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The bees (Apidae, Hymenoptera) of the Botanic Garden in Graz, an annotated list

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With 65 Figures
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Summary: During studies in floral ecology 151 bee (Apidae) species from 25 genera were recorded in the Botanic Garden of the Karl-Franzens-Universität Graz since 1981. The garden covers an area of c. 3.6 ha (buildings included). The voucher specimens are listed by date, gender and plant species visited. For a part of the bee species additional notes are presented. The most elaborated notes concern *Hylaeus styriacus*, three species of *Andrena* subg. *Taeniandrena* (opening of floral buds for pollen harvest, slicing calyx or corolla for reaching nectar), *Andrena rufula*, *Andrena susterai*, *Megachile nigriventris* on *Glaucium*, behaviour of *Megachile willughbiella*, *Eucera nigrescens* (collecting on *Symphytum officinale*), *Xylocopa violacea* (vibratory pollen collection, *Xylocopa*-blossoms, nectar robbing), *Bombus haematurus*, *Nomada trapeziformis*, behaviour of *Lasioglossum* females, honeydew and bumblebees as well as the flowers of *Viscum*, *Forsythia* and *Lysimachia*. *Andrena gelriae* and *Lasioglossum setulosum* are first records for Styria. This inventory is put in a broader context by the addition of publications with enumerations of bees for 23 other botanic gardens of Central Europe, of which few are briefly discussed. An index of plant names permits to find the bees observed on one and the same plant species.

Zusammenfassung: Die Bienen (Apidae, Hymenoptera) des Botanischen Gartens in Graz, eine Liste mit Anmerkungen. Im Zuge blütenökologischer Studien wurden im Botanischen Garten der Karl-Franzens-Universität Graz 151 Bienenarten (Apidae) aus 25 Gattungen nachgewiesen. Die Fläche des Gartens beträgt ca. 3,6 ha (Gebäude eingeschlossen). Die Belegtiere sind mit Datum, Geschlecht und besuchter Pflanzenart gelistet. Für einen Teil der Bienen werden zusätzliche Notizen gebracht. Die ausführlichsten Anmerkungen betreffen *Hylaeus styriacus*, drei Arten von *Andrena* subg. *Taeniandrena* (Öffnen von Blütenknospen zur Pollenernte, Schlitzen von Kelch oder Krone um Nektar zu erreichen), *Andrena rufula*, *Andrena susterai*, *Megachile nigriventris* auf *Glaucium*, Verhalten von *M. willughbiella*, *Eucera nigrescens* (Sammeln an *Symphytum officinale*), *Xylocopa violacea* (Vibrationssammeln, Holzbienen-Blumen, Nektarraub), *Nomada trapeziformis*, *Bombus haematurus*, Verhalten von *Lasioglossum*-Weibchen, Honigtau und Hummeln ebenso wie die Blüten von *Viscum*, *Forsythia* und *Lysimachia*. *Andrena gelriae* und *Lasioglossum setulosum* sind Neufunde für die Steiermark. Schließlich sind Publikationen mit Bienen-Listen für 23 andere mitteleuropäische botanische Gärten angeführt und einige davon kurz diskutiert. Ein Index der Pflanzennamen erlaubt es, die Bienen, die an ein und derselben Pflanzenart beobachtet wurden, zu ermitteln.

Key words: Apidae, Apoidea, Hymenoptera, Botanic Gardens, Graz, Styria, Austria.

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1. Introduction

Universitary teaching in flower morphology without discussion of the most important pollinators – the bees – was not satisfactory for the first author. So, in January1981 a section “Melittophily” originated as part of the lecture “selected chapters of systematics, morphology and biology of seed plants”. With the help of the coauthors in determination of the specimens, knowledge of bees increased and consequently, since 1990 “Melittophily – Bees and Flowers” was given as its own lecture. For all these purposes, observations on floral ecology were made in the Botanic Garden of Graz and in other parts of the city, as far as it was possible beside the other obligations. A complete faunistic inventory was not the primary intention.

For a new, well presented approach to the phylogeny of the bees up to tribus and genera on the base of DNA studies see Danforth & al. 2013 (Melittidae basal, Colletidae derived). As standard works for Central European bees Westrich 1989 and Scheuchl & Willner 2016 can be used and the booklet of Amiet & Krebs 2012 as an introduction. Many informations and photos can be found at, e.g., <http://www.wildbienen.de/>.

We are familiar with the fact that this paper is a severe sin against increasing of our bibliometric values because many “least publishable units” are included in one paper. But we would like to serve the subject and not the increase for our bibliometric factors (see for e.g., Teppner 2014 and Mattern 2007). The choice of the journal was also influenced by the subject and not by the expected citations.

2. Material and Methods

All bees (Apidae) were caught by hand by using a small plastic tube so that in all cases the visited flower species is known. Especially, it was attempted to collect bees after having taken photos to ensure correct determinations. The mention of a plant name indicates that a bee has collected nectar and / or pollen for their brood or was drinking nectar and / or eating pollen for their own needs – if not otherwise indicated.

Apidae s.l. were collected, from 1981 on, mainly during the observations in floral ecology. It was intended to capture as few bees as possible. Thus, the indication of only one or few specimens in the sections 4–9 may have three reasons: 1) rarity, 2) species not in focus of the observations on floral ecology, and 3) species easy to recognize with the naked eye by morphology and / or behavior. Also dead bees were collected as faunistic vouchers, especially in *Bombus*. All vouchers are located in the collection of the first author. It is intended to incorporate this collection in future into the collection of the Biologiezentrum in Linz.

In some notes (No. 51, 69, 81, 82, 91, 94, 124, 147, 150 and 151) experience from other sites whithin Graz is also included.

Nomenclature of bees follows strictly Gusenleitner & al. 2012, thus the indication of taxonomical authors could be omitted. We do not deviate from the cited work, even when one of the authors would prefer another solution, especially in the case of the higher categories (for these see e.g. Danforth & al. 2013) and when in single cases opinions about valid names changed. Plant names are – as far as possible – in accordance with Fischer & al. 2008 or Ehrhardt & al. 2000.

The photos were taken by the first author (Fig. 29 excepted) by using an Exakta VX 1000 with a Steinheil Macro-Quinon objective and, since 2010, a Panasonic DMC-GH1 with a Leica DG Macro-Elmarit objective.

The first author is responsible for the observations, collection of vouchers, formulation of the main text and the comments concerning floral ecology. The coauthors contributed the determinations or revisions of bees (A. Ebmer: Halictidae, F. Gusenleitner: *Andrena*, M. Schwarz: other bees) and FG and MS the faunistic comments sub No. 9, 45, 48, and 135. The *Hylaeus* species collected in 2006 were determined by H. H. Dathe (Eberswalde) and since 2005 J. Neumayer (Elixhausen, Salzburg) determined the bumblebees. *Colletes* from 2013 was revised by M. Kuhlmann (London), Megachilidae from 2014 by C. Praz (Neuchâtel).

3. The Botanic Garden

After many efforts of Prof. Hubert Leitgeb, the ministery of the government in Vienna bought in 1874 a piece of land (a field for sugar-beets of the company Reininghaus) in the E of the city to found a botanic garden for the University of Graz. 128 years before present, 1888/89 the greenhouse was built and the garden was realized after the idea of Leitgeb by its successor Gottlieb Haberlandt. As much as possible the plants from the forerunner-garden at the Joanneum (donation of Erzherzog Johann and the government of Styria) were used (Teppner 1997, Ster & Brosch 2011).

Primarily, the garden covered an area of c. 1.98 ha (19,754 m^2) and lies at about 365 m above sea level. The intended extension was left undone. In 1913 1,211 m^2 were bought for the construction of the institute for systematic botany. Since 1936 an area of 1,278 m^2 is rented and is used as nursery. The gain of 63 m^2 in 1976 permitted a junction of the nursery with the garden. As late as 1985 and 1991 it was possible to save two pieces (1,349 m^2 and 5,600 m^2, respectively) for the garden. Since 1994 another area of 1,688 m^2 with meadows and an orchard is rented, as well as a small piece of 230 m^2 along the street since 1986. So, the total area comprises today c. 3.6 ha (30,568 m^2), from which c. 0.55 ha (5,479 m^2) are covered by buildings (after: Digitaler Atlas Steiermark. Kataster). For the garden see also Teppner & al. 2015: 88–105.

Since the begin, the largest area within the garden hosts the arboretum with meadows as understory, followed by the rock garden (featuring mainly more or less alpine and montane plants from Eurasia and America). Other grounds are the division for medical plants and, in the manner of a rock garden, hardy Cacti and other desert plants as well as Mediterranean plants. On the newly acquired areas, larger meadows in their near natural state exist.

Taken together, the garden hosts in spite of the small area a high diversity of habitats, enriched by the relief in the rock gardens, by embankments, paths and their verges and garden frames (permanently open below sash at two or three sides).

Most important for bees is the high plant species diversity, i.e., in the open the species number is estimated to reach 3,500 (Berg & al. 2011: 9, Anonymous 2014) and many of the species of the plant cover remained constant over decennia.

It should be emphasized that the garden is embedded in a surrounding of residential areas with a lot of gardens and parks (also with a high diversity of habitats and plants), which connect the garden with the natural or cultivated landscape at the periphery of the city.

4. Colletinae

4.1. *Hylaeus*

Distribution of 18 *Hylaeus* species in Styria: Hausl-Hofstätter 2004.

1. *Hylaeus communis*

6.6.1981, ♀, *Campanula latifolia* (2 ×). – 24.8.1990, 25.8.1990 (2 ×), ♀, *Allium ochroleucum*. – 28.8.1997, ♀, *Campsis radicans*. – 29.7.2005, ♂, *Eryngium planum* (3 ×). – 23.9.2009, ♀, *Hedera helix*. – 13.10.2014, ♀, *Hedera helix*. – 6.7.2015, ♀, *Michauxia tchihatchewii*. – 18.8.2015, ♀, *Solidago canadensis*. – 16.8.2016, ♂, *Isodon japonicus*

During pollen thieving in a flower of *Rosa* 'Gloria Dei' a female harvested directly from the anthers by vibratory pollen collection.

2. *Hylaeus dilatatus* (*H. annularis*)

23.5.2011, ♀, *Ferulago sylvatica*. – 24.6.2016, ♀, *Opopanax hispidus*

3. *Hylaeus duckei*

14.7.2010, ♀, *Eryngium planum*

4. *Hylaeus gibbus*

12.8.1993, ♀, *Solanum peruvianum* × *corneliomulleri*

On the anther tube of *Solanum lycopersicum* vibratory pollen collection occurs, see Teppner 1993: 207–208, Fig. 12, 13, 30–32 and 2005: 221, Fig. 1–2.

5. *Hylaeus hyalinatus*

24.8.1990, ♀, *Mentha spicata*. – 6.9.1991, ♀, *Mentha spicata*, drinking nectar. – 29.5.1993, ♀, *Angelica archangelica*. – 26.7.2006, ♀, *Origanum vulgare*. – 14.7.2010, ♀, *Eryngium planum*. – 5.7.2014, ♂, *Helichrysum italicum*. – 30.7.2016, ♀, ♂, *Seseli gummiferum*

6. *Hylaeus nigritus*

8.7.1989, ♀, *Achillea millefolium*. – 19.6.1990, ♀, *Stemmacantha pulchra*. – 15.7.2006, ♂, *Mentha longifolia*. – 5.7.2014, ♀, *Helichrysum italicum*. – 7.7.2014, ♀, *Santolina chamaecyparissus*. – 4.8.2016, ♀ (2×), *Centaurea nigra*. – Fig. 1

7. *Hylaeus punctatus*

26.7.2006, ♀, *Origanum vulgare*. – 8.9.2014, ♀, *Rhus chinensis*-♂

8. *Hylaeus signatus*

11.7.1984, ♀ (2 ×), ♂, *Reseda luteola*

9. *Hylaeus styriacus*

30.7.2016, ♀, *Seseli gummiferum*

This species is known from all Austrian provinces, Switzerland, as well as from Germany. Dathe 1980 indicated the following distribution: France, Central and Eastern Europe and the Ukraine. Regarding flower visitation Stoeckhert 1933 mentioned especially *Apiaceae* and *Allium cepa*. Pittioni treated *H. styriacus* in his unpublished paper „Die Bienen des Wiener Beckens und des Neusiedlersee-Gebie-

Fig. 1: *Hylaeus nigritus*, female, harvesting pollen on *Centaurea nigra*. Gripping the anther tube or touching the filaments lead to the extrusion of a small amount of pollen on the tip of the tube.

Fig. 2: *Colletes daviesanus*, female, collecting pollen and nectar from *Santolina chamaecyparissus*.

tes" and writes: „Sicherlich ist die Art nicht nur weiter verbreitet, sondern auch in unserem Gebiet nicht so vereinzelt wie aus den bisher bekannten Fundorten hervorzugehen scheint, sondern sie ist nur infolge ihrer Kleinheit an vielen Orten bisher übersehen worden" [This species is surely more widely distributed, however because of ist small size often overlooked]. Regarding flower visits, referring literature, he mentioned *Apiaceae*, *Allium cepa*, *Achillea millefolium*, and *Reseda* sp.

4.2. *Colletes*

10. *Colletes daviesanus*

7.7.1989, ♀, ♂, *Achillea millefolium*. – 28.8.1990, ♀, *Tanacetum vulgare* (2 ×). – 29.5.1993, ♂, *Matricaria chamomilla*. – 3.7.2014, ♀ (2 ×), ♂, *Helichrysum italicum*. – 5.7.2014, ♂, *Helichrysum italicum*. – 7.7.2014, ♀, *Santolina chamaecyparissus*

Abundant mainly on *Asteraceae-Anthemideae* (Fig. 2).

11. *Colletes hederae*

21.9.2009, 22.9.2009, ♀, *Hedera helix*. – 23.9.2009, ♂, *Hedera helix*. – 7.10.2009, ♀, *Hedera helix*. – 9.9.2010, ♀, *Hedera helix*. – 21.8.2010, ♂, *Eryngium planum*. – 26.8.2010, ♀, ♂, *Hieracium sabaudum*. – 26.8.2010, ♂, *Solidago canadensis*. – 9.9.2010, ♀, *Hedera helix*. – 19.8.2011, ♀, *Potentilla fruticosa*. – 20.8.2011, ♂, *Clematis* sp. (2 ×). – 3.9.2012, ♂, nesting site. – 17.8.2013, ♀, ♂, *Patrinia scabiosifolia*. – 20.8.2013, ♂, *Solidago caesia*. – 21.8.2013, ♀, *Potentilla fruticosa*. – 14.9.2013, ♀, *Rhus chinensis*-♂. – 23.9.2013, ♀, *Rhus chinensis*-♂. – 3.9.2014, ♀, nesting site. – 16.9.2014, ♂, *Rhus chinensis*-♂. – 11.10.2014, ♀, *Hedera helix*. – 18.8.2015, ♂ (3×), *Soliadago canadensis*. – 16.8.2016, ♂, *Isodon japonicus*

First observations in Styria, morphology, nectar- and pollen-gathering are described in Teppner & al. 2009. Studies of the last years lead to the opinion that *C. hederae* is pseudo-oligolectic, i.e., that the species is polylectic and usually driven only by environmental factors (lack or insufficient presence of other food sources) to focus on *Hedera* (Teppner & Brosch 2015).

12. *Colletes similis*
29.7.2005, ♀, *Eryngium planum*. – 8.8.2015, ♀, ♂, *Tanacetum vulgare*

5. Andreninae

5.1. *Andrena*

13. *Andrena agilissima*
3.6.1991, ♀, *Brassica rapa*
In large parts of Styria very rare, more abundant in the adjacent Burgenland.

14. *Andrena apicata*
13.3.1990, ♀, *Salix purpurea*-♂

15. *Andrena bicolor*
23.2.1990, ♂, patroling. – 26.2.1990, ♀, *Eranthis hyemalis*. – 26.2.1990, ♂, *Erica carnea*. – 31.3.1990, ♀, *Taraxacum officinale* s.l. – 4.5.1990, ♀, *Ornithogalum* "*umbellatum*" and *Geum sudeticum*. – 30.6.1990, ♀, *Campanula medium*. – 28.2.1992, 14.3.1992, ♂, patroling between spring flowers. – 30.6.1992, ♂, *Bryonia dioica*-♀. – 19.3.1993, ♂, *Scilla bifolia* s.l. – 16.4.1993, ♀, *Coluria geoides*, gathering pollen. – 26.2.1994, ♀, *Crocus exiguus*. – 26.2.1994, ♂, patroling. – 29.6.1999, ♂, *Mentha spicata* s.l. – 30.5.2014, ♀, *Geranium* cv.

16. *Andrena carantonica*
8.5.1993, ♀, *Prunus virginiana*, collecting nectar and pollen. – 13.5.1993, ♀, *Spiraea ulmifolia*. – 21.5.1993, ♂, *Spiraea ulmifolia*. – 30.4.1994, ♀, *Prunus virginiana*. – 16.51997, ♀, *Rosa* sp. – 17.5.1997, ♀, *Rosa* sp. (2 ×)

17. *Andrena chrysosceles*
2.4.1990, ♀, *Ribes fasciculatum*. – 7.5.1990, ♀, *Isatis tinctoria*. – 15.5.1990, ♀, *Isatis tinctoria*. – 6.5.1992, ♂, patroling around *Genista radiata*. – 22.5.1993, ♀, *Viburnum trilobum*. – 30.4.1994, ♀, *Alyssum orientale*. – 2.5.1994, ♂, patroling around *Genista radiata*. – 22.5.1996, ♀, *Euphorbia* "*villosa*". – 16.9.2014, ♂, *Rhus chinensis*-♂

18. *Andrena clarkella*
21.2.1990, ♂, *Galanthus nivalis*. – 3.4.1992, ♀, *Salix repens*-♂, gathering pollen. – 3.3.1999, ♀, *Galanthus nivalis*

19. *Andrena congruens*
16.7.1981, ♂, *Mentha longifolia* (2 ×). – 18.5.1990, ♀, *Angelica archangelica*. – 14.7.2010, ♀, *Eryngium planum*. – 8.7.2014, ♂, *Helichrysum italicum*

20. *Andrena dorsata*
11.4.1992, ♂, *Oemleria cerasiformis*. – 31.7.1992, ♀, *Brassica juncea* 'Cai-cai-tai'. – 21.5.1993, ♀, *Spiraea ulmifolia* (4 ×). – 2.5.1995, ♂, *Alyssum orientale*. – 16.5.1997, ♀, *Rosa* sp. – 17.7.2009, ♀, *Eryngium planum* and *Astrantia major*. – 30.7.2016, ♀, *Seseli gummiferum*

Fig. 3: *Andrena flavipes* ♀, collecting pollen on *Meconopsis cambrica* became a prey of a crabspider.

21. *Andrena flavipes*

14.5.1993, ♀, *Brassica napus* 'Ragged Jack Kale'. – 10.3.1994, ♂, *Helleborus niger*. – 4.5.1994, ♀, *Valerianella locusta*. – 4.5.1994, ♂, *Myosotis sylvatica*. – 17.5.1997, ♀, *Rosa* sp. – 21.5.2004, ♀, *Petteria ramentacea*. – 14.7.2010, ♀, *Eryngium planum*. – 13.7.2013, ♀, *Astrantia major*. – 24.5.2014, ♀, *Meconopsis cambrica* (prey of a crabspider). – 7.7.2014, ♀, *Santolina chamaecyparissus*. – Fig. 3

22. *Adrena florea*

Since we grow *Bryonia alba* (1981), and *B. dioica* (1990), now also established in hedges of adjacent gardens, *A. florea* is not rare (♀, ♂).

23. *Andrena fulva*

8.3.1990, ♂, *Salix caprea*-♂. – 12.3.1990, ♀, *Salix purpurea*-♂. – 15.3.1990, ♂, *Eranthis hyemalis*. – 31.3.1990, ♂, *Ribes fasciculatum*, patroling (2 ×). – 11.4.1992, ♀, *Ribes fasciculatum*. – 2.4.1993, ♀, found dead inside the house. – 28.3.1994, ♀, found dead on a window sill. – 29.3.1994, ♀, found dead on a trail. – 4.4.2005, ♂, found dead on a window sill

On many spring flowers and an excellent pollinator of *Ribes* species cultivated for fruit. For *Forsythia* see sub *Andrena tibialis*, for *Viscum* sub *Andrena helvola*. Nests single or in small groups, mainly on verges in the arboretum.

24. *Andrena fulvata*

21.5.2004, ♀, *Laburnum anagyroides*. – 5.5.2012, ♀, *Meconopsis cambrica*

25. *Andrena gelriae*

14.5.2004, ♀, *Petteria ramentacea*, presses down the wing-keel complex and harvests pollen from the anthers

First record for Styria.

26. *Andrena gravida*

7.5.1990, ♀, *Alyssum wulfenianum.* – 20.4.2012, ♀, *Lunaria annua.* – 28.3.2015, ♀, sun-bathing

27. *Andrena haemorrhoa*

13.3.1990, ♂, *Eranthis hyemalis.* – 14.3.1990, ♂, patroling between *Eranthis* flowers. – 17.3.1990, ♂, *Scilla bifolia* s.l. – 22.3.1990, ♂, *Salix repens*-♂. – 31.3.1990, ♂, *Taraxacum officinale* s.l. – 12.4.1990, ♀, *Taraxacum officinale* s.l. – 11.5.1990, ♀, *Isatis tinctoria.* – 16.5.1990, ♀, *Isatis tinctoria.* – 21.3.1991, ♀, *Crocus versicolor*, sucking nectar. – 25.3.1991, ♂, *Salix purpurea*-♂. – 3.4.19992, ♂, *Salix repens*, sucking nectar. – 11.4.1992, ♂, patroling around *Oemleria.* – 19.3.1993, ♂, patroling in numbers near *Salix caprea*-♂. – 17.5.1993, 20.5.1993, ♀, *Spiraea ulmifolia.* – 19.3.1994, ♂, patroling. – 17.5.1997, ♀ *Rosa* sp. – 25.9.2009, ♀, *Hedera helix.* – 15.6.2013, ♀, *Aruncus dioicus*-♂. – 23.9.2013, ♀, *Rhus chinensis*-♂. – 1.4.2014, ♀, on a *Forsythia* twig

A. haemorrhoa is very abundant in spring. In September it is very rare and was observed on *Hedera* (Teppner & al. 2009: 199) and *Rhus chinensis* ♂; in 2014 females and males were observed on *R. chinensis* ♂ and ♀ several times. Thus it seems to be normal that few individuals emerge in fall. For *Forsythia* see sub *Andrena tibialis.*

28. *Andrena hattorfiana*

This beautiful bee occurred abundantly in all parts of the garden on diverse *Knautia* and *Scabiosa* species. Since the replacement of the *Knautia arvensis*-richest meadows in 2008 and the increased installation of honey-bee hives in the garden, the number of individuals drastically decreased (♀, ♂). In the nearby Leechwald, on forest margins and openings with *Knautia drymeia*, the species is still abundant.

29. *Andrena helvola*

12.4.1990, ♂, *Taraxacum officinale* s.l. – 11.5.1990, ♀, *Rhamnus imeretinus*-♀. – 8.5.1993, ♀, *Prunus virginiana.* – 11.5.1993, ♀, *Rosa hugonis*, collecting pollen. – 22.5.1993, ♀, *Cerastium holosteoides* and *Listera ovata.* – 14.3.1994, ♀, *Viscum album*-♂

In *Viscum album* amounts of the sticky pollen adhere in the male flowers up to postanthesis as well as after storms. During anthesis insects are abundant, e.g. *Andrena fulva* ♀, *A. helvola* ♀, *A. rufula* ♂ (Fig. 12), and other *Andrena* species (not get caught), *Osmia cornuta* ♂, *Apis mellifera* (Fig. 62), a great variety of flies, hoverflies, *Harmonia axyridis*, and a nectar drinking bug were observed during spot-checks in March 1994 and 2014–2016. Thus, *Viscum* is mainly insect pollinated as stated already by Loew 1890 (see also Zuber 2004, Hatton 1963 and Walladén 1961), and not by wind; pollen transport by wind is imaginable only at a very small extent because sometimes in adjacent spiderwebs pollen stuck on the silk. *Viscum* can be an important pollen source for spring-borne Andrenas. In the study of *Viscum*-insects by Hellrigl 2006 flower visitors are not considered. – For *Forsythia* see sub *Andrena tibialis.*

30. *Andrena lagopus*

13.5.1993, ♀, *Brassica juncea* 'Cai-cai-tai', gather nectar and pollen. – 14.5.1993, ♀, ♂, *Brassica napus* 'Ragged Jack Kale'. – 11.5.2010, ♀, *Crambe pontica.* – 14.4.2014, ♀, ♂, *Alliaria petiolate*

The first records in 1993 were new for Styria, in the meantime the species is more widely distributed.

Fig. 4–7: *Andrena lathyri*. – Fig. 4. A female opens a bud of *Vicia sepium*. – Fig. 5: A female scrapes pollen from the keel-tip of an opened bud of *Vicia sepium*. – Fig. 6: In *Vicia sepium* a female puts the head under the claw of the standard and begins from here to slice the calyx. – Fig. 7: A male sucks nectar after slicing the calyx tube of *Vicia sativa*.

31. *Andrena lathyri*

10.5.1990, ♀, *Vicia sepium*, gathering pollen and nectar. – 14.5.1993, ♂, *Vicia sativa* (2 ×)

The three species of *A.* subg. *Taeniandrena* which were observed in detail in the BG, *A. lathyri*, *A. ovatula* and *A. similis*, behave basically similar (the fourth, *A. gelriae*, was seen only once). Females harvest on *Fabaceae*, enter flower buds or newly opened flowers, press down the wing-keel-complex, scrape pollen from the anthers (or style brush), bend back, groom the body and press the pollen into the scopa. In flowers suited for several visits the complete pollen mass is removed suddenly. Then, if the flowers contain nectar, the bee searches for nectar in the same or in other flowers by slicing the calyx or, in *Trifolium*, the corolla. Details depend on the flower type visited.

In the BG *A. lathyri* was mainly studied on *Vicia sepium* (Fig. 4–6) and *V. sativa*

(Fig. 7), to a lesser extent on *Trifolium pratense*. The slicing of the calyx for searching the nectar was (to our knowledge) described for the first time by Westrich (e.g. Westrich 1989: 271, 272, Fig.). The bee sets its head laterally under the claw of the standard (Fig. 6) and goes unilaterally, with one mandible outside the calyx, the other mouth parts inside, to its base as far as this is necessary for reaching the nectar (Fig. 7); this is done also on withered flowers (postfloral). If close enough to the flower the snapping sound of the mandibles cutting the calyx can be heard. Scraping and grooming for pollen can be repeated in the same flower. If available, buds immediately before opening (with the complete amount of pollen) are preferred (Fig. 4–5) against open flowers and smaller buds. In *Trifolium* the harvesting of pollen could not be observed exactly. For nectar the flower is accessed in the edge between standard and keel and here the corolla tube is sliced unilaterally nearly down to the base.

32. *Andrena limata*
11.5.1990, ♀, *Anthriscus sylvestris*

33. *Andrena minutula*
7.6.1981, ♀, *Angelica archangelica*. – 10.3.1990, ♂, on a stone. – 13.3.1990, ♂, in sun on a stone. – 22.3.1990, ♀, *Taraxacum officinale* s.l. – 12.5.1990, ♀, *Isatis tinctoria*. – 5.3.1994, ♂, patroling. – 14.3.1994, ♂, *Bellis perennis*. – 19.3.1994, ♀, on a leaf in sun. – 19.3.1994, ♂, patroling

34. *Andrena minutuloides*
7.6.1990, ♀, *Aegopodium podagraria*

35. *Andrena nigroaenea*
15.4.2000, ♀, *Taraxacum officinale*

36. *Andrena nitida*
11.5.1990, ♀, *Angelica archangelica*. – 14.5.1992, ♀, *Isatis tinctoria*. – 18.5.1993, ♀, dead near the nest. – 22.5.1993, ♀, *Spiraea ulmifolia*. – 7.5.1996, ♀, *Taraxacum officinale*. – 2.5.2005, ♀, *Galeobdolon montanum*. – 27.4.2012, ♀, *Rhododendron* sp. – 15.7.2013, ♀, *Eryngium planum*. – 9.10.2014, ♀, *Hedera helix*. – 20.3.2015, ♀, on a leaf of *Mahonia bealei*. – 1.4.2015, ♂, on soil

37. *Andrena nitidiuscula*
16.7.1981, ♂, during gloomy weather in numbers sitting on leaves (4 ×)

38. *Andrena ovatula*
13.5.1993, ♀, *Trifolium pratense*, gathering nectar and pollen. – 18.5.1993, ♂, patroling around *Trifolium pratense* (not around *Vicia*). – 21.5.1993, ♀, *Trifolium pratense* and *T. dubium*. – 23.5.1993, ♂, *Trifolium pratense*, slicing the corolla tube and drinking nectar. – 24.5.1993, ♀, *Genista radiata*. – 13.5.2011, ♂, *Ornithogalum* sp. – 28.5.2012, ♂, patroling between *Onosma*

Our observations of *A. ovatula* were made on *Trifolium pratense* (Fig. 8, 10), *Genista radiata* and exceptionally on *Vicia sativa* (Fig. 9). In these species the behavior is comparable to that of *A. similis*. In *Trifolium pratense* the flower is opened from the tip, the anterior part of the wing-keel-complex is put down, pollen is scraped from the anthers, for grooming the bee bents back; the procedure can be repeated in the same flower. For searching nectar the corolla tube is sliced laterally at the

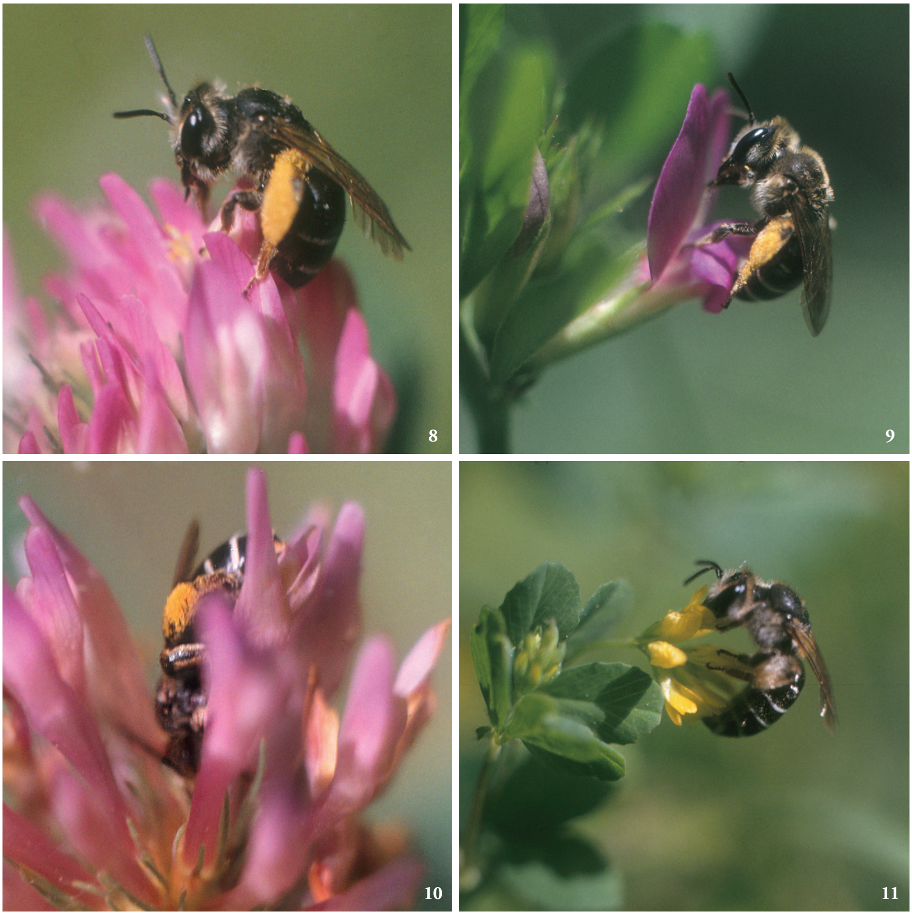

Fig. 8–11: *Andrena ovatula*. – Fig. 8: A female scrapes and grooms pollen from the anthers of *Trifolium pratense*. – Fig. 9: After scraping pollen from the anthers and the keel tip of *Vicia sativa*, a female grooms the mouth parts. – Fig. 10: After slicing the corolla tube in *Trifolium pratense*, a female is sucking nectar. – Fig. 11: A female exploits flowers of *Trifolium dubium*.

left or right side nearly up to the base. In the pollen-only flowers of *Genista radiata* preferably buds were opened by pressing down the wing-keel-complex encompassed by the legs, an explosion of decreased intensity occurs and the remaining pollen is scraped from the anthers with the help of mandibles and forelegs. In *Vicia sativa* only pollen collection was seen.

Often also the small flowered *Trifolium dubium* is exploited "normally" (Fig. 11). In one case a female was sucking nectar from *Veronica filiformis* and *Cardamine impatiens* before landing on *Trifolium pratense*. Males also slice corolla tubes for sucking nectar.

39. *Andrena pandellei*
6.6.1981, ♀, *Campanula latifolia*

40. *Andrena paucisquama*
23.5.1990, ♀, *Veronica multifida*, *Campanula patula* and *Geranium* sp.

41. *Andrena praecox*
23.2.1990, ♂, *Galanthus nivalis*. – 7.3.1990, ♂, *Salix caprea*, patroling (2×). – 12.3.1990, ♀, *Salix caprea*-♂. – 12.3.1990, ♂, on dry leaf producing sounds. – 14.3.1990, ♀, *Salix purpurea*-♂. – 19.3.1992, ♂, near *Salix caprea* patroling. – 11.4.1992, ♀, *Salix repens*-♂, gathering pollen. – 11.4.1992, ♀, flying around *Oemleria cerasiformis*

42. *Andrena propinqua*
31.3.1990, ♀, *Taraxacum officinale* s.l. – 12.4.1990, ♀, *Taraxacum officinale* s.l. – 3.5.1994, ♀, *Aubrieta deltoidea*

43. *Andrena proxima*
7.5.1990, ♀, *Carum carvi*. – 10.5.1990, ♂, around *Vicia sepium* patroling (2 ×). – 1.5.1990, ♂, *Anthriscus sylvestris*. – 23.5.1990, ♀, *Carum carvi*. – 23.5.2011, ♀ (2 ×), *Ferulago sylvatica*. – 19.6.2013, ♀, *Orlaya grandiflora*. – 2.5.2015, ♀ (2×), *Smyrnium perfoliatum*. – 24.6.2016, ♀, *Opopanax hispidus*

A. proxima is one of the *Andrena* species in which pollen transport in the corbiculae on the propodeum is easiest to see. The oligolectic species is well known from white-flowered umbellifers. It was surprising that it gathers also on yellow flowered ones (*Ferulago, Opopanax* and *Smyrnium*). In America *A. ziziae* is specialized on yellow flowered umbellifers (Lindsey & Bell 1985).

44. *Andrena rosae*
21.5.1993, ♀, *Spiraea ulmifolia*. – 14.7.2007, ♀, *Eryngium planum*. – 17.7.2009, ♂, *Eryngium planum*. – 20.7.2009, ♀, *Eryngium planum*

For *Forsythia* see sub *Andrena tibialis*.

45. *Andrena rufula*
18.3.2015, ♂, *Viscum album*-♂. – 20.3.2015, ♂, *Viscum album*-♂. – Fig. 12

A. rufula is one of the rarest *Andrena* species in Austria and has been never found in numbers. For the first time detected in 1941 for Lower Austria, 1990 for Wien, 1993 for Upper Austria and Styria and in 2002 for Burgenland (Pittioni & Schmidt 1943, Schwarz & al. 2005, Zettel & al. 2005, Schwarz & Gusenleitner 1997).

46. *Andrena similis*
8.5.1992, ♀, *Genista radiata*. – 24.5.1993, ♂, patroling around *Genista radiata* (2 ×). – 24.5.1993, ♀, *Genista radiata*. – 29.4.1994, ♀, *Genista radiata*. – 30.4.1994, ♀, *Genista pilosa* (2 ×). – 30.4.1994, ♀, *Genista pilosa* . – 2.5.1994, ♂, patroling around *Genista pilosa* (2 ×). – 3.5.1994, ♀, *Petteria ramentacea* (2 ×), ♀, *Genista radiata*. – 4.5.1994, ♀, *Trifolium pratense*. – 22.5.1996, ♀, *Trifolium pratense*. – 15.5.2004, ♂ (3 ×), *Petteria ramentacea*. – 23.5.2006, ♀, *Petteria ramentacea*

This species is active from the last days of April up to the end of May. Even when regarded as oligolectic on *Fabaceae* it exploits flowers with very different functions. *A. similis* visits the pollen-only and explosion-blossoms of *Genista pilosa* and *G. radiata* (according literature also *G. anglica*), the nectar bearing slight explosion-blossoms of *Trifolium pratense*, and the large nectar bearing flowers with flap-mechanism of *Petteria ramentacea*. Westrich 1989: 537 mentions *Lotus corni-*

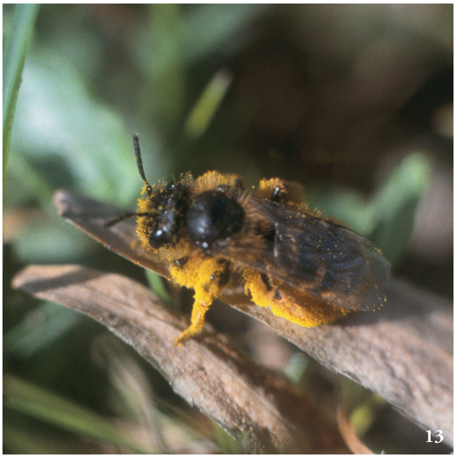

Fig. 12: *Andrena rufula*, male, drinking nectar in a male flower of *Viscum album*.
Fig. 13: *Andrena taraxaci*, female after visits of *Taraxacum*, immediately before the homing flight.

culatus (pump-mechanism). In such a case also an oligolectic bee shows a high level of plasticity in behavior for exploiting the different flower types. Visits on *Vicia* species (burst-mechanism) are not recorded till now. In open flowers of the two *Genista* species the female bee is landing on the wing-keel-complex, encompasses it with the legs, fit against the standard and presses the wing-keel complex down (Fig. 15); by this decelerated explosion of the flowers a small cloud of pollen is ejected to the body, but apparently large amounts of pollen remain in the keel-tip in the anthers, so the bee turns to the anthers and is – usually in a transversal position – scraping pollen with the help of forelegs and mandibles (Fig. 16). Then the body is groomed (Fig. 17). More often than open flowers, buds are exploited (Fig. 14, 15). Buds immediately before opening (with loosened but still folded standard) can be handled in a similar way as open flowers. Very often smaller buds are broken up what we have mainly observed in *G. pilosa*: the bee enters the bud laterally between a downward appressed margin of the standard and a wing and then presses the wing-keel-complex down. In this case no explosion takes place and the complex returns into its original position. Thus the wing-keel-complex can be pressed down more than once (2–3 ×) during one visit and we must assume that in this stage the anthers are still closed and must be bitten for accessing pollen.

In *Petteria ramentacea* the flowers show a flap-mechanism, thus a flower can be exploited more than once for pollen. Nectar is secreted at the outer bases of the claws of wings and keel. In the 16 mm long flowers the distance from the keel-joint (over the margin of calyx) to the nectar is 5.0–5.5 mm, from the upper side of the filament tube c. 7 mm. Thus it seems to be impossible, that *A. similis* can reach the nectar. *A. similis* is pressing down the wing-keel complex and spreads it down with the help of the hind legs and then gathers the pollen directly from the anthers (Fig. 18); during one visit the carina can be pressed down more than once. The bee does not try to reach the nectar.

The flowers of *Trifolium pratense* are up to 13–18 mm long. The calyx measures c. 3 mm. The parts of the corolla and the filaments are united and form a tube of c. 8–10 mm length. A joint below the standard-blade permits pressing down of the wing-keel-complex (c. 4.4–5.7 mm of the wings and c. 3.5–5.0 mm of the keel).


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Fig. 14–20: *Andrena similis.* – Fig. 14: A female opens a bud of *Genista pilosa.* Below an exploded flower. – Fig. 15: Flower bud of *Genista pilosa* immediately before opening, pressing down the wing-keel-complex and explosion. – Fig. 16: Scraping of pollen from the anthers of an exploded flower of *Genista pilosa.* – Fig. 17: A female grooms the body during exploitation of a flower bud of *Genista radiata.* – Fig. 18: Opening of a bud of *Petteria ramentacea* and scraping pollen. – Fig. 19: Scraping pollen from the anthers of *Trifolium pratense.* – Fig. 20: After slicing the corolla tube a female sucks nectar in *Trifolium pratense.*

The upper margin of the two keel petals is united for c. 2 mm. So the first visit of a flower needs pressing down for explosion and opening of the keel tip; it returns in the original position and now can be manipulated as flap-mechanism. For pollen the bee puts the head under the base of the standard, presses-down the wing-keel complex and then, sitting on its end, scrapes the pollen from the anthers (without buzzing) (Fig. 19). Then, or in other flowers, nectar is taken by longitudinally slicing of the corolla tube from the edge between standard and wing-keel-complex to the base, as far as needed for reaching the nectar (Fig. 20; some details in Teppner 2011: 171–172).

In *Genista* it was seen that bees arriving with empty scopae, collect pollen as long up scopae are filled completely, with no nectar gathering in between. On the other hand nectar concentrating was observed once on *Genista radiata*, the origin of this nectar was unknown. Sporadically a mixed pollen load (yellow and orange) was seen.

The males patrol around the pollen sources, copula was seen only once and nectar drinking of males was not observed.

47. *Andrena subopaca*

21.5.1993, ♀, *Spiraea ulmifolia*. – 23.5.1993, ♀, *Cardamine impatiens*. – 29.9.2009, ♀, *Hedera helix*. – 15.6.2013, ♀, *Aruncus dioicus*-♂

48. *Andrena susterai*

25.3.2011, ♂, sitting on a *Mahonia bealei*-leaf

This species was recorded for Austria for the first time by Fritsch 1931: 831 from Styria (Ruckerlberg in Graz, 27.5.1911, ♀, on *Spiraea ulmifolia*). One no longer current status of distribution was published by Gusenleitner 1984; the first verification for Germany was given by Scheuchl 2011.

49. *Andrena symphyti*

18.5.1996, ♀, *Symphytum officinale* (2 ×). – 18.5.1996, ♀, *Onosma stojanoffii*. – 23.5.2006, ♀, *Cerinthe minor*

For nectar robbing of females and males by bite slits in the corolla of *Symphytum*, *Onosma* and *Cerinthe* and for pollen collection see Teppner 2011. The occurrence of *A. symphyti* in the Botanic Garden was very irregular (Teppner 2011: 163 for 1996–2010). In 2011 the bee was observed between May 11 and 14 on *Symphytum officinale*, in 2012 some biting slits were seen on *S. tuberosum* on April 20 and 21 and on Mai 11. Since 2013 no traces of *A. symphyti* were detected.

50. *Andrena taraxaci*

19.3.1990, ♀, ♂, *Taraxacum officinale* s.l. – 23.3.1990, ♂, *Taraxacum officinale* s.l. (2 ×). – 31.3.1990, ♂, *Taraxacum officinale* s.l. – 2.4.1990, ♂, *Taraxacum officinale* s.l. – 12.4.1990, ♂, *Taraxacum officinale* s.l. – 4.4.1992, ♂, *Ficaria verna*, drinking nectar. – 3.5.1994, ♀, sitting on a leaf of *Petteria ramentacea*, with orange pollen in the scopa, but not seen collecting

Pollen is transported on hind legs and nearly on the whole body (Fig. 13). In the load of the female from *Petteria Taraxacum*-pollen dominated; *Petteria*-pollen constituted c. 10 %, all other grains in sum less than 4 %.

51. *Andrena tibialis*

17.3.1990, ♀, *Salix purpurea*-♂. – 1.4.1993, ♂, patroling around *Erica herbacea*. – 17.3.1997, ♂, found in a window of the institute

A. tibialis exploits also pollen and nectar from *Forsythia ×intermedia*. In *Forsythia* (in the BG *F. ×intermedia* and *F. europaea*) at anthesis on the inside of the corolla tube and in the basal third of the lobes nectar is available and in the two anthers easily accessible pollen. Thus the flowers are attractive for males and females of spring-born Andrenas (*A. fulva*, *haemorrhoa*, *helvola*, *rosae*, *tibialis*), *Osmia rufa* and *Lassioglossum laticeps*, as well as for different wasps and flies and some beetles. After anthesis the corolla persists for a long time and from observations at this stage it is sometimes erroneously believed that *Forsythia* flowers in our gardens should be useless for insects.

5.2. *Panurgus*

52. *Panurgus calcaratus*
16.7.1981, ♀, *Leontodon helveticus* (spending the night in a head). – 21.7.1989, ♂, *Crepis biennis*. – 22.7.1989, ♀, *Crepis biennis*

6. Halictinae

The list of Ebmer 1988 is still helpful for Halictids of Central Europe.

6.1. *Halictus*

53. *Halictus langobardicus*
22.6.1991, ♀, *Edraianthus serbicus*. – 27.8.2014, ♀, *Scabiosa argentea*. – 3.7.2015, ♀, *Campanula trachelium*

54. *Halictus maculatus*
13.7.1990, ♀, *Inula ensifolia*. – 13.7.2023, ♀, *Astrantia major*. – 21.8.2013, ♂, *Helenium autumnale*. – 25.7.2015, ♀, *Tanacetum vulgare*

55. *Halictus scabiosae*
18.8.2004, ♀, *Calystegia sepium*. – 13.8.2013, ♀, *Cirsium canum*. – 13.8.2015, ♂, *Cirsium canum*

56. *Halictus simplex*
19.6.1990, ♀, *Stemmacantha pulchra*. – 11.6.2005, ♀, *Lithospermum officinale*. – 12.7.2006, ♀, *Origanum vulgare*. – 26.7.2006, ♀, *Origanum vulgare*. – 31.7.2010, ♀, *Fagopyrum esculentum*. – *H. simplex* group, 3.7.2015, ♀, *Michauxia tchihatchewii*. – 4.8.2016, ♀, *Seseli gummiferum*

57. *Halictus subauratus*
8.7.1989, ♀, *Achillea millefolium* (2 ×). – 16.5.1990, ♀, *Isatis tinctoria*. – 23.5.1993, ♀, *Matricaria chamomilla* and *Trifolium pratense*. – 29.7.2005, ♀, *Eryngium planum*. – 6.8.2013, ♀, *Campanula pyramidalis*. – 2.8.2016, ♂, *Seseli gummiferum*. – 16.8.2016, ♂, *Isodon japonicus*

Abundant on *Asteraceae-Anthemideae*, often harvesting pollen of *Trifolium pratense*.

58. *Halictus tumulorum*
3.9.1991, ♀, *Melothria scabra*, drinking nectar. – 18.7.2006, ♀, *Anchusa officinalis*, drinking postfloral nectar

6.2. *Lasioglossum*

59. *Lasioglossum angusticeps*
19.5.2004, ♀, *Petteria ramentacea*

60. *Lasioglossum calceatum*
19.6.1981, ♂, *Scrophularia nodosa*. – 29.6.1981, ♀, *Cirsium* sp. – 22.8.1983, ♀, in a greenhouse on *Scaevola sericea*. – 12.7.1989, ♀, *Achillea millefolium*. – 21.7.1989, ♀, *Crepis biennis*. – 12.8.1989, ♀, *Cucurbita maxima* subsp. *andreana* (dead in a flower). – 22.8.1989, ♂, *Brassica rapa* subsp. *chinensis* (3 ×). – 31.3.1990, ♀, *Taraxacum officinale* s.l. – 13.4.1990, ♀, *Taraxacum officinale* s.l. – 13.4.1990, ♀, *Cardamine pratensis*. – 30.6.1990, ♀, *Oenothera fruticosa*. – 13.7.1990, ♀, *Inula ensifolia*. – 25.8.1997, ♂, *Campsis radicans*. – 20.7.2000, ♀, *Cucurbita pepo*. – 11.8.2000, ♀, *Cucurbita maxima* subsp. *andreana*. – 26.7.2003, ♀, *Cucurbita pepo*. – 29.7.2005, ♂, *Eryngium planum*. – 29.7.2005, ♀, *Cucurbita pepo*. – 6.7.2006, ♀, *Papaver somniferum*. – 15.7.2006, ♀, *Anchusa officinalis*, drinking postfloral nectar. – 23.8.2011, ♀, *Clematis* sp. – 19.6.2013, ♀, *Lysimachia punctata* hort. [see sub *Macropis*] – 3.7.2013, ♀, *Hosta sieboldiana*. – 24.9.2014, ♀, *Rhus chinensis*-♀. – 13.6.2015, ♀, *Lysimachia punctata* s.str. – 18.8.2015, ♂, *Solidago canadensis*. – Fig. 21, 22

61. *Lasioglossum fulvicorne*
22.4.1993, ♀, *Veronica filiformis*. – 25.8.1997, ♀, *Campsis radicans*

62. *Lasioglossum laticeps*
15.6.1981, ♀, *Scrophularia nodosa* (5 ×). – 22.3.1990, ♀, *Salix repens*-♂. – 12.4.1990, ♀, *Taraxacum officinale* s.l. – 13.4.1990, ♀, *Ribes fasciculatum*. – 12.5.1990, ♀, *Isatis tinctoria*. – 11.4.1992, ♀, *Oemleria cerasiformis*. – 1.8.1992, ♀, *Solanum lycopersicum* 'Mirabell' and *S. pimpinellifolium* Lambeyeque type. – 27.4.1994, ♀, *Veronica filiformis*. – 2.5.1994, ♀, *Alyssum orientale*. – 4.5.1994, ♀, *Veronica filiformis*. – 24.4.1998, ♀ (3 ×), *Euphorbia verrucosa*. – 26.3.2011, ♀, *Lonicera ×purpusii*. – 18.8.2011, ♀, *Anaphalis margaritacea*. – 23.8.2011, ♀, *Clematis* sp. – 25.4.2012, ♀, *Rhododendron davidsonianum*. – 22.4.2013, ♀, dead on a window sill. – 17.6.2013, ♀, *Lysimachia punctata* hort. [see sub *Macropis*] – 10.7.2013, ♀, *Hosta* sp. –24.7.2013, ♂, *Eryngium planum*. – 2.4.2014, ♀, *Forsythia europaea*. – 14.4.2014, ♀, *Alliaria petiolata*. – 11.10.2014, ♀, *Hedera helix*. – 7.5.2015, ♀, *Allium ursinum*, sucking postfloral nectar. – 4.4.2016, ♀, nesting site in a garden frame

63. *Lasioglossum leucozonium*
31.5.1993, ♀, *Tragopogon porrifolius*. – 3.5.1994, ♂, *Verbena officinalis*. – 8.6.2004, ♀, *Knautia arvensis*. – 13.10.2005, ♀, *Leontodon hispidus*. – 11.7.2006, ♀, *Knautia arvensis*. – 20.8.2013, ♀, *Limonium vulgare*. – 13.8.2015, ♂, *Cirsium canum*. – 18.8.2015, ♂, *Solidago canadensis*. – 2.8.2016, ♀, *Althaea cannabina*. – 3.8.2016, ♂, *Cirsium canum*

64. *Lasioglossum minutulum*
21.5.1993, ♀, *Spiraea ulmifolia*


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Fig. 21–22: *Lasioglossum calceatum*, female. – Fig. 21: Thieving pollen from an anther of *Verbascum densiflorum*. – Fig. 22: With pollen load. In Lasioglossums the scopae on the sternites are filled subsequently, here 1–4 already filled with pollen, 5 with a small amount.


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Fig. 23–26: *Lasioglossum* spec. – Fig. 23: *Lasioglossum nitidulum*, female, thieving pollen from an oil-blossom of the south African *Diascia barberae*. – Fig. 24: *Lasioglossum pauxillum*, female, exploiting a flower of *Cymbalaria muralis*. – Fig. 25: *Lasioglossum politum,* female, gleaning the anthers of a flower of *Genista pilosa* after the explosion triggered by a visit of *Andrena similis*. – Fig. 26: *Lasioglossum sabulosum*, female, collects pollen from an oil-blossom of *Lysimachia nummularia*.

65. *Lasioglossum morio*

27.6.1981, ♀, *Bryonia alba* (4 ×). – 29.6.1981, ♀, *Bryonia alba*. – 16.7.1981, ♀, *Digitalis laevigata* (3 ×). – 2.7.1992, ♀, *Bryonia dioica*-♀. – 2.7.1994, ♀, *Verbena officinalis*. – 17.6.2013, ♀, *Lysimachia nummularia* [see sub *Macropis*]. – 14.4.2014, ♀, *Alliaria petiolata*. – 18.5.2016, ♀, nesting site in a garden frame

For *L. morio* on *Solanum lycopersicum* and vibratory pollen collection see Teppner 2005: 221–222.

66. *Lasioglossum nigripes*

18.5.2016, ♀, nesting site in a garden frame

67. *Lasioglossum nitidulum*

12.9.1981, ♀, *Passiflora incarnata*. – 13.4.1990, ♀, *Schievereckia doerfleri* (*Brassicaceae*). – 3.7.1993, ♀, *Solanum neorickii*. – Fig. 23

68. *Lasioglossum pauxillum*

25.6.1990, ♀, *Cymbalaria muralis*. – 4.5.1994, ♀, *Veronica filiformis*. – 7.8.2004, ♀, *Cucrbita pepo*. – 11.6.2005, ♀, in the temperate greenhouse on *Angophora* sp. (*Myrtaceae*). – Fig. 24

69. *Lasioglossum politum*

12.7.1989, ♀, *Hypericum perforatum*. – 11.5.1990, ♀, *Isatis tinctoria*. – 31.7.1992, ♀, *Solanum lycopersicum* 'Mirabell' (2 ×). – 16.8.1993, ♀, *Solanum lycopersicum* 'Mirabell'. – 30.4.1994, ♀, *Genista pilosa*. – 27.6.2002, ♀, *Bryonia alba*. – 26.7.2006, ♀, *Origanum vulgare*. – 23.6.2012, ♀, *Bryonia alba*. – 3.7.2013, ♀, *Hosta sieboldiana*. – 13.10.2014, ♀, *Hedera helix*. – Fig. 25

Small *Lasioglossum* bees visit on the one hand "Kleinbienenblumen" (small flowers for small bees) such as *Veronica* species with single flowers or loose inflorescences, *Cymbalaria muralis* (Fig. 24), *Microrrhinum minus, Scophularia* div. spec. (not wasp-blossom), *Verbena officinalis*, *Medicago lupulina*, *Myosotis* div. spec., *Brunnera macrophylla, Stellaria media, Capsella bursa-pastoris* etc. On the other hand they are nectar- and especially pollen-thieves or glean in large flowers (*Verbascum* div. spec., *Digitalis* div. spec., *Diascia barberae* (Fig. 23), *Lamium maculatum*, *Salvia sclarea, Campsis radicans*, *Hypericum* div. spec., *Phacelia tanacetifolia*, *Lupinus polyphyllus*, *Cytisus scoparius*, *Spartium junceum, Genista pilosa* (Fig. 25), *Gladiolus italicus*, *Cucurbita pepo* etc. The scopae on the sternites 1–6 (Thorp 1980:791: 1–5) in *Lassioglossum* are filled successively (Fig. 22; compare also Tepedino & al. 2006, 2007 for ventral pollen transport). For *Lasioglossum* bees on *Solanum lycopersicum* see Teppner 2005: 222–223. An early paper on Lasioglossums (included in *Halictus*) and flowers and on some experiments is Kugler 1940.

70. *Lasioglossum sabulosum* (*L. monstrificum*)

5.6.2015, ♀, *Lysimachia nummularia* [see sub *Macropis*]. – Fig. 26

71. *Lasioglossum setulosum*

27.4.1994, ♀, *Veronica filiformis*

First record for Styria.

72. *Lasioglossum sexstrigatum*

15.6.1981, ♀, *Scrophularia nodosa* (5 ×)

73. *Lasioglossum villosulum*

22.5.1989, ♀, *Taraxacum officinale*. – 16.6.1990, ♀, *Hieracium intybaceum*

74. *Lasioglossum zonulum*

4.10.1991, ♀, ♂, *Antirrhinum majus* 'Trumpet Serenade'. – 27.7.2000, ♀, *Cucurbita maxima* subsp. *andreana*. – 26.7.2003, ♀, *Cucurbita pepo*. – 8.6.2015, ♀, dead in a shoe of *Cypripedium reginae*

For *L. zonulum* on *Solanum lycopersicum* and vibratory pollen collection see Teppner 2005: 223.

6.3. *Sphecodes*

75. *Sphecodes albilabris*
24.7.2009, ♀, *Eryngium planum*

76. *Sphecodes ephippius*
3.7.1993, ♀, near nest entrance. – 30.4.1994, ♀, at a nest entrance. – 24.5.1996, ♀, searching in a dry garden frame

77. *Sphecodes gibbus*
23.4.2004, ♀, searching in the arboretum. – 6.6.2012, ♀, searching on a nesting site in a dry garden frame

78. *Sphecodes monilicornis*
29.7.2005, ♂, *Eryngium planum*. – 28.6.2014, ♀, searching in the arboretum

79. *Sphecodes reticulatus*
28.5.2016, ♀, from a nest entrance of *Lasioglossum* sp.

7. Melittinae

7.1. *Melitta*

80. *Melitta haemorrhoidalis*
14.8.1989, ♀, *Campanula nitida* and other *Campanula* species. – 11.7.2015, ♀, *Campanula trachelium*. – 13.5.2016, ♀, *Campanula trachelium*

7.2. *Macropis*

81. *Macropis fulvipes*
6.6.2005, ♀, during bad weather sitting on a flower of *Anchusa azurea*

Macropis is extremely rare in the Bot. Garden in spite of some stands of *Lysimachia* species and the occurrence of both species in other parts of the city and in the surroundings. Maybe the reason lies in the lack of suited nesting sites. According the field experience of H. T. a complete fruit set in *Lysimachia vulgaris* points to the presence of *Macropis* whereas an only partial set is a sign for pollination by *Lasioglossum* species collecting pollen as facultative visitors. In the BG in a stand of *Lysimachia punctata* hort., probably because of the high number of individuals, *Lasioglossum calceatum, L. laticeps* and *L. morio* lead to a nearly full fruit set.

A number of papers deal with the chemical basis (diacetin) of the interaction of the *Lysimachia punctata* flowers and *Macropis fulvipes* (e.g. Schäffler & al. 2015 and literarure cited therein; see also Schäffler & Dötterl 2011).

In the botanical literature (Vogel 1986: 217–219, 252) one can read that *Lysimachia nummularia* in Central Europe has lost its pollinators because of change of flowering time. However, *L. nummularia* flowers more or less at the same time as *L. punctata* and *Macropis fulvipes* is a pollinator (e.g., Westrich 1989: 351, 724, 2005–2014: 2, Bassin & al. 2011: 592, suppl. mat. 1–3). In the absence of *Macropis* even *Lasioglossum* females [*L. morio* (Teppner 2005: 222) and *L. sabulosum* (Fig. 26)] are sufficient for fruit setting (if at least two different clones of the self-sterile species are mixed in a meadow).

8. Megachilinae

8.1. *Anthidium*

Eight species in Styria, distribution e.g., Hausl-Hofstätter 1995: 16–21.

82. *Anthidium manicatum*
16.6.1981, ♂, *Digitalis lanata*. – 27.6.1981, ♀, *Digitalis lanata* (2 ×). – 16.7.1981, ♂, *Sempervivum* sp. – 7.6.1990, ♂, *Betonica alopecuros*

Abundant in the Bot. Garden, especially on *Lamiaceae* (Fig. 28), *Fabaceae* and *Antirrhinaceae* (*Digitalis*, former *Scrophulariaceae*). *A. manicatum* is scraping hairs from *Lychnis coronaria* (Fig. 27) and *Anaphalis margaritacea*, to a lesser extent from *Verbascum*, *Stachys byzantina*, some thistles or *Anemone japonica*, in another part of the city mainly from *Echinops bannaticus*. Females have collected the secrete from glands on the calyx of buds of *Antirrhinum majus*.

83. *Anthidium oblongatum*
17.7.1981, ♀, ♂, *Sempervivum* sp. – 11.7.1984, ♀, ♂ (couple), *Reseda luteola*. – 1991, ♀. – 16.6.2005, ♂, *Sedum rupestre*. – 10.6.2014, ♀, ♂, *Sedum* sp. – 29.7.2016, ♂, patroling around *Satureja* sp. where females suck nectar

84. *Anthidium septemspinosum*
29.6.1981, ♂, *Cirsium canum*

Abundant in the Bot. Garden, especially on *Lamiaceae*, *Fabaceae*, *Antirrhinaceae* (*Digitalis*, former *Scrophulariaceae*) and *Asteraceae*, also on *Allium ramosum*. Females collected intensively on *Medicago sativa*, after the explosion of the flower gleaning the anthers by legs and mandibles; males land sporadically for sucking nectar (16.7.2005). Otherwise bumblebee workers are abundant visitors.

85. *Anthidium strigatum*
17.7.1989, ♀, *Inula ensifolia*. – 25.6.1990, ♂, *Cymbalaria muralis*. – 23.7.1994, ♂, *Verbena officinalis*. – 7.7.2014, ♀, *Galega officinalis*

Fig. 27–28: *Anthidium manicatum*, female. – Fig. 27: Transport of a bolt of wool of *Lychnis coronaria* into the nest in an iron pipe. – Fig. 28: Visit of a flower of *Salvia pratensis* actually in the male stage. The anthers touch the end of the abdomen.

8.2. *Stelis*

Distribution of six species in Styria: Hausl-Hofstätter 2001: 15–20.

86. *Stelis punctulatissima*
20.7.1989, ♀, *Inula ensifolia*. – 10.6.2009, ♂, *Knautia arvensis*. – 20.8.2011, ♂, *Hieracium sabaudum*. – 2.7.2013, ♀, *Inula ensifolia*

8.3. *Megachile*

87. *Megachile alpicola*
14.7.1990, ♀, *Inula ensifolia*

88. *Megachile apicalis*
19.7.1989, ♂, *Inula ensifolia*. – 13.7.1990, ♀, *Inula ensifolia*

89. *Megachile centuncularis*
20.6.2005, ♀, *Medicago sativa*

Other visitors of *Medicago sativa* were mainly *Anthidium septemspinosum* ♀ and workers of *Bombus hypnorum*, *B. lapidarius*, *B. pascuorum* and *B. terrestris*.

90. *Megachile ericetorum*
25.6.1981, ♂, during bad weather staying overnight on *Marrubium vulgare*. – 27.6.1981, ♂, *Lavandula angustifolia* (2 ×). – 29.6.1981, ♀, *Galega officinalis* (2 ×). – 2.6.1990, ♂, *Betonica alopecuros*. – 7.6.1990, ♂, *Linaria alpina*. – 19.6.1990, ♂, *Stemmacantha pulchra* (3 ×). –8.6.1996, ♂, *Symphytum officinale*. – 12.6.2006, 19.6.2006, ♂, *Anchusa officinalis*. – 3.7.2014, ♀, *Phaseolus vulgaris*. – 11.6.2016, ♂, *Salvia coahuilensis*. – 11.6.2016, ♂, *Nepeta ×faassenii*

Abundant, especially on *Fabaceae*, *Lamiaceae*, *Campanula*, *Boraginaceae*, etc.

91. *Megachile ligniseca*

The presence of *M. ligniseca* is easy to prove by the flowers of *Salvia glutinosa* destroyed in a characteristic manner (Fig. 29–31). This was firstly described by Schremmer 1941 under the name *M. circumcincta*. It was present at different stands of *S. glutinosa* in the BG. Since 2011 it disappeared without any apparent reason. In the nearby Leechwald the species is still present.

92. *Megachile nigriventris*
11.6.2014, ♀, *Glaucium flavum*. – 14.5.2016, ♀, *Alyssum transylvanicum*

M. nigriventris was observed between June 11 and 16 on *Glaucium flavum* (Fig. 32); the start of the activity period was not observed. The pollen-only-blossoms are open for one day. Anthers open successively from the tip to the base so that pollen presentation lasts for few hours. The bees visit the flowers regularly during 1–3 hours in the morning and up to three bees were present simultaneously. Later in the day visits were scarce and very short. *M. n.* collects the yellow pollen by very intensive manipulation of the anthers by mandibles and legs and without vibration. Sometimes the bees arrived with an orange content of the scopa. Nevertheless, pollen analysis of grains from scopa, thorax and a mid leg revealed *Glaucium* pollen only. The species was observed on *Fabaceae* (e.g. Westrich 1989: 741). But in 2014 *M. n.* was never seen on simultaneously blooming *Fabaceae* (especially *Ononis spi-*

Fig. 29–31: *Megachile ligniseca*, female, the visit of a flower of *Salvia glutinosa*. – Fig. 29: Gathering pollen directly from the anthers (phot. W. Obermayer). – Fig. 30: The corolla tube is penetrated by force so that it burst. – Fig. 31: Sucking nectar at the left side of the destroyed corolla limb. In the left flower the corolla tube is sliced at the right side.

nosa, *Spartium junceum* and *Cladrastis sinensis*). In 2016 a female visited only few flowers of *Spartium junceum* very quickly, in spite of many not visited, open flowers available. Another bee had a load of *Campanula* pollen in the hairs of the thorax.

Other visitors of *Glaucium* flowers were mainly *Apis* and *Bombus* workers (partly collecting by vibration, mainly *B. terrestris*, *B. lucorum* and *B. pratorum*), furthermore *Megachile willughbiella*, *Anthophora crinipes, Xylocopa violacea* (rarely; also indicated by Loew 1894: 396) and some syrphid flies (*Eristalis* sp., and others). Small and medium-sized *Lasioglossum* species are pollen-thieves or glean the flowers during the day.

93. *Megachile rotundata*
2.7.1994, ♀, *Verbena officinalis*. – 29.7.2005, ♀, *Eryngium planum*. – 23.6.2006, ♂, resting. – 12.7.2006, ♀, *Verbena officinalis*. – 3.7.2014, ♀, *Galega officinalis*

Not seen on *Medicago sativa*.

Fig. 32: *Megachile nigriventris*, female, harvesting pollen in *Glaucium flavum*.

94. *Megachile willughbiella*

1.6.1990, ♀, *Edraianthus serbicus*. – 7.61990, ♂, *Campanula poscharskyana*. – 8.6.1990, ♀, *Asphodeline lutea*. – 11.6.1990, ♂, *Campanula poscharskyana*. – 18.61990, ♀, *Lathyrus latifolius*. – 25.6.1990, ♀, *Campanula* sp. – 7.6.1996, ♂, patroling between *Onosma*. – 14.6.2014, ♀, *Cladrastis sinensis*. – 18.6.2014, ♀, *Salvia coahuilensis*

Abundant, especially on *Fabaceae*, *Lamiaceae*, *Campanula*, *Borago*, etc.

In the c. 20 mm long flowers of the Mexican *Salvia coahuilensis M. w.* is landing on the lower side of the upper lip, the ventral side upwards and the head at the entrance of the c. 13 mm long corolla tube. The bee cuts the base of the upper lip at the right side of the flower up to the dorsal side. Then it bends the tightly closed upper lip aside so that the anthers become free for harvesting pollen. (Fig. 35, 36). Seldom, additionally, the corolla tube is split up to 4.5 mm at the dorsal side. In *Salvia ringens* (flowers c. 3.5 cm long) and *Antirrhinum majus* collecting of pollen in inverse position, with the scopa oriented upwards, was observed sporadically.

In *Opuntia whipplei M. w.* is drinking nectar and collects pollen actively (as a medium-sized *Lasioglossum*), whereas *Apis* and bumblebees (mainly *B. pascuorum* workers) reject the pollen. In *Spartium junceum M. w.* is not able to open the wing-keel-complex but gleans the anthers with the help of the legs (Fig. 34) after the visits of *Xylocopa*. For *Glaucium flavum* see sub *Megachile nigriventris*.

Nests are mainly found in the rock gardens below and between stones. Usually leaf pieces of *Rosa* are used (Fig. 33).

Fig. 33–36: *Megachile willughbiella*, female. – Fig. 33: A piece of a leaf of a *Rosa* cultivar is transported to the nest. – Fig. 34: Gleaning the anthers in an exploded flower of *Spartium junceum* with the help of the legs after a visit of a *Xylocopa violacea* female. – Fig. 35: Cutting the corolla of *Salvia coahuilensis* and pollen harvest. – Fig. 36: Flower of *Salvia coahuilensis*, cut in the corolla between lips and tube.

8.4. *Coelioxys*

95. *Coelioxys aurolimbata*
11.7.1990, ♂, *Lavandula angustifolia*

96. *Coelioxys elongata*
6.8.1991, ♂, ♀, *Platycodon grandiflorus*. – 11.6.2005, ♀, *Campanula poscharskyana*

97. *Coelioxys inermis*
17.7.1989, ♀, *Inula ensifolia*. – 19.7.1989, ♂, *Coreopsis lanceolata*. – 3.6.2015, ♂, *Geranium sanguineum*. – 20.8.2016, ♂, *Asclepias labriformis*

8.5. *Heriades*

98. *Heriades crenulatus*
23.7.1994, ♀, *Verbena officinalis*. – 11.7.2006, ♂, *Knautia arvensis*

99. *Heriades rubicola*
7.7.2014, ♀, *Helichrysum italicum*

100. *Heriades truncorum*
21.8.2013, ♀, *Helenium autumnale*

An experimental study of Praz & al. 2008 proves the genetic basis for the recognition of pollen sources (*Asteraceae* flowers). The vibration of the abdomen in harvesting pollen is very apparent.

Abundant in June to August on *Asteraceae-Anthemideae* and other *Compositae.*

8.6. *Chelostoma*

From data of 35 *Chelostoma* species from around the world a hypothesis is developed for understanding of evolutionary shifts in the choice of pollen sources: Sedivy & al. 2008.

101. *Chelostoma emarginatum*
2.5.1994, ♂, *Taraxacum officinale*

102. *Chelostoma campanularum*
25.6.1990, ♂, *Campanula medium*

103. *Chelostoma rapunculi*
6.6.1981, ♀, ♂, *Campanula latifolia*. – 1.6.1990, ♂, *Edraianthus serbicus*. – 11.6.1990, ♀, *Campanula poscharskyana*. – 25.6.1990, ♀, *Campanula medium*. – 30.6.1990, ♂, *Campanula medium*

104. *Chelostoma ventrale*
19.6.1990, ♀, *Stemmacantha pulchra*

8.7. *Osmia*

105. *Osmia aurulenta*
14.5.2004, ♀, rock garden

106. *Osmia bicolor*
29.3.2016, ♂, *Muscari* sp.

Nests in the shells of *Cepaea hortensis* and *C. nemoralis* in the rock garden and in garden frames. Near an old *Fagus sylvatica* the fallen stipules are used to cover the snail shells.

107. *Osmia caerulescens*
4.4.1992, ♂, sun-bathing. – 30.4.1994, ♀, *Genista pilosa*. – 23.5.1995, ♂, in a flower of *Onosma* sp. – 19.5.2004, ♀, *Petteria ramentacea*. – 5.5.2006, ♀, *Cymbalaria muralis*. – 23.6.2006, ♂, resting. – 12.7.2006, ♀, *Melissa officinalis*. – 24.5. 2011, ♀, *Onosma rigida*. – 28.5.2012, ♀, *Astragalus angustifolius*. – 7.8.2012, ♀, *Ajuga chamaepitys*

Fig. 37: *Osmia cornuta*, male, drinking nectar in a male flower of *Viscum album*.
Fig. 38: *Osmia leaiana*, female, harvesting pollen and nectar in a head of *Cirsium canum*.

108. *Osmia cornuta*

20.2.1990, ♂, *Crocus exiguus*. – 15.3.1990, ♀, *Erica carnea*. – 16.3.1990, ♂, *Scilla bifolia* s.l. – 5.5.1992, ♀, dead on a window sill

O. cornuta and *O.rufa* are the best pollinators of rosaceous fruit trees and *Fragaria* (see Teppner 1966). Visits also *Viscum album* (Fig. 37).

109. *Osmia leaiana*

19.6.1990, ♀, *Stemmacantha pulchra*. – 18.6.1992, ♀ *Calendula officinalis*. – 5.6.2013, ♀, *Cirsium scariosum*. – 3.8.2016, ♀, *Cirsium canum*

This species, as well as *O. niveata*, vibrate the abdomen up and down during pollen harvesting (in a similar manner as well known from *Heriades truncorum*) and the hind legs help by gripping the anther tubes and combing of pollen from the styles and press the pollen into the scopa (Fig. 38).

110. *Osmia leucomelana*

16.7.1994, ♀, *Verbena officinalis*

111. *Osmia niveata*

12.7.1989, ♀, *Ptilostemon afer*. – 13.6.2013, ♀, *Cirsium scariosum*

112. *Osmia rufa*

13.3.1990, ♂, patroling; – 19.3.1990, ♂, *Scilla* sp. – 23.3.1990, ♂, *Taraxacum officinale* s.l. – 31.3.1990, ♂, *Lathyrus vernus*. – 2.4.1990, ♂, *Ribes fasciculatum*. – 13.4.1990, ♂, patroling. – 13.4.1990, ♀, *Lathyrus vernus*. – 13.5.1993, ♂, *Spiraea ulmifolia*. – 23.5.1995, ♀, *Onosma stojanoffii*. – 10.2.1997, ♀, inside the institute building. – 12.6.2006, ♀, *Cynoglossum officinale*. – 31.5.2007, ♀, *Cerinthe minor*. – 11.5.2015, ♀, *Petteria ramentacea*

For *Forsythia* see sub *Andrena tibialis*.

113. *Osmia tergestensis*

10.7.1981, ♀, *Onopordon acanthium* (2 ×)

9. Apinae

9.1. *Anthophora*

114. *Anthophora crinipes*
26.5.1994, ♂, *Anchusa azurea.* – 5.5., 6.5.2006, ♀, *Cerinthe minor.* – 6.5.2006, ♀, *Pulmonaria rubra.* – 13.6.2006, ♀, *Cerinthe minor.* – 12.6.2006, ♂, *Cynoglossum officinale.* – 2.5.2015, ♀, *Paeonia mascula.* – 11.5.2015, ♀, *Petteria ramentacea.* – 12.5.2015, ♀, *Tradescantia virginiana.* – 20.5.2015, ♀, *Glaucium flavum.* – 7.5.2016, ♀, *Papaver pseudo-orientale.* – 7.5.2016, ♀, *Meconopsis cambrica*

115. *Anthophora furcata*
31.5.1990, ♀, *Gladiolus illyricus.* – 30.7.1992, ♀, *Solanum pimpinellifolium* Lambeyeque-type. – 30.5.1994, ♂, *Betonica alopecuros*

116. *Anthophora plumipes*
26.4., 29.4.1989, ♀, *Pulmonaria rubra.* – 5.5.1989, ♀, ♂, *Pulmonaria rubra.* – 26.5.1989, ♀, *Anchusa azurea.* – 20.2.1990, ♂, *Crocus exiguus.* – 1.6.1990, ♀, lying damaged on the ground. – 27.4.1992, ♀, found dead on a window sill. – 31.5.1998, ♀, div. *Onosma* spec. – 10.6.2006, ♀, dead in a shoe of *Cypripedium reginae*

A very impressive nesting site with c. 300 nests (and with *Melecta albifrons*) in the rain shadow of a balcony not far from the garden (Liebiggasse 4) known since 1990 was abandoned because of overgrowing ornamental shrubs, weeds and creeping *Hedera*. *A. plumipes* is still abundant in the BG but actually no other nesting site is known to us. Abundant, especially on *Boraginaceae* (*Symphytum*, *Onosma Trachystemon*: vibratory pollen collection), *Lamiaceae*, *Primula vulgaris*, *Jasminum nudiflorum*, *Erythronium dens-canis, Lonicera* ×*purpusii*, *Weigela*, *Lupinus polyphyllus*, *Petteria*, *Papaveraceae* (*Meconopsis*, *Glaucium*: vibratory p. c.), etc.

117. *Anthophora quadrimaculata*
15.7.1981, ♀, ♂ (2 ×), *Lavandula angustifolia.* – 16.7. 1981, ♂, *Lavandula angustifolia*

9.2. *Amegilla*

118. *Amegilla garrula* (*Anthophora garrula*)
2.8.2013, ♀, nesting site in a garden frame

9.3. *Melecta*

119. *Melecta albifrons*
4.5.1990, ♀, *Muscari* sp. – 1.6.1990, ♀, *Gladiolus illyricus.* – 7.4.1993, ♂, exploring holes in a gravely hill-side. – 5.5.1994, ♀, in the institute building. – 10.6.2006, ♀, sitting stiff on *Cynoglossum officinale.* – 13.5.2007, ♀, institute, window. – 13.5.2011, ♂, *Symphytum officinale*

Only once a bee was seen crawling back and forth for some time on resinous bud-scales of *Picea*. Distribution in Styria: Hausl-Hofstätter 2001: 20–22.

9.4. *Eucera*

120. *Eucera longicornis*
12.6.2006, ♂, *Vicia sepium* and *Anchusa officinalis*

121. *Eucera nigrescens*
30.4.1990, ♂, *Lathyrus vernus*. – 17.5.1990, ♂, *Vicia sepium* (2 ×). – 28.5.1990, ♂, *Vicia sepium*. – 13.5.1993, ♂, *Vicia sativa*. – 4.5.1996, ♀, *Lathyrus vernus*. – 24.5.1996, ♂, *Symphytum uplandicum* × *asperum*, sucking nectar. – 29.5.1996, ♂, *Onosma echioides*, sucking nectar, several observations. – 14.5.2004, ♀, *Symphytum officinale*, vibratory pollen collection. – 5.5.2007, ♂, *Symphytum officinale*. — 12.5.211, ♀, *Symphytum officinale*

Females are also abundant on *Vicia sepium*. Furthermore females were observed on *Trifolium pratense*, males on *Ajuga reptans*. *E. nigrescens* is usually indicated as oligolectic on *Fabaceae* (e.g. Westrich 1989: 634). But females were observed twice in collecting persistently (also for pollen) on *Symphytum officinale*! In the case of bees recorded as oligolectic the visits of other flowers usually are dismissed with the remark that nectar sources can be variable. In fact exact observations on the flowers or pollen analyses are needed. In *Symphytum*, because of the vibratory exploitation for pollen, the decision is relatively easy.

9.5. *Ceratina*

Distribution of three *Ceratina* species in Styria: Hausl-Hofstätter 2000.

122. *Ceratina chalybea*
1.7.2006, ♀, *Knautia arvensis*

9.6. *Xylocopa*

Distribution in Styria: Hausl-Hofstätter 1998.

123. *Xylocopa valga*
19.6.2006, ♂, *Baptisia australis*. – Fig. 54

124. *Xylocopa violacea*
21.5.2004, ♀, *Petteria ramentacea*, arrived from *Paulownia* visits. – 13.6.2013, ♀, *Spartium junceum*

Up to 2005 only *X. violacea* was observed in the BG and on the other main study site in the W of the city. As late as 2006 on both sites *X. valga* appeared. Thus, now only the males can be surely distinguished in the field. Regarding the number of individuals, *X. violacea* clearly dominates. In Teppner 1988: 326 an own chapter is attended to the males, thus the determination is doubtless, contrary to the assumption by Hausl-Hofstätter 1998: 23.

In such species as *Papaver somniferum*, *P. orientale*, *Verbascum densiflorum* (Fig. 39), and *Anemone japonica* (Fig. 40) vibratory pollen collection (= buzz collection, not buzz pollination: Teppner 2005: 219) takes place. The explosion blossoms and pollen-only blossoms of *Spartium junceum* are exploited in a special manner. The bee encompasses the wing-keel complex with the legs, fight against the claw of the standard and presses so the wing-keel-complex down. So the bee triggers an explosion of decreased intensity of the flower and the main pollen mass is deposited in

Fig. 39–40: *Xylocopa violacea*, female, vibratory pollen collection. – Fig. 39: On *Verbascum densiflorum*. Pollen of *Salvia sclarea* on the thorax – Fig. 40: On *Anemone japonica*.

their ventral indumentum. Then, usually, the anthers are gleaned with the help of the fore-legs (Fig. 41–44).

Pollen deposition on wings is unusual for pollination. This occurs when bees must entrance very deep in flowers with anthers above for reaching nectar, and if the inner of the flower is so narrow that the wings are driven to overlap on the back. For *Xylocopa* this is the case in *Acanthus hungaricus*, where nearly the whole body, wings included, is powdered with pollen (Fig. 45–46). Because the body is not groomed after every visit, pollen on the wings can contribute to pollination. [A principally similar example is given in *Impatiens glandulifera* with diverse bumblebees and the honeybee. A completely other mechanism (anthers on divergent filaments) of pointed deposition of pollen of *Mexacanthus mcvaughii* (also *Acanthaceae*) on the wings of a Neotropical *Xylocopa* is described by Holmqvist & al. 2005.]

From the plants grown in the open, the following ones are regarded by the first author to possess *Xylocopa*-blossoms (Cammerloher1931: 64–68, van der Pijl 1954, Schremmer 1960, 1972: 277, 291): *Acanthus hungaricus* (Fig.45–46) (*A. mollis*: Schremmer 1960)*, Lathyrus grandiflorus* (Fig. 48; Teppner 1988), *Salvia sclarea* (Kugler 1972), *Antirrhinum majus, Phlomis anisodonta, P. russeliana, Spartium junceum* (Fig. 41–44), *Papaver somniferum, P. orientale* group*, Campanula medium* (Fig. 47), *Michauxia tchihatchewii* (Fig. 49–50), *Dictamnus albus* (in spite of abundant visits by smaller bees: Fisogni & al. 2016), *Asphodeline lutea* (Teppner 1996b, Fig.), *A. liburnica*, *Lilium candidum*. In *Michauxia* the bee touches the style with the body along their whole length, inserts the proboscis immediately at the style in the crotch between two filaments (Fig. 49) and presses apart the margins of the widened, cartilaginous filaments (Fig. 50) as far as necessary for reaching the nectar. At our knowledge, *Xylocopa* only is able to do so. This remembers the entering into the nectar chambers in *Calotropis* (Schremmer 1972). If strong flowerwalls and force requiring access to the nectar – two characters of perfect *Xylocopa*-blossoms – are not realized, then smaller bees can visit the flowers too, especially when the plants are grown outside the center of diversity and / or abundance of *Xylocopa*.

In the case of rich amounts of pollen it is stored for the transport in the scopae of the hind legs (Fig. 40–45, 47, 48), irrespective if the pollen is offered in the lower

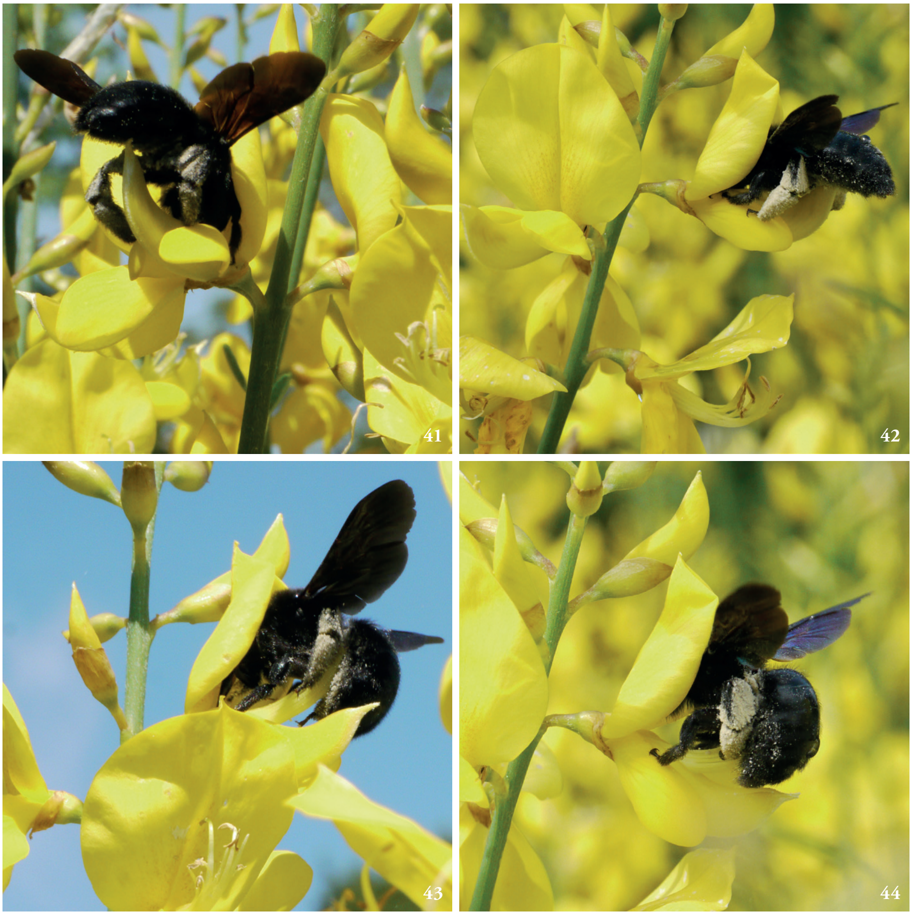

Fig. 41–44: *Xylocopa violacea*, female, on *Spartium junceum*. – Fig. 41, 42: Pressing down of the wing-keel-complex. In Fig. 42 left flower untouched, lower flower exploded. – Fig. 43: Immediately after the explosion of the flower. – Fig 44: Gleaning of the anthers in the exploded flower with the help of the fore-legs.

or upper part of the flower. For transport of pollen in the foregut see Schremmer 1972.

In flowers in which the carpenter bees (females and males) cannot reach the nectar legally, the bee is landing on the limb and climbs upwards to the margin of the corolla and the upper side of the tube. Here the corolla tube (in other cases calyx) is pierced with the hard galeae [Stechsaugrüssel (= piercing and sucking proboscis) of Schremmer 1972] and is slit basewards if this should be necessary for reaching the nectar. The fresh slit is often narrow and difficult to see. This nectar robbing regularly takes place in *Jasminum nudiflorum* (males only, females usually not flying at that early time), *Corydalis solida* (ditto males), *Weigela floribunda*, *Phlox paniculata* (Fig. 52), *Monarda didyma*, *Nepeta sibirica* (Fig. 51), *Physostegia virginiana, Maurandya scandens, Delphinium* cultivars, *Stachys macrantha, Saponaria officinalis* (Fig. 54) and rarely in *Onosma echioides* (Fig. 53). The slits are used by *Apis* and bumblebees. – For *Glaucium flavum* see sub *Megachile nigriventris*.

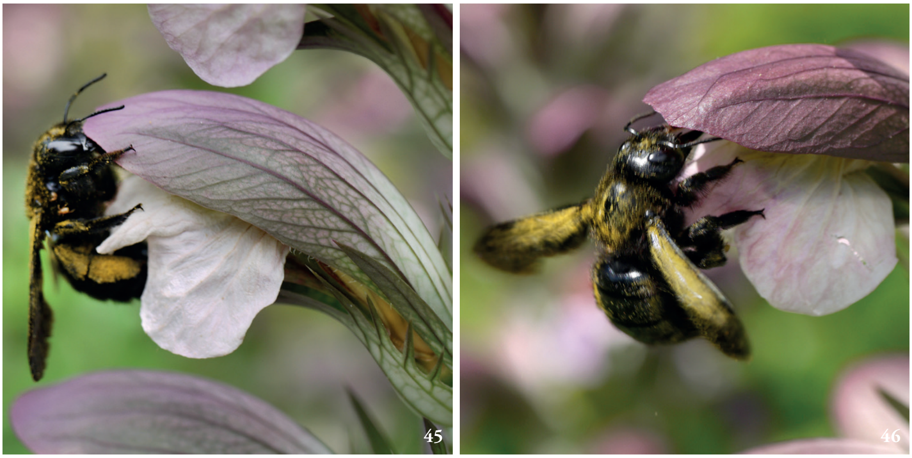

Fig. 45–46: *Xylocopa violacea*, female, on *Acanthus hungaricus*, leaving the flowers, deposition of pollen on the whole body, wings included.

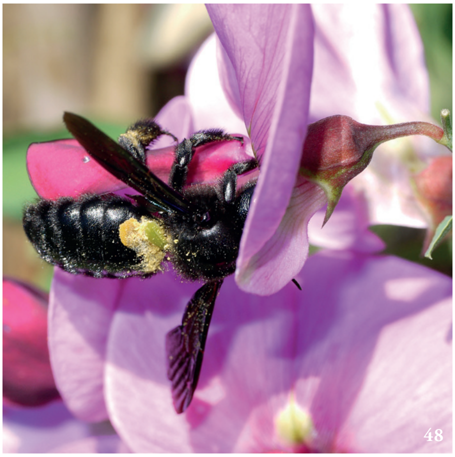


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Fig. 51–53: *Xylocopa violacea*, nectar robbing. – Fig. 51: Female on *Nepeta sibirica*. – Fig. 52: Female on *Phlox paniculata*. – Fig. 53: Male on *Onosma echioides*.
Fig. 54: *Xylocopa valga*, male, nectar robbing on *Saponaria officinalis*, on the thorax pollen of *Catalpa* and cf. *Antirrhinum*.

Fig. 47–50: *Xylocopa violacea*, females, in *Xylocopa*-blossoms. – Fig. 47: *Campanula medium*. – Fig. 48: *Lathyrus grandiflorus*, stigma and style in the waist, here also actual pollen as well as a plaque of old *Lathyrus* pollen; pollen load in the scopa of the hind leg. – Fig. 49–50: *Michauxia tchihatchewii*, the proboscis entering between the margins of the dilatated, cartilaginous filament bases.

9.7. *Nomada*

125. *Nomada bifasciata*
16.4.2011, ♀, *Taraxacum officinale*

126. *Nomada conjungens*
8.5.1990, ♀, searching flight near *Vicia sepium*

127. *Nomada fabriciana*
21.3.1992, ♀, flying at nesting site of *Andrena bicolor*. – 11.4.1997, ♀, lawn. – 23.4.2002, ♀, searching in the arboretum. – 3.4.2014, ♀, searching in the arboretum

128. *Nomada flava*
30.4.1990, ♀, searching flight. – 25.4.1994, ♂, *Allium ursinum*. – 19.4.1996, ♀, searching above soil in the arboretum. – 7.5.1996, ♂, arboretum. – 24.5.1996, ♀, *Symphytum* ×*uplandicum*, robbing nectar

129. *Nomada flavoguttata*
14.3.1994, ♂, *Bellis perennis* and *Veronica persica*. – 19.3.1994, ♂, *Ficaria verna*. – 25.4.1994, ♂, *Taraxacum officinale*. – 23.4.2004, ♀, searching in the arboretum

130. *Nomada fulvicornis*
2.4.1990, ♀, searching flight. – 14.3.1994, ♀, on soil. – 23.5.1996, ♀, searching in a dry garden frame. – 4.4.2002, ♀, searching in the arboretum

131. *Nomada goodeniana*
23.4.2004, ♀, searching in the arboretum

132. *Nomada integra*
18.5.2016, ♀, nesting site of *Lasioglossum* in a garden frame

133. *Nomada marshamella*
18.5.1994, ♀, searching flight close to the ground

134. *Nomada sexfasciata*
28.5.2009, ♀, *Anchusa officinalis*

135. *Nomada trapeziformis*
19.8.1992, ♀, *Mentha* ×*rotundifolia*

A rare species, distributed in Austria, southern Germany, and the Czech Republic. The published record for Switzerland by Frey-Gessner 1908–1912 could not be confirmed by Amiet & al. 2007. This species occurs in two generations from early April to mid May and late July to early September. Koller 1958 published flower visititations on *Thymus serpyllum* and *Solidago virgaurea*, Stöckhert 1930 also on *Thymus* sp. As possible hosts *Andrena barbareae* and *A. limata* were named, the latter one occurring in the BG.

9.8. *Bombus*

136. *Bombus argillaceus*
16.4.1997, worker, dead in the greenhouse. – 28.6.2013, worker, *Penstemon* sp. Queens seen every spring, but no nests recorded.

137. *Bombus barbutellus* (*Psithyrus*)
18.6.1990, ♂, *Stemmacantha pulchra.* – 19.6.1990, ♂, ♀, *Stemmacantha pulchra.* – 22.6.1990, ♂, *Stemmacantha pulchra.* – 27.4.1992, ♀, dead on a window sill. – 2.5.2002, ♀, searching in the arboretum. – 9.5.2003, ♀, searching in the arboretum. – 25.4.2013, ♀, *Rhododendron dauricum*

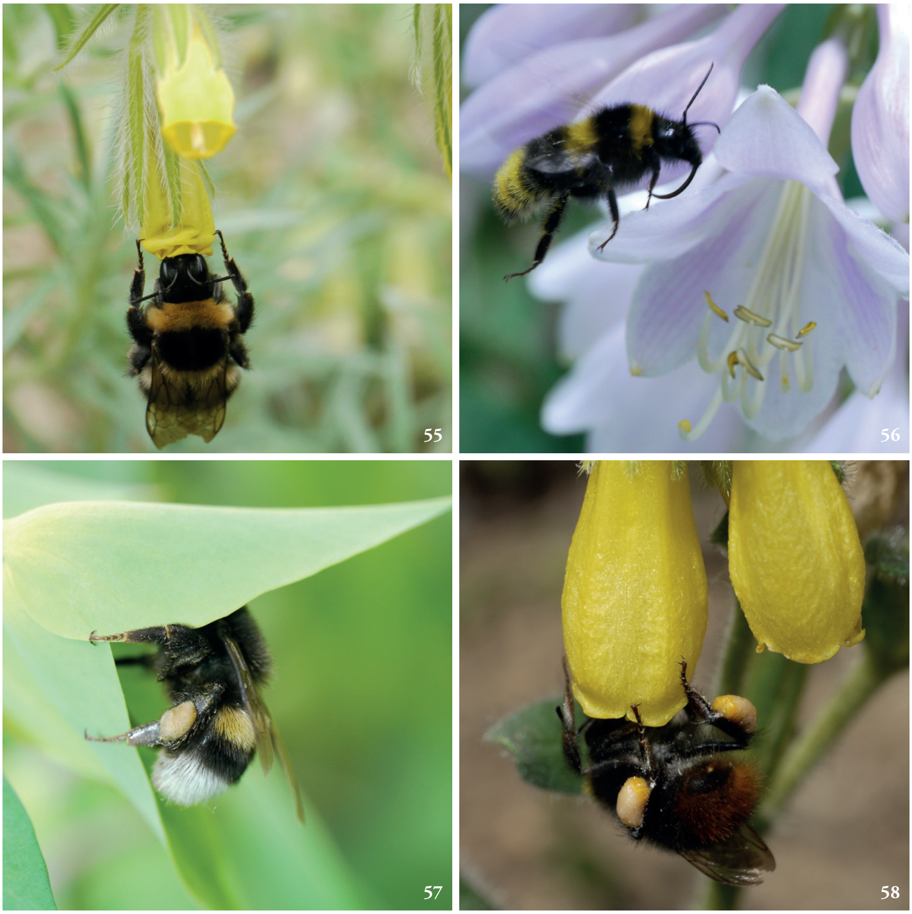

Fig. 55–58: *Bombus* workers. – Fig. 55: *B. hortorum* sucks nectar on *Onosma polyphylla*. The flowers are too long, so the bee compresses the corolla for reaching the nectar. – Fig. 56: In *B. hortorum* the white, abdominal bands are tinged yellow by pollenkitt during visits on *Hosta sieboldiana*. – Fig. 57: *B. lucorum* sucks nectar on the cyathium-glands of *Euphorbia lathyris*. – Fig. 58: *B. pratorum* during vibratory pollen collection on *Onosma taurica*, whitish *Onosma* pollen on the ventral side, mixed pollen load in the corbiculae.

138. *Bombus bohemicus* (*Psithyrus*)
9.5.2003, ♀, searching in the arboretum

139. *Bombus campestris* (*Psithyrus*)
24.8.1990, ♂, *Carlina* cf. *corymbosa*

140. *Bombus haematurus*
2.7.2005, ♂, from a nest in the greenhouse (see Teppner 2010). – 23.5.2006, worker, *Papaver pseudo-orientale*

Observations on *B. haematurus* in the garden in 2005–2009 are described in Teppner 2010. In the following years *Mahonia bealei* proved to be the most important food source for queens in our garden. 2010 a queen on *M. bealei* was seen only once. In 2011 queens were observed between March 25 and April 6 on *Lonicera ×purpusii*, *M. bealei* and *Pieris japonica*, up to two at the same time and individuals with bright yellow and one with brown-yellow band on the tergites 2 and 3. Workers gathered on May 12 and 13 on *Meconopis cambrica* and *Symphytum officinale*. In 2012 the queens appeared between March 24 and April 11, up to two at the same time on *M. bealei*, workers from April 25 to May 30 on *Meconopsis cambrica* and *Rhododendron davidsonianum* and *Rh.* spec. 2013 queens collected as usual on *M. bealei* and several times on *Lathraea squamaria*, one overnighted on a leaf near these plants. 2014 a queen was seen March 17 on *M. bealei*. 2015 and 2016 queens collected additionally intensively on *Trachystemon orientalis*. The occurrence of *B. haematurus* in the BG was sporadically and irregular in all years. Where the bees stay during the other times and where the colony sites are, remains a mystery. Only once, in 2015, a female was seen outside the BG in the western part of the city on *Lonicera ×purpusii*. At least in southeasternmost Styria (district Radkersburg) colonies are regularly present.

141. *Bombus hortorum*
17.5.1990, worker, *Vicia sepium*. – 7.7.1990, ♀,hanging dead from a flower head of *Ptilostemon afer*. – 19.6.1992, worker, dead under flowering *Lonicera japonica* (2 ×). – 23.5.1997, worker, dead in the greenhouse; ditto 10.6.1997 and 30.6.1997. – 1.7.2006, ♂, *Digitalis purpurea*. – 7.7.2010, worker, *Acanthus hungaricus*. – 20.10.2012, ♂, *Aconitum carmichaelii*. – 20.6.2013, worker, *Onosma echioides* s.l. – 28.6.2013, worker, *Salvia officinalis*. – 3.7.2013, worker, *Hosta sieboldiana*

In some *Hosta* species the white hairs are turned yellow by pollenkitt (Fig. 56). Sucking nectar: Fig. 55. For honeydew see sub *B. terrestris*.

142. *Bombus humilis*
19.8.1992, worker, from a nest in an *Acantholimon* cushion. – 25.5.1993, worker, dead on the ground. – 12.6.2006, worker, *Betonica alopecuros*. – 21.6.2013, worker, *Veronica maritima*. – 28.6.2013, worker, damaged on soil. – 28.4.2014, ♀, *Centaurea montana*

143. *Bombus hypnorum*
10.5.1990, worker, *Rosa pendulina*. – 20.7.1990, worker, dead on the trail. – 20.6.1991, ♀, dead on the trail

For honeydew (Fig. 60) see sub *B. terrestris*, for *Medicago sativa* sub *Megachile centuncularis*.


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Fig. 59–60: *Bombus* workers harvesting honeydew. – Fig. 59: *B. terrestris*, honeydew from *Cacopsylla* on *Pyrus*. – Fig. 60: *B. hypnorum*, honeydew from Aphids on *Pyrus*.

144. *Bombus lapidarius*

24.8.1990, ♂, *Carlina* cf. *corymbosa*. – 6.8.1991, worker, dead on the street. – 17.8.1993, worker, *Solanum habrochaites*. – 12.5.1995, ♀, dead in the new greenhouse

For honeydew see sub *B. terrestris*, for *Medicago sativa* sub *Megachile centuncularis*.

145. *Bombus lucorum*

18.7.1990, ♂, *Lavandula angustifolia*. – 29.7.2005, ♂, *Eryngium planum*. – 19.7.2012, ♂, *Eryngium planum*. – Fig. 57

For *Glaucium flavum* see sub *Megachile nigriventris*.

146. *Bombus norvegicus* (*Psithyrus*)

10.6.2006, ♂, *Knautia arvensis*. – 2.8.2006, ♂, *Agastache* sp.

147. *Bombus pascuorum*

26.5.1989, worker, *Stachys* sp. – 17.5.1990, worker, *Vicia sepium*. – 14.8.1991, worker, *Solanum pimpinellifolium*, vibratory pollen collection. – 4.7.1997, worker, from a damaged nest (2 ×). – 11.6.2005, worker, *Anchusa azurea*. – 22.7.2006, worker, *Satureja* sp.

Workers regularly harvest nectar from *Fuchsia magellanica* in summer and fall. For *Medicago sativa* see sub *Megachile centuncularis*, for *Opuntia* sub *M. willughbiella*.

148. *Bombus pratorum*

3.5.1990, worker, *Geum* sp. – 1.6.1990, ♂, sitting on a leaf. – 22.6.1990, ♂, near *Cerinthe minor* on a leaf. – 6.6.1992, ♂, *Symphytum officinale*. – 27.3.1993, ♀, dead in the garden. – 27.5.1993, worker, dead on the ground. – 26.3.2011, ♀, *Pulmonaria officinalis*. – 28.3.2011, ♀, *Lonicera* ×*purpusii*

Vibratory pollen collection: Fig. 58. For honeydew see sub *B. terrestris*, for *Glaucium flavum* sub *Megachile nigriventris*.

149. *Bombus sylvestris* (*Psithyrus*)

19.3.1990, ♀, *Scilla mischtschenkoana* and *Muscari* sp. – 2.4.1990, ♀, dead on the street

150. *Bombus terrestris*

1.6.1992, ♀, dead on the ground. – 16.6.1992, ♀, dead under a flowering *Tilia*. – 18.4.1997, worker, dead in the greenhouse (3 ×), from a commercial colony; ditto, 30.4.1997, ♂. – 28.2.1998, ♀, worker (2 ×), dead in the greenhouse, from a commercial colony. – 26.6.2003, ♀, from a commercial colony. – 20.6.2006, worker, dead near nest. – 14.6.2013, worker, *Onosma echioides* s.l.

Contrary to *Symphytum*, nectar robbing in *Onosma* seems to be extremely rare. Probably this is hindered by the robust sepals and / or by the thick part of the filaments adnate to the corolla. Under all the species cultivated over the years, in *O. isaurica* only, with its relatively soft sepals, biting by *B. terrestris* workers was observed directly. – For visits of *Medicago sativa* see sub *Megachile centuncularis*, for *Glaucium flavum* sub *Megachile nigriventris*.

Bumblebee workers harvest also honeydew, even when this is very rarely reported in the literature (for e.g., Bischoff 2013: 85). *B. terrestris* has taken honeydew from *Cacopsylla* (*Psyllidae*) (Fig. 59) and Aphids, both on *Pyrus communis*, *B. hypnorum* (Fig. 60) and *B. pratorum* from Aphids also on *Pyrus*. In the greenhouse *B. hortorum* (Teppner 2015: 120) and *B. lapidarius* collected honeydew from a large Aphid on *Quercus ilex*.

9.9. *Apis*

151. *Apis mellifera*

15.3.1990, worker, *Scilla bifolia* s.l. – 31.3.1990, worker, *Taraxacum officinale* s.l. – 20.5.1993, worker, *Spiraea ulmifolia*, collecting nectar and pollen. – 1.9.1997, 2.9.1997, worker, *Cucurbita maxima*. – 3.6.2015, worker (2×), *Cypripedium reginae*, dead and alive, respectively, in shoes

During observations of Andrenas on *Vicia sepium, Apis* workers were seen to gather extrafloral nectar from the stipules of the inflorescences and sporadically to visit flowers in a seemingly legal manner. In spring *Viscum album* is exploited (Fig. 62). Workers enter the shoe of *Cypripedium reginae* but are apparently not able to leave it (Fig. 61). From *Fuchsia magellanica* nectar is taken up to the end of October. For *Glaucium flavum* see sub *Megachile nigriventris*, for *Opuntia* sub *M. willughbiella* and for *Impatiens glandulifera* sub *Xylocopa violacea*.

If pollen is needed in the hieve, also anemophilous plants such as *Corylus*, *Populus tremula*, different grasses (Fig. 64), *Cannabis sativa, Plantago lanceolata* (Fig. 63), etc. are accepted as pollen source. Nectar robbing through biting holes of bumblebees or slits of *Xylocopa* (Fig. 65) is common.

Fig. 61–65: *Apis mellifera*, workers. – Fig. 61: Bees trapped in the shoe of *Cypripedium reginae* cannot leave it. – Fig. 62: Collecting pollen in a male flower of *Viscum album*. – Fig. 63: In the early morning *Plantago lanceolata* is accepted as pollen source. – Fig. 64: Pollen harvest on *Poa pratensis*. – Fig. 65: Nectar robbing on *Saponaria officinalis* through the slits made by *Xylocopa*.

10. Discussion

It seems to be generally accepted that high diversity of habitats and a plant cover of many species (more or less constant over the years) as well as an abandonment of insecticides in botanic gardens are prerequisites of a high species diversity of bees. We keep bee species lists for 24 botanic gardens (Graz included) of Central Europe. They are mentioned in alphabetical order:

Bayreuth, ökol. bot. G.	Dötterl & Hartmann 2003
Berlin-Dahlem	Loew 1884, Saure 2012
Bern	Augstburger & Zettel 2002
Bochum	Küpper 1999
Bonn	Bischoff 1996
Dresden	Münze & al. 2006
Düsseldorf	Walge & Lunau 2003, Diestelhorst & Lunau 2007
Edinburgh	Mill 2012
Fribourg/Suisse	Bur 1974
Göttingen (Alter Bot. G.)	Braun 1997
Göttingen (Neuer Bot. G.)	Braun 1997
Graz	(this paper)
Halle/Saale	Dorn 1977
Hamburg	van der Smissen & Krohn 2007
Innsbruck	Schedl 2015
Kiel (Alter Bot. G.)	Haeseler 1972
Köln (Garten Zool. Inst. Univ.)	Risch 1996
Lübeck	van der Smissen & Eckloff 1992
München	Bembé & al. 2001
Münster	Steven 1995
Praha	Pádr 1990
Stuttgart	Schwenninger 1999
Zürich	Bernasconi 1993
Wien	Wettstein 1912, Hölzler 2004

Most of them are included in the table in Saure 2012: 58 so that a detailed discussion seems not to be obligatory. The area of the gardens ranges from 2.0 ha to 43 ha and the number of proved bee species from 36 to 156. In six gardens (Bayreuth, Berlin, Dresden, Göttingen, Graz, Halle) more than hundred bee species were recorded. Apparently it can be expected, also for small gardens of 3–4 ha, that an intensive search yields up to c. 100–150 bee species.

Gusenleitner & al. 2012 recorded 690 bee species for Austria. In the botanic garden in Graz with c. 2.5 ha of planted area (paths included) and 3,500 plant species 151 bee species from 25 genera have been detected. This corresponds to a theoretical density of one bee species per c. 170 m^2. The only garden with more species records (Berlin-Dahlem, 156), in contrast, covers an area of 43 ha (1 bee species per c. 3,000 m^2) and contains 22,000 plant species. If the reason of this high species diversity in the small garden in Graz lies 1) in the many green corridors which connect the garden with the surrounding landscape, 2) in the observation method or, 3) in the time span of observations, we cannot decide. A similar high species number probably could be reached in Halle (Dorn 1977) when parasitic bees and bumblebees would have been counted as well. 2–3 ha of a well differentiated garden seem to be sufficient to depict the maiority of the bee fauna of a region.

The plant with the highest number of recorded bee species was *Eryngium planum* (17), followed by *Taraxacum officinale* (16), *Petteria ramentacea* (10), and *Spiraea ulmifolia* (9).

The first bee list of a botanic garden known to us is that in Loew 1884 with 71 species (not mentioned in Saure 2012). The author had no faunistic intentions. He intended to check the flower theories of Hermann Müller, especially the selection of forage plants in a mixture of species from all continents and the color preferences. So, all observed flower visitations are reported with an incredible exactness and richness in details.

Loew stood fully in the spirit of the middle phase (sometimes regarded as the classical period) in the evolution of floral ecology in the second half of the 19th century and at the beginning of the 20th (usually named floral biology at that times): The connection between plants and visitors was interpreted strictly teleologically, from the point of view of human utilitarian thinking or under pathetic fallacy of insects. The connection was also seen as pure exploitation of otherwise present structures without any causal correlation between plant and animal. Evolutionary traits were often overestimated in relation to plasticity in behavior and learning in insects. Furthermore, there is often a satisfaction with the indication of the presence merely of an insect on a flower.

Modern floral ecology with experimental traits and the inclusion of insect behavior begins approximately with Troll 1928, Knoll 1930 and a series of ten papers on floral ecology and bumblebees by Kugler between 1930 and 1941, e.g. Kugler 1933.

Fritsch 1906–1933 has published 11 contributions about observations on flower-visiting insects in Styria from the years 1904–1914. The order in the text follows the systematic order of plants, thus species of visitors as well as localities can only be extracted with time-consuming efforts. So, the few observations from the BG Graz are hidden between the many other localities and concern often the most abundant species such as *Apis*, and some *Bombus* and *Eristalis* species. Usually only the presence of a visitor is indicated, more seldom are notes on the behavior of insects or their importance as pollinators.

The next list is the report of Wettstein 1912 for the botanic garden in Vienna. It is a faunistic study in which also 71 species are reported. For each species, the month of observation, gender of the bee and visited plant genus or species are mentioned.

One paper falling largely out of the usual faunistic studies is that of Stevens 1995 for Münster. The observations of 86 bee species are reported (p. 49–51) and are also shown in separate lists for the months (p. CXXXVI–CXLV). The main objective was the offer of food (flowers) in the garden in relation to the activities and the needs of the bees. The proposals for the protection and promotion of the wild bees in the BG Münster can be generalized for other botanic and private gardens. Such preventive measures H.T. also intended to realize in the BG Graz during his responsibility.

For the BG Halle (Dorn 1977) one must keep in mind that bumblebees and parasitic bees are not treated. Not only the species spectrum but also the abundance of individuals was considered, and comparisons with a collection of this area from 1900–1910 were made.

Gardens not treated in Saure 2012 are Bern, Düsseldorf, Edinburgh, Fribourg, Lübeck, Innsbruck, Prague, Vienna and Zürich.

The BG Bern has a planted area of 2.4 ha and from the bee fauna 71 species had been proven (Augstburger & Zettel 2002). Nests and flower visitations were observed.

In Düsseldorf, in the garden of c. 7 ha, Walge & Lunau 2003 and Distelhorst & Lunau 2007 have proven the presence of 86 bee species.

From the Royal Botanic Garden in Edinburgh with an area of c. 28 ha Mill 2012 reported an inventory of all animals with 36 bee species.

In the BG Fribourg (Suisse) Bur 1974 recorded 79 bee species.

In the Immengarten of the museum for natural history in Lübeck van der Smissen & Exckloff 1992 recorded 51 bee species on an area of c. 800 m^2 with c. 70 plant species (now c. 3,000 m^2 and a vitreous beehive in the museum; information from Dr. Susanne Füting).

From his observations on Hymenoptera Schedl 2015 published an annotated list of 37 bee species for the BG of Innsbruck (area 2 ha).

Pádr 1990 recorded 55 species from the 2 ha of the BG Prague. The peculiarities of the urban climate and its importance for insects are shortly discussed.

The BG in Vienna (Wettstein 1912, Hölzler 2004) is an environment for 131 bee species from 22 genera. The area is c. 8 ha with c. 5,500 plant species in the open (M. Kiehn, oral comm.).

For the 5.3 ha BG Zürich 85 (in Table 3 86) bee species are recorded (Bernasconi 1993; annotated list in the appendix). Seven areas within the city were studied and the relative frequency of bee species within and between these sites is indicated. Synanthropy is especially discussed.

11. Index of Plant Names

12. Acknowledgements

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