Wild bee (Insecta: Hymenoptera: Anthophila) species diversity and pollination effectiveness in mass flowering crops of oilseed rape in Central Bulgaria

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Introduction

The pollination of oilseed rape occurs through a combination of wind and insect vectors with considerable autogamy apparent. In addition, the abundance of wild bees visiting flowers plays also a role on gene flow and cross-pollination within and between crop fields. The aim of the present study is to assess the wild bee diversity and the relationship between bee pollinator communities and oilseed rape successful pollination at local level in Bulgaria. Cross-pollination in *Brassica napus* is unlikely to be done by a bee coming from the flower of the same plant; in addition, successful pollination is less probably to be done by a bee having specialized pollen transporting structures (scopa) than a bee that leaves pollen where it lodges on its body; this also is similar with the general body size of the bees and finally, a bee moistening the collected pollen with other agents (oil or nectar) is less likely to pollinate than a bee carrying pollen dry and loose. In general, the exact location of the carried pollen on the bee body and the movement patterns of the bee are of key position for further picking up the pollen by the floral stigma, thus, the relative contribution of wild bee pollinators in term of species one to another to oilseed rape pollination is not equal. The variety of wild bee species that visit oilseed flowers, and their potential impact on crop production can be divided into four groups: (1): short-tongued bees of small to big size, mostly hairless and transporting the pollen swallowed, females; (2): long-tongued bees with small to medium sized body and transporting structures developed on the legs or the ventral metasomal surface, females, worker-females; (3): long-tongued bees of big sized body and transporting structures developed on the legs or the ventral metasomal surface, females, worker-females; (4): long or short-tongued free-living or parasitic bees of any kind of size and with no specialized pollen collecting areas on its body, males. The open and accessible nature of oilseed flowers suggests that they are visited by a diverse pollinators and the functional importance of the pollinator activity between the four groups is small, however significant enough to be delimited. It is the most effective for the group 2 and in descending order for the groups 3, 4, and 1, respectively.

Material and methods

Study area. We selected 10 oilseed rape fields as well as neighbor semi-natural grasslands, respectively across a moderate in size geographical area in Central Bulgaria (N42º01'–N42º23'; E24º36º'–E25º32').

Sampling. Sampling of wild bees has been conducted by the way of sweeping by entomological net on a particular route (transect) and by the way of a day-long exposition of five series each consisting of three Moericke traps, colored in blue, red and yellow. Transects along the field border were 100 m long and divided into 20 m segments; the transect width was 1 m. Both sweeping and Moericke trapping were conducted twice in the end of month April and May, respectively – at the onset and at the advanced stage of bloom.

Results & discussion

Based on material of about 800 individuals (788 bees, including 120 honeybees) both in the crop fields and semi-natural grasslands are established 104 species of the families Andrenidae, Apidae, Colletidae, Halictidae and Megachilidae. Most abundant specimen/species representatives are for the bee genera *Andrena* (67/26), *Lasioglossum* (439/22) and *Eucera* (40/9).

Pollinator community in oilseed rape fields. A total of 599 specimens representing 76 pollinator species were collected in oilseed rape fields. The top five most abundant species were *Lasioglossum pauperatum* (125 individuals), *Apis mellifera* (121 individuals), *Lasioglossum pauxillum* (53 individuals), *Lasioglossum laticeps* (43 individuals), *Lasioglossum lucidulum* (25 individuals).

Pollinator community in semi-natural grasslands. A total of 189 specimens representing 66 pollinator species were collected in semi-natural grasslands. The top five most abundant species were *Lasioglossum pauperatum* (13 individuals), *Lasioglossum griseolum* (13 individuals), *Apis mellifera* (12 individuals), *Andrena ventricosa* (10 individuals), *Lasioglossum pauxillum* (9 individuals).

Bee species list assigned to a functional group for successful pollination.

Andrena braunsiana Friese, 1887 - 2; Andrena cineraria (Linnaeus, 1758) - 3; Andrena colletiformis F. Morawitz, 1874 - 3; Andrena combinata (Christ, 1791)- 2; Andrena flavipes flavipes Panzer, 1799 - 2; Andrena floricola Eversmann, 1852 - 2; Andrena gravida Imhoff, 1832 - 2; Andrena hattorfiana dimidiata Brullé, 1833 - 3; Andrena impunctata Pérez, 1895 – 2; Andrena labialis (W. Kirby, 1802) - 2; Andrena nana (W. Kirby, 1802) - 2; Andrena nitida nitida (O. F. Müller, 1776) - 3; Andrena nitidiscula nitidiuscula Schenck, 1853 - 2; Andrena nitidiscula Schenck, 1853 - 2; Andrena panurgimorpha Mavromoustakis, 1957 - 2; Andrena propinqua Schenck, 1853 - 2; Andrena rugulosa Stöckhert, 1935 - 2; Andrena simillima F. Smith, 1851 - 2; Andrena subopaca Nylander, 1848 - 2; Andrena tarsata Nylander, 1848 - 2; Andrena tenuis F. Morawitz, 1877 - 2; Andrena transitoria F. Morawitz, 1871 - 2; Andrena tscheki F. Morawitz, 1872 - 2; Andrena ventricosa Dours, 1873; - 2; Anthophora aestivalis (Panzer, 1801) - 2; Anthophora crassipes Lepeletier de Saint-Fargeau, 1841 - 3; Apis mellifera Linnaeus, 1758 - 2; Bombus argillaceus (Scopoli, 1763) - 3; Bombus lucorum (Linnaeus, 1761) - 3; Bombus soroeensis (Fabricius, 1777); - 3; Bombus terrestris (Linnaeus, 1758) - 3; Bombus vestalis (Geoffroy, 1785) - 3; Ceratina acuta Friese, 1896 - 2; Ceratina cucurbitina (Rossi, 1792) - 2; Ceratina dallatorreana Friese, 1896 - 2; Ceratina nigrolabiata Friese, 1896 - 2; Chelostoma florisomne (Linnaeus, 1758) - 4; Eucera chrysopyga Pérez, 1879 - 3; Eucera clypeata Erichson, 1835 - 3; Eucera dalmatica Lepeletier de Saint-Fargeau, 1841 - 3; Eucera digitata Friese, 1896 - 3; Eucera nigrescens Pérez, 1879 -3; Eucera nigrifacies Lepeletier de Saint-Fargeau, 1841 - 3; Eucera proxima F. Morawitz, 1875 - 3; Eucera seminuda Brullé, 1833 - 3; Eucera vulpes Brullé, 1833 - 3; Halictus cochlearitarsis (Dours, 1872) - 3; Halictus eurygnathus Blüthgen, 1930 - 2; Halictus kessleri Bramson, 1879 - 2; Halictus maculatus F. Smith, 1848 - 2; Halictus phryganicus (Pauly & Devalez, 2015) - 2; Halictus seladonius (Fabricius, 1794) - 2; Halictus semitectus F. Morawitz, 1873 - 2; Halictus sexcinctus sexcinctus (Fabricius, 1775) - 3; Hoplitis adunca (Panzer, 1798) - 2; Hylaeus angustatus (Schenck, 1861) - 1; Hylaeus annularis (W. Kirby, 1802) - 1; Hylaeus annulatus (Linnaeus, 1758) - 1; Hylaeus brachycephalus (F. Morawitz, 1868) - 1; Hylaeus breviceps F. Morawitz, 1876 - 1; Hylaeus cornutus Curtis, 1831 - 1; Hylaeus leptocephalus (F. Morawitz, 1870) - 1; Hylaeus moricei (Friese, 1898) - 1; Hylaeus punctatus (Brullé, 1833) - 1; Lasioglossum crassepunctatum (Blüthgen, 1923) - 2; Lasioglossum damascenum (Pérez, 1903) - 2; Lasioglossum discum (F. Smith, 1853) - 2; Lasioglossum glabriusculum (F. Morawitz, 1872) - 2; Lasioglossum griseolum (F. Morawitz, 1872) - 2; Lasioglossum interruptum (Panzer, 1798) - 2; Lasioglossum laticeps (Schenck, 1870) - 2; Lasioglossum lativentre (Schenck, 1853) - 2; Lasioglossum leucopus (W. Kirby, 1802) - 2; Lasioglossum lucidulum (Schenck, 1861) - 2; Lasioglossum malachurum (W. Kirby, 1802) - 2; Lasioglossum marginatum (Brullé, 1833) - 2; Lasioglossum minutulum (Schenck, 1853) - 2; Lasioglossum nigripes (Lepeletier de Saint-Fargeau, 1841) - 2; Lasioglossum pauperatum (Brullé, 1833) - 2; Lasioglossum pauxillum (Schenck, 1853) - 2; Lasioglossum puncticolle (F. Morawitz, 1872) - 2; Lasioglossum quadrinotatum (W. Kirby, 1802) - 2; Lasioglossum setulosum (Strand, 1909) - 2; Lasioglossum sexnotatum (W. Kirby, 1802) - 2; Lasioglossum truncaticolle (F. Morawitz, 1877) - 2; Lasioglossum villosulum (W. Kirby, 1802) - 2; Megachile leachella Curtis, 1828 - 2; Nomada bispinosa Mocsáry, 1883 - 4; Nomada ferruginata (Linnaeus, 1767) - 4; Nomada flavoguttata (W. Kirby, 1802) - 4; Nomada goodeniana (W. Kirby, 1802) - 4; Nomada sheppardana (W. Kirby, 1802) - 4; Nomada stigma Fabricius, 1804 - 4; Osmia aurulenta (Panzer, 1799) - 2; Osmia bicornis globosa (Scopoli, 1763) - 2; Osmia jason Benoist, 1929 - 3; Osmia leaiana leaiana (W. Kirby, 1802) - 2; Osmia rufohirta rufohirta Latreille, 1811 - 3; Pseudoanthidium nanum (Mocsáry, 1879) - 2; Sphecodes crassus Thomson, 1870 - 4; Sphecodes ephippius (Linnaeus, 1767) - 4; Sphecodes monilicornis (W. Kirby, 1802) - 4; Sphecodes pseudofasciatus Blüthgen, 1925 - 4; Systropha planidens Giraud, 1861 - 2; Xylocopa violacea (Linnaeus, 1758) - 3.

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