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Pseudo-oligolecty in *Colletes hederæ* (Apidae-Colletinae, Hymenoptera) *

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Abstract: *Colletes hederæ* SCHMIDT & WESTRICH, 1993 females collect pollen from a number of different plant families at the beginning of the activity period (own observations and literature). Later, when *Hedera helix* is fully in bloom, it was believed for a long time, that the bee restricts its gathering to *Hedera*. However, at the peak of *Hedera* anthesis, *C. hederæ* favours flowers of *Rhus chinensis* (Anacardiaceae) and *Fallopia japonica* (Polygonaceae), and others. Thus *C. hederæ* is clearly polylectic with a binding to *Hedera* only caused due to environmental factors, i.e. the lack or insufficient presence of other attractive nectar and pollen sources. For this behaviour the term pseudo-oligolecty is proposed.

Key words: Hymenoptera, Apidae, *Colletes hederæ*, Colletidae, pollen collection, pollen transport, propodeum-corbiculae, monolecty, oligolecty, polylecty, pseudo-oligolecty

Introduction

Colletes hederæ SCHMIDT & WESTRICH, 1993 was observed for the first time in Styria in 2008 (TEPPNER & al. 2009). Since then, the species was observed regularly every year. So some additions can be given, especially information about the range of visited flowers.

U. BROSCHE contributed the analyses of pollen loads whereas the first author is responsible for the other parts of the paper.

Material and methods

Additionally to the voucher specimens mentioned in TEPPNER & al. (2009) 21 specimens from Graz and one from Vienna are deposited in the first author's collection.

Pollen for analyses of pollen loads was taken from specimens in the collection or from live bees after cooling. The pollen was prepared in glycerine gelatine, stained with

* The paper is dedicated to my (H.T.) teacher and later colleague Univ.-Prof. Dr. Irmtraud THALER on the occasion of her 90th birthday. She was a professor of plant anatomy at the University of Graz. For biography and bibliography see p. 736-740 in KEINTZEL B. & I. KOROTIN (ed.), Wissenschaftlerinnen in und aus Österreich. Leben — Werk — Wirken. — Böhlau Verlag Wien, Köln, Weimar, 2002.

safranine, and investigated using a Zeiss Axioskop. Per sample 200 (one sample only) – 4,000 grains were counted. Species with five grains or less per 1000 were omitted.

Results and discussion

In 2012 a gardener (F. STIEBER) discovered a nesting site with c. 60 nests within the Botanic Garden in Graz (the second site known in Graz). The number of females in the garden is so high that we suppose the existence of other nesting sites in the surroundings. If the weather permits, the activity period of *C. hederæ* lasts up to the last days of October, otherwise at least up to the end of September.

Pollen is actively collected: the fore legs brush the open anthers (distinctly to see in the video at BWARS 2014). For transport into the cells, pollen is carried not only in the corbicula on trochanter and femur and in the scopa on tibia and metatarsus of the hind leg (SEM-Figures in TEPPNER et al. 2009), but also in the corbiculae on the posterior sides of the propodeum (Fig. 2) and in the small scopae on the sternites one (hairs plumose) and two (hairs dentate-pectinate) (Fig. 1).

From the observations in the Botanic Garden one can conclude that *C. hederæ* is primarily polylectic (the terms are used in the usual sense, following e.g., LINSLEY & MACSWAIN 1957: 224-225, MICHENER 2000: 15-17, MÜLLER & KUHLMANN 2008, WESTRICH & SCHMIDT 1987: 199-200, 210, WESTRICH 1989: 283-288). In the Botanic Garden Graz from mid-August up to the beginning of the anthesis of *Hedera helix* a wide spectrum of easily accessible nectar (and potential pollen) sources from very different plant families is visited by males and females. These are *Pycnanthemum pilosum*, *Mentha spicata* group (both Lamiaceae), *Patrinia scabiosifolia* (Valerianaceae), *Eryngium planum*, *E. wrightii* (Apiaceae), *Potentilla fruticosa* (Rosaceae), *Clematis* sp. similar to *C. vitalba* (Ranunculaceae), *Eriogonum allenii* (Polygonaceae), *Limonium vulgare* s.l. (Plumbaginaceae) or very different tribes of Asteraceae [*Leontodon hispidus*, *Hieracium sabaudum* (both Cichorieae), *Anaphalis margaritacea* (Gnaphalieae), *Solidago caesia*, *S. canadensis* (Astereae), *Helenium autumnale* (Helenieae)]. Apparently Cynareae (= Cardueae) are not visited, according to our own investigations, neither are visits reported in the literature (but well documented in *C. succinctus*: MÜLLER & KUHLMANN 2008: 722). Anthemideae may lack because most of them do not flower so late (easily remontant species excepted, as for e.g. in *Tanacetum parthenium*, *T. vulgare*, and *Achillea millefolium* s.l.). In a female on *Hieracium sabaudum* an incomplete (26.8.2010) pollen load and on *Solidago canadensis* (24.9.2013) a full one was seen.

From an extensive analysis of pollen loads WESTRICH (2008) has proven that at the beginning of the activity period *C. hederæ* females collect large amounts of pollen of Asteraceae, Fabaceae (*Medicago*, *Melilotus*, *Trifolium*) and *Colchicum autumnale* (Colchicaceae). In the pollen loads investigated by MÜLLER & KUHLMANN (2008) furthermore *Odontites* (Orobanchaceae, former Scrophulariaceae) and *Calluna vulgaris* (Ericaceae) were observed.

Hedera helix is by far the easiest accessible and richest source for nectar and pollen. As soon as the anthesis in *Hedera* begins (end of August or beginning of September) and progresses ahead, the bees switch to these flowers, which are then usually the only optimal resource at this time.



Fig. 1: *Colletes hederæ* ♀ captured at the nest entrance with pollen load on hind legs and on the sterna 1 and 2. Botanic Garden Graz, September 3, 2014. Phot. H. TEPPNER.

Fig. 2: *Colletes hederæ* ♀ collecting and with pollen load on *Rhus chinensis* ♂. Botanic Garden Graz, September 8, 2014. Phot. H. TEPPNER. — The arrow points to the corbicula on the propodeum.

Fig. 3: *Colletes hederæ* ♂ drinking nectar on *Fallopia japonica* ♂. Vienna, September 19, 2013. Phot. H. TEPPNER.

In the Botanic Garden in Graz *Rhus chinensis* (Anacardiaceae, a male individual), which blooms approximately during the first two thirds of September at the same time as *Hedera*, is apparently a lot more attractive than *Hedera*. On a treelet of c. 5 × 3 m (with many large inflorescences) in 2013, alone at eye level approximately five to ten females of *C. hederæ* (Fig. 2) and some males were present simultaneously over the whole day. This is a much higher density of individuals than on the closest *Hedera* shrubs (distance 8 m) at the same time. In 2014 the visitation rate on *Rhus* varied from approximately equal to higher than observed for *Hedera*. The female tree of *Rhus chinensis* blooms c. one week later than the male one and it is by its nectar production for insects as attractive as the male tree. *C. hederæ* ♀♀ with and without pollen loads collect nectar and ♂♂ patrol and sporadically drink nectar.

Tab. 1: Pollen types in pollen loads of *Colletes hederæ* from the Botanic Garden in Graz

Date	Captured on	<i>Hedera helix</i>	<i>Rhus chinensis</i>	Asteraceae
03.9.2014	nest entrance	99.8 %	–	0.2 %
09.9.2014	<i>Rhus chinensis</i> ♂	25.0 %	75.0 %	–
09.9.2014	<i>Hedera helix</i>	100.0 %	–	–
14.9.2013	<i>Rhus chinensis</i> ♂	2.5 %	97.5 %	–
23.9.2013	<i>Rhus chinensis</i> ♂	1.5 %	98.5 %	–
29.9.2014	nest entrance	100.0 %	–	–

In Vienna, at "An der Oberen Alten Donau" on September 19, 2013, in a male stand of *Fallopia japonica* (Polygonaceae) many females and fewer males (Fig. 3) of *C. hederæ* were observed, whereas on the neighbouring *Hedera* (in full bloom) not a single individual was seen. In Graz, at least in the observation area, female *F. japonica* strongly dominates, on which *C. hederæ* never was observed, in spite of its high acceptance by *Apis mellifera*. On the only one male stand seen till now in 2014 bee visits were scarce, even of *Apis mellifera*, and no *C. hederæ* was observed. On September 24, 2013, as well as on September 20 and October 12, 2014 in Graz, spot-checks at the base of a gigantic *Fallopia baldschuanica* (hermaphroditic) (Polygonaceae) revealed one female each, collecting for a long time, most probably also taking pollen (concluded from the manner of movements and from the colour of the initial of the pollen load). — All parallel to the bloom of *Hedera*! *Fallopia baldschuanica* s.l. seems to be an important food source (besides *Hedera*) for bees gathering late.

Plants used at the beginning of the activity period can also be visited during the anthesis of *Hedera* (see *Solidago* above), but this generally goes down because of the abundance of *Hedera* flowers.

The results of the few own investigations of pollen loads are summarized in Table 1. The counts prove that the pollen of *Rhus* is indeed gathered in large amounts in spite of the anthesis of *Hedera*. Mixed loads show that on one and the same collecting trip, beside of *Hedera*, other plants can be visited. The sample from September 3, with the high percentage of *Hedera* pollen is remarkable, because at that time very few flowers of *Hedera* were in anthesis in the Bot. Garden (at least in the lower 2-3 m of the shrubs).

Thus, the restriction to *Hedera* is apparently not an adaptation of the bee and not obligatory but is obligated because of the lack or insufficient presence of other attractive nectar and pollen sources in the late season. If another attractive and optimal source is

available, it is preferred and *C. hederæ* neglects *Hedera*. The new term pseudo-oligolecty appears to be appropriate for this facultative, temporarily oligolectic behaviour of a polylectic bee. It permits the distinction from an obligatory, genetically fixed oligolecty. Why *Rhus* and *Fallopia* can be more attractive than *Hedera* remains to be investigated, but this is beyond our possibilities. According to the results of MÜLLER & KUHLMANN (2008: 722, 727) it cannot be excluded that *C. succinctus* could also be pseudo-oligolectic.

The term monolecty is avoided here because instead of expressing a character of the bee it is rather the result of plant phylogeny when only one species of a genus (*Calluna*) or at least one species over a large area (*Hedera*) survived.

Oligolecty, pseudo-oligolecty and monolecty should not be confused with flower constancy, i.e. the "voluntary" preference of one flower type by an individual bee on one or more collecting trips if more than one suited pollen source is available (e.g. WESTRICH 1989: 288-290, GEGEAR 2005).

The assignment of *C. hederæ* as a pseudo-oligolectic species fits well with the general picture of the genus *Colletes*, which contains oligo- and polylectic species (MÜLLER & KUHLMANN 2008) and the today predominant opinion that oligolecty is usually basal and polylecty mostly a derived condition (e.g. MICHENER 2000: 18, MÜLLER 1996). According to KUHLMANN & al. (2007) *C. hederæ* and its relatives "have diverged very recently".

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Zusammenfassung

Weibchen von *Colletes hederæ* SCHMIDT & WESTRICH, 1993 sammeln Pollen am Beginn ihrer Aktivitätsperiode von einer Anzahl verschiedener Pflanzenfamilien (eigene Beobachtungen und Literatur). Später, wenn sich *Hedera* voll in Blüte befindet, meinte man lange, dass diese Biene auf *Hedera* beschränkt sei. Aber gerade zum Höhepunkt der *Hedera*-Blüte verlässt *C. hederæ* diese zugunsten der Blüten von *Rhus chinensis* (Anacardiaceae) und *Fallopia japonica* (Polygonaceae), sowie einiger anderer. Daher ist *C. hederæ* klar polylektisch und die Bindung an *Hedera* ist durch Umweltfaktoren aufgezwungen (durch das Fehlen oder unzureichende Vorhandensein anderer, attraktiver Nektar- und Pollenquellen). Für dieses Verhalten wird der Terminus Pseudo-Oligolectie vorgeschlagen.

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