augsburg.
- Pasteels J.J., Pasteels J.M. (1977) Étude au microscope électronique à balayage des scapas collectrices de pollen chez les Andrenidae (Hymenoptera, Apoidea, Andrenidae), Arch. Biol. (Bruxelles) 90, 113–130.
- Schmid-Egger C., Scheuchl E. (1997) Illustrierte Bestimmungstabellen der Wildbienen Deutschlands und Österreichs. Band III: Andrenidae – Eigenverlag Scheuchl, Velden.
- Schönitzer K., Grünwaldt W., Gusenleitner F., Osytshnjuk A.Z., Schuberth J. (1995) Klärung von *Andrena forsterella*, mit Hinweisen zu den anderen Arten der *Andrena labialis*-Gruppe (Hymenoptera, Apoidea, Andrenidae), Linzer Biol. Beitr. 27, 823–850.
- Schwarz M., Gusenleitner F., Westrich P., Dathe H.H. (1996) Katalog der Bienen Österreichs, Deutschlands und der Schweiz (Hymenoptera, Apidae), Entomofauna Supplement 8, 1–398, Ansfelden.
- Stöckert E. (1942) *Andrena proxima* K. und ihr bisher unbekannter "Doppelgänger", *Andrena alutacea* n. sp. (Hym. Apid.), Mitt. Münch. Entomol. Ges. 32, 236–252.
- Strand E. (1913) Apidae aus Pingshiang (Süd-China), gesammelt von Herrn Dr. Kreyenberg, Arch. Naturgesch. A 3, 103–108.
- Warncke K. (1968) Die Untergattungen der westpaläarktischen Bienengattung *Andrena* F., Mem. Est. Mus. Zool. Univ. Coimbra 307, 1–111.
- Westrich P. (1989) Die Wildbienen Baden-Württembergs, Band I u. II – Ulmer Verl., Stuttgart.
- Westrich P., Schmidt K. (1987) Pollenanalyse, ein Hilfsmittel beim Studium des Sammelverhaltens von Wildbienen (Hymenoptera, Apoidea), Apidologie 18, 199–214.