bembiX 33 (2012): 8-18

# Pollen collecting behaviour of the hylaeine bees *Hylaeus (Hylaeteron) douglasi* MICHENER, 1965 and *H. (Hylaeteron) riekianus* HOUSTON, 1981 (Colletidae, Hylaeinae) on *Grevillea*-species (Proteaceae) in Western Australia

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**Zusammenfassung**

Weibchen der Maskenbiene *Hylaeus (Hylaeteron) douglasi* wurden an mehreren Fundorten im Wheatbelt und den Goldfields in Westaustralien ausschließlich auf Blütenständen von zwei *Grevillea*-Arten (Proteaceae) angetroffen. Die Analyse der zahlreichen angefertigten Makroaufnahmen ergab, dass die Biene dort neben der Aufnahme von Nektar sich durch Aufbeißen der noch geschlossenen Tepalen Zugriff zum Pollen verschafft. Die angewandte Technik des Pollenraubes, bei dem die Bienen vermutlich keinen Beitrag zur Bestäubung ihres Wirtes leisten, unterscheidet sich bei den beiden Wirtspflanzenarten entsprechend ihrem etwas unterschiedlichen Blütenbau. Daneben wurde bei *Grevillea petrophiloides*, als „normale“ Technik der Pollenernte, das Ablesen des Pollens von der Spitze des Stempels beobachtet und dokumentiert. Die verwandte Art *H. riekianus* wurde beim zerstörungsfreien Pollensammeln auf *G. petrophiloides* beobachtet und fotografiert.

**Summary**

In the Wheatbelt and Goldfields area of Western Australia females of the Masked bee *Hylaeus (Hylaeteron) douglasi* were encountered exclusively on two species of *Grevillea* (Proteaceae). Scrutiny of the many macro photos taken resulted in the discovery of pollen robbery by this species of bee, which bites open the closed individual flowers to access the pollen, before the tepals split naturally to free the style on top of which the pollen would normally be presented. The opening technique applied by *H. douglasi* is different in both floral host species used, according to the species-specific flower anatomy. Probably the oligolectic bee does not contribute to pollination when applying this technique. However „normal“ pollen harvest from the pollen presenter on top of the style was documented. Non-damaging pollen collecting in the related species *H. riekianus* has been observed and photographed on one of the *Grevillea*-species.

## 1 Western Australian species of the subgenus *Hylaeteron*

MICHENER (1965) named *Hylaeus douglasi* (after a single male WA specimen). He originally included it into the subgenus *Prosopisternon*. In the same paper he defined a new subgenus *Hylaeteron* to encompass three species of *Hylaeus*, one of which has fallen into synonymy of one of the others since then. Later HOUSTON (1981) revised the subgenus *Hylaeteron*. He included *H. douglasi* and named two new species, *H. riekianus* from WA among them. Fig. 1 (© CSIRO 1981) is taken from this ground breaking work. A map published in HOUSTON (1981) shows the distribution of both

WA *Hylaeteron* species as restricted to the southern part of WA, with the smaller *H. riekianus* reaching further inland.

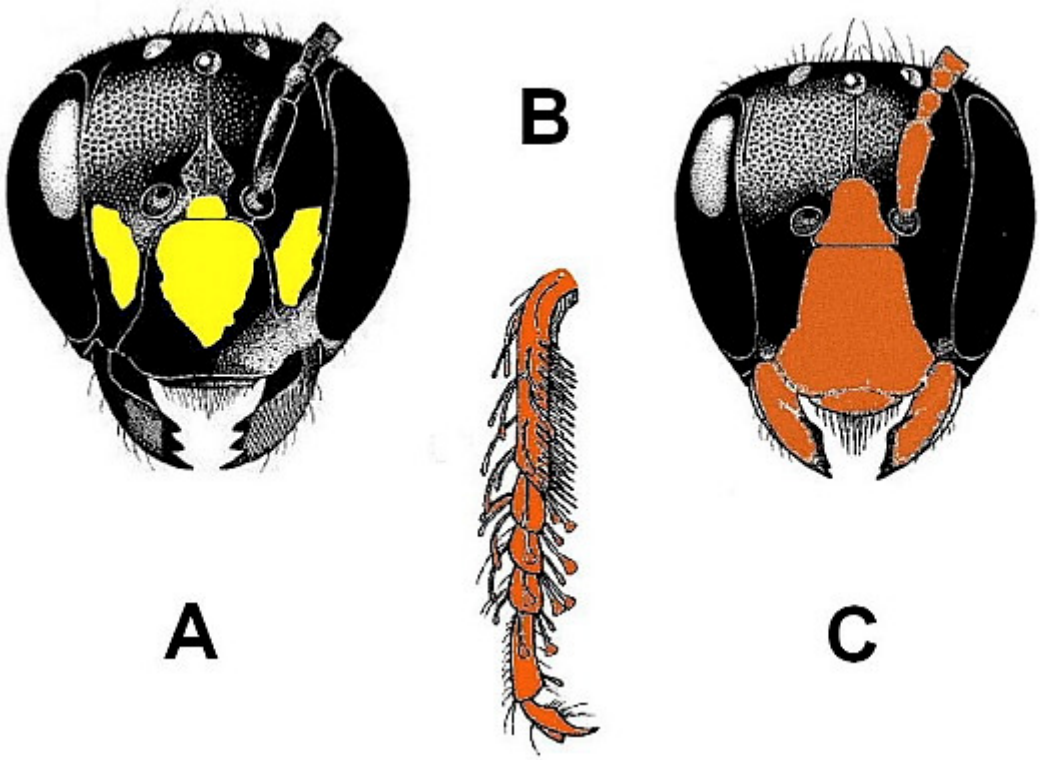


Fig. 1: Face (A) and left fore tarsus (B) of female *Hylaeus (Hylaeteron) douglasi* and face of female *Hylaeus (Hylaeteron) riekianus* (C). Modified (colour) from HOUSTON (1981): © CSIRO 1981.

## 2 Floral anatomy of the hosts: *Grevillea* species

To introduce the reader to the basic facts of *Grevillea* floral anatomy it seems apt to cite a passage from OLDE & MARRIOTT (1994-1995), p. 188: „A look at a typical grevillea conflorescence shows that the peduncle is the stalk of the conflorescence, the floral rachis extends from the peduncle and from this the pedicals connect to the florets. At the base of the floret is the torus or receptacle, a disc-like organ that supports the perianth on ist outer rim, houses the nectary over most of its surface and supports the pistil which emerges on its dorsal side. The perianth is the floral tube made up of two dorsal and two ventral tepals, which terminate at their apex in a ball-like limb (tepals are the equivalent of the petals and sepals of other flowers). Within the perianth is the nectary (the organ which produces the nectar), the ovary that becomes the seed, and the style. The anthers are attached to the inner surface of the tepal limb. At the time of anthesis, i.e. when the style end is released from the limb, the pollen grains are deposited on the pollen presenter. In most species the perianth falls soon after anthesis.“

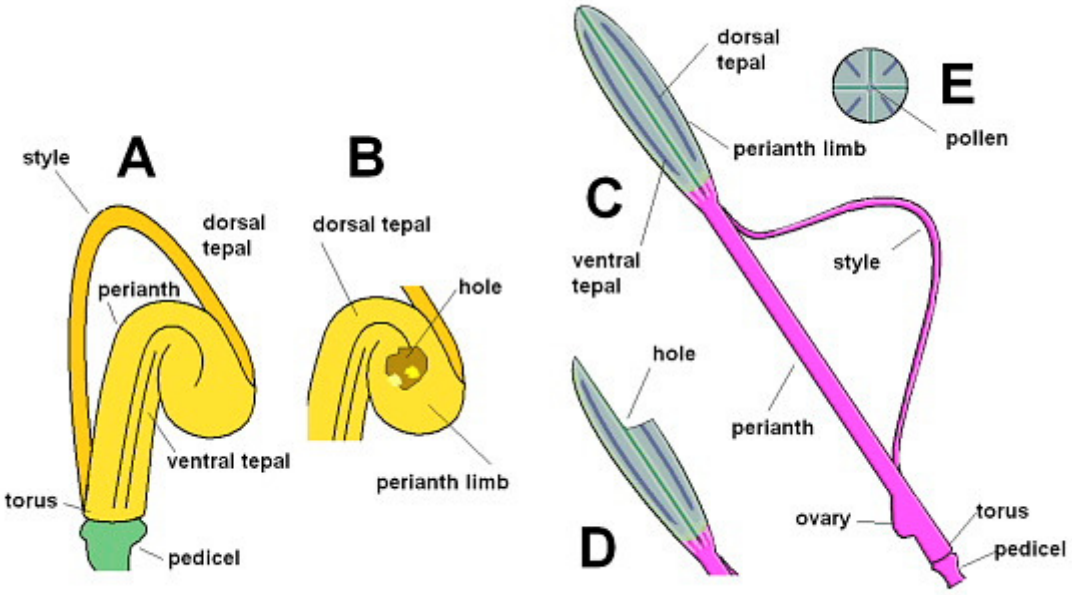


Fig. 2: Flowers of *Grevillea excelsior* (A, B) and *G. petrophiloides* (C, D) in lateral view and perianth limb of the latter species from top (E) showing the minimally parted tepals exposing some pollen. B and D show parts of flowers with holes cut by *Hylaeus (Hylaeteron) douglasi*. Graphics: BJ.

Interestingly anthesis in conflorescences of *Grevillea excelsior* progresses outward (base of conflorescence to apex), while in *G. petrophiloides* anthesis proceeds inward (apex of conflorescence to base). Spent flowers continue to produce nectar, while pollen can only be had from a narrow zone of newly opened flowers, moving outward (*G. excelsior*) or inward (*G. petrophiloides*) within a few days (*G. petropiloides*) or weeks (*G. excelsior*). Semi-diagrammatic views of the flowers of both *Grevillea* species, including the typical damage caused by *Hylaeus (Hylaeteron) douglasi* are shown in Fig. 2.

## 3 Behavioural observations in *H. douglasi* on Orange Flame Grevillea (*Grevillea excelsior*)

The brightly coloured inflorescences of the Orange Flame Grevillea *G. excelsior* are very attractive for a variety of nectarivorous birds (Honeyeaters, Meliphagidae) and insects, mostly bees. Floral relationships of another oligolectic Western Australia species of native bee involving *G. excelsior* have been described and illustrated by JACOBI (2009) in an earlier issue of this journal.

On the recent (private) „GoBeeWA II excursion“ to Western Australia we found *H. douglasi* repeatedly on *G. excelsior*. The bee seemed to represent a regular element of the flower visitor community on this plant species. On at least one occasion several individuals were encountered on one conflorescence (MN, Fig. 3).

Fig. 3: Two female *Hylaeus (Hylaeteron) douglasi* among pre-anthesis flowers at the tip of a conflorescence of *Grevillea exselsior* (Orange Flame Grevillea). Photo: MN.

Fig. 4: Female *Hylaeus (Hylaeteron) douglasi* extracting pollen from a hole cut in the perianth limb of a flower of *Grevillea excelsior* still closed. To the left more cut flowers are visible with some remaining clumbs of pollen. Photo: MN.

The analysis of photos taken by one of us (MN) showed that *H. douglasi* forcibly opens flowers still closed in this host species, too. One photo shows a group of flowers with pollen presenter still hidden, that have been opened laterally by biting a hole into the incurved limb of one of the ventral tepals.

Small amounts of pollen strewn in the following extraction process are visible in the photo. The bee is seen extracting pollen from the last hole by means of its fore tarsi (Fig. 4). We did not see *H. douglasi* removing pollen from the pollen prescenters of already erected styles, even though such pollen was present on a conflorescence were two bees were active on unopened flowers (Fig. 3).

## 4 Behavioural observations in *H. douglasi* on Pink Pokers (*Grevillea petrophiloides*)

In one location a female was observed and photographed by one of use (BJ) removing pollen from the pollen presenter of a fresh post-anthesis flower. The bee was photographed ingesting small clumps of pale pinkish-violet pollen until the pollen presenter was freed of pollen almost completely (Fig. 5). Afterwards, the bee cleaned her body from adhering pollen, which she ingested, too (Fig. 6). Additionally, the tepals with their fused anthers are cleaned of remaining pollen after the pollen presenter has left the perianth limb (MN, Fig. 7).

The newly discoverd specialized pollen robbing behaviour has not been noticed in the field, but only when looking closely at the many photos taken. Among them at least one complete series was found, showing the opening of a still closed *Grevillea petrophiloides* flower by a female *H. douglasi*. Generally the flowers cut open were in the transition zone of a conflorescence in progressing anthesis. The bees concentrates on flowers about to open, which apparently had a pollen already deposited on the spindle like pollen presenter of the style, which was still enclosed by the four tepals with their set of fused anthers. The tepals were chewed open always from top laterally. As a rule two tepal tips were partly severed in the process. The opening having been achieved, one or (alternating) both fore tarsi were inserted to the tibial joint into the narrow cleft between the enclosing tepal-anther complex and the enclosed pollen carrier of the style (BJ, Fig. 8). After retracting the tarsi, pollen grains trapped in the tarsal brush were ingested by the female. The procedure of inserting, - retraction – ingestion was repeated several times apparently until the pollen of the flower had been depleted.

Fig. 5: Female *Hylaeus (Hylaeteron) douglasi* ingesting pollen from the pollen presenter of a post-anthesis flower of *Grevillea petrophiloides* with the help of the fore tarsi, which even a hint of the specialized knobbed setae visible. Photo: BJ.

Fig. 6: Female *Hylaeus (Hylaeteron) douglasi* cleaning itself of pollen after pollen removal from the pollen presenters seen lower right. Some pale violet pollen is still adhering to the face, body and wings of the bee. Photo: BJ.

Fig. 7: Female *Hylaeus (Hylaeteron) douglasi* gleaning remaining pollen from the perianth limb of a *Grevillea petrophiloides* flower after anthesis. The pollen presenters of the erected styles are already cleaned of any pollen. Photo: BJ.

Fig. 8: Female *Hylaeus (Hylaeteron) douglasi* extracting pollen with her fore tarsi from a hole cut into the perianth limb of flower of *Grevillea petrophiloides* prior to anthesis. Above the female another flower cut open is visible, showing the bared pollen presenter. Photo: BJ.

## 5 Behavioural observations in *H. riekianus* on Pink Pokers (*Grevillea petrophiloides*)

To observe details of behaviour in this tiny bee with unaided eyes is even more difficult than in the previous species. The less often encountered females of *H. riekianus*, too, preferred the intermediate zone of the conflorescences, between pre- and post-anthesis flowers (Fig. 9). On some photos the tip of the worked flower is visible, showing the four tepals having parted and minimally diverged apically, forming an minute cross-shaped opening through which the pale violet pollen is visible (Fig. 10). The bee was busy ingesting the pollen directly from there. Utilisation of forelegs in pollen harvest has not been observed clearly in this species but does not seem unlikely, either. Neither has the opening of closed flowers by force of mandibles been seen in this species. May be the mandibles are used to expand the naturally formed opening just a little?

Fig. 9: Female *Hylaeus (Hylaeteron) riekianus* on conflorescence of *Grevillea petrophiloides* in the narrow zone between pre- (right) and post-anthesis flowers (left). Some tepals show damage but this may have been caused by the co-occurring *H. douglasi*. Photo: BJ.

Fig. 10: Female *Hylaeus (Hylaeteron) riekianus* extracting pollen from a pre-anthesis flower of *Grevillea petrophiloides* in the narrow zone of the conflorescence between pre- (left) and post-anthesis flowers (right). Lower in the photo a perianth limb split open marginally is visible exposing a small quantity of pollen. Photo: BJ.

## 6 Discussion

### 6.1 Oligolecty on *Grevillea*

HOUSTON (1981) already stated: „These bees appear to be specialist visitors to flowers of *Hakea* and *Grevillea* (Proteaceae)“ (p. 77). As we did not find *Hylaeteron* of any other flowering plants except *Grevillea*, our observations agree well with the citation above.

### 6.2 Knobbed setae on fore tarsi

When discussed oligolecty among Western Australia bees HOUSTON (2000) suggested, referring to *Hylaeteron* species: „Their knobbed fore tarsal setae may be an adaptation for removal of pollen from flowers of these genera [*Grevillea* and *Hakea*]“ (p. 7). The

knobbed setae on the fore tarsi of *H. douglasi*, as illustrated by HOUSTON (1981) in his revision of several subgenera of *Hylaeus*, form excellent tools the pollen-robbing behaviour described above for this species. Likely the forms of the front tarsal claws, which apparently can be held at right angles to the last tarsal member, aid the extraction of pollen from the intra-floral pollen storage space, too.

### 6.3 Mandibular shape of females

From other female *Hylaeus* depicted in HOUSTON (1981) *H. douglasi* differs in having stout mandibles with three sharp apical teeth (Fig. 1: A). Such mandibles are present in bees regulary destroying plant tissues. Well known example is the stingless bee *Trigona silvestriana* from tropical Meso-America. For sources see ROUBIK (1989), p. 154. Interestingly *H. riekianus* females have differently shaped mandibles with one apical tooth only (Fig. 1: C), suggesting absence of plant-tissue cutting behaviour.

### 6.4 Pollen robbery – a strategy to reduce competiton?

It is assumed that in areas with strong honeybee presence these, together with native bees, remove the rather small amount of pollen presented in the narrow zone of flowers on each progressively opening conflorescence very effectively as soon it becomes available, so that there may be little left for specialist bees like both *Hylaeteron* species herein discussed.

In this situation a method ensuring access to pollen ahead of competitors may greatly reduce the impact of competition. Interestingly, the anatomical adaptation of knobbed setae on the fore tarsi is useful especially in the context of this competition-reducing strategy. As competition can act as a strong selective force, it may have driven the transformation of fore tarsal setae, present in and used for pollen harvest by all Hylaeinae females, to a form increasing effectiveness of pollen removal from flowers with tepals still fused.

A related strategy to reduce honeybee competition has been recently described by NEWMAN & JACOBI (2011) for two other hylaeine bees from southern Queensland. In this case no apparent anatomical adaptation was found. So this purely behavioural adaptation may be a more short term response to the presence of honeybees, while anatomical adaptations, like specialized setae probably predate the honeybee importation to Australia, which only happened around 200 years ago.

## 7 Acknowledgements

Special thanks go to CSIRO and CSIRO Publishing, specifically to Carla Flores, for granting us a permit to use three illustrations from the *Hylaeus* revision by HOUSTON (1981), Ken Walker (Museum Victoria) for building up the great online resource of Australian pollinators on the PaDIL website (WALKER 2010), which helped in identifying *H. douglasi*, and to our travelling companions Linda Rogan (Victoria) and Paul Zborowski (Kuranda) on the 2nd GoBeeWA excursion Oct./Nov. 2011. Jean and Fred Hort amiably showed us round near Perth and kindly hosted us at the end of the trip. Thank you!

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