

Article

Pollen Beetles in Oilseed Rape Fields: Spectrum and Distribution in Czech Republic during 2011–2013

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Abstract: Oilseed rape is frequently damaged by insect pests. Much attention is paid to the protection of oilseed rape against *Brassicogethes aeneus* (Coleoptera: Nitidulidae), which is one of the most significant pests of spring and winter oilseed rape. The presence of different pollen beetle species was monitored in the Czech Republic in the years 2011–2013. A minimum of 500 individuals were captured at each site. Morphometric characteristics and the morphology of male and/or female genitalia were used to determine species. *B. aeneus*, *B. subaeneus*, *B. viridescens* and *B. coracinus* were most abundant. Other species presented in oilseed rape were *B. coeruleovirens*, *B. czwalinai*, *B. matronalis*, *B. anthracinus*, *Boragogethes symphyti*, *Cychramus luteus*, *Fabogethes nigrescens*, *Genistogethes carinulatus*, *Meligethes atratus*, *Sagitogethes maurus*, and *Lamiogethes atramentarius*. Our main conclusion is that the reason for the presence of the pollen beetle species associated with their development into non-cruciferous plants in oilseeds is the sufficiency of pollen as food for beetles. In addition, they may occur here incidentally, as they can be transported relatively long distances by air. Accompanying species of pollen beetles probably also have a positive effect on abundance reduction in species considered to be harmful as they are hosts to parasitoids of the oilseed rape pest.

Keywords: *Brassicogethes*; species spectrum; canola; pests



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1. Introduction

Brassicogethes aeneus Fabricius, 1775 is one of the most significant pests of spring and winter oilseed rape. Treatment against this pest has been used regularly for several decades and is causing problems with resistance to the insecticide's active ingredients. Insecticide resistance testing is carried out in most European countries, including the Czech Republic (CZ). Pollen beetle populations were highly resistant to the pyrethroid lambda-cyhalothrin, according to 2014–2015 test results from CZ [1]. Relatively high proportions of the populations also showed resistance to the pyrethroid tau-fluvalinate [2]. At present, especially if the number of registered active ingredients is reduced, a reduction in the level of resistance cannot be expected. Many other pollen beetle species were present in the oilseed rape in addition to *Brassicogethes* spp. (Coleoptera: Nitidulidae). The larvae of all *Brassicogethes* species develop on Brassicaceae plants, and adults feed on the pollen of various family plants [3,4]. Usually, the pollen beetle (*Brassicogethes aeneus*) is considered a pest of oilseed rape, although there are several other pollen beetle species that may inflict damage as well [5].

The pollen beetles, which are the oilseed rape pests, formerly belonged to the genus *Meligethes* Stephens, 1830. Until recently, the genus *Meligethes* was one of the most numerous of the Nitidulidae family. Just in the Palearctic region, there are about 250 polinivorous species associated with plants of the families Brassicaceae, Lamiaceae, Fabaceae, and

Rosaceae [6]. The classification of this genus, as well as the subfamily Meligethinae, has been revised. Currently, this genus contains many groups of species that are morphologically similar and hardly distinguishable [6]. Some species were excluded from the genus *Meligethes* and newly classified as separate genera: *Boragogethes*, *Brassicogethes*, *Clypeogethes*, *Fabogethes*, *Genistogethes*, *Lamiogethes*, *Meligethes*, *Pria*, and *Sagittogethes* [7].

The beetles of the Nitidulidae family overwinter as adults, in early spring they leave the wintering ground and there is a possibility to find them feeding on the pollen of different species of flowering plants [8]. There are many species of pollen beetles associated with Brassicaceae plants present in the Czech Republic. Namely: *Brassicogethes aeneus*, *B. viridescens* (Fabricius, 1787), *B. anthracinus* (C. Brisout de Barneville, 1863), *B. coeruleovirens* (Forster, 1849), *B. coracinus* (Sturm, 1845), *B. czwalinai* (Reitter, 1871), *B. subaeneus* (Sturm, 1845), *B. matronalis* (Audisio & Spornraft, 1990), and *Clypeogethes lepidii* (Miller, 1852). Other species whose larval development is not associated with Brassicaceae plants but whose adults feed on the pollen of oilseed rape are *Boragogethes symphyti* (Heer, 1841), *Cychnus luteus* (Fabricius 1787), *Epurea aestiva* (Linnaeus, 1758), *Fabogethes nigrescens* (Stephens, 1830), *Genistogethes carinulatus* (Förster, 1849), *Lamiogethes atramentarius* (Förster, 1849), *Meligethes atratus* (Olivier, 1790), *Pria dulcamare* (Scopoli, 1763), and *Sagittogethes maurus* (Sturm, 1845).

Brassicogethes aeneus biology is the best described. All developing stages are described according to Osborn [9]. Adults are 1.9–2.7 mm long, oval in shape, broadly rounded, and have a relatively broad head. The head and body are black with a metallic shine or green, blue, or purple. The legs are lighter, especially the front tibiae, up to dark yellow. The length of the antennae is almost as long as the width of the head. The anterior tibiae are finely toothed on the outer margin (Figure A1 in Appendix A). The middle femur lacks a tooth in the apical third. The eggs are cylindrical, 0.81 mm long, 0.29 mm wide, and whitish gray. The first instar larva is up to 4.4 mm long, and whitish with a brown to black scutellum. The pupa is about 2.35 mm long, oval-shaped, and creamy white colored. *B. aeneus* occurs in Europe, North Africa, and West Asia in fields and forests [10]. This species is oligophagous, their larvae are associated with species of the Brassicaceae family, especially the subfamilies Arabidae, Brassicae, and Hesperidae. It is a significant pest on all Brassicaceae plants, and its larvae develop on *Brassica oleracea* var. *Capitata* L., *B. nigra* (L.) W. D. J. Koch, *Sinapis alba* L., and *S. arvensis* L. [11]. They also develop on *Barbarea verna* (Mill.) Asch. and *B. vulgaris* W. T. Aiton [12] and the genera *Cakile* and *Biscutella* [10]. *B. aeneus* prefers *Brassica rapa* L. to *B. napus* L. after overwintering due to its earlier flowering, as stated by Cook et al. [13]. Borg [14] studied pollen beetle preferences to the host plants and shows this sequence: *B. juncea* (L.) Czern. > *B. napus* > *S. alba*. Kaasik et al. [15] found that beetles are more attracted to *Sinapis alba* than *B. napus*. According to Veroman et al. [16], females of the common pollen beetle prefer species of genus *Brassica* for laying eggs over other species of this family, and if the larvae develop on *Raphanus sativus* L., up to 35% of them remain undeveloped. Noronha and Mason [17], said that *B. aeneus* in Europe infests particularly winter oilseed rape, while spring oilseed rape is infested mainly by *B. viridescens*.

Brassicogethes viridescens (Fabricius, 1787) is 2.4–2.9 mm long. This species is similar to *B. aeneus*, and is metallic shine colored with yellowish legs and finer punctuation at the dorsal part [17]. Hoebeke & Wheeler [18] pointed out that the legs, mouthpart, and proximal antennal segments are yellowish or orange-yellow. The body is elongated-oval, and the color is variable, usually dark green, often with bluish, violet, or less often black, bronze, or copper shining. Pubescence is fine, sparse, silver or yellow, and uniformly distributed. This species is slightly distinguished from the others by the presence of a subapical tooth along the posterior margin of the middle femur [18]. Male and female genitalia bear important distinguishing marks (Figure A2). This species is oligophagous on plants of the Brassicaceae family, mainly on the genus *Brassica* spp. and *Sinapis* spp. Borg [14] shows the order of preferences for nutrient plants: *B. napus* > *S. alba* > *B. juncea*. The beetles were found on flowers of different plant species—*Acer pseudoplatanus* L., *Tripleurospermum inodorum* (L.) Sch.-Bip., *Crataegus* sp., and on plants of the family Ranunculaceae as well. Audisio et al. [19] present *Diploaxis* as a host plant for larvae. Its larval biology is similar to

B. aeneus [17,20] and it is associated with oilseed rape during its larval development [11] and also with species of the Brassicaceae family [21]. Females lay eggs on flower bud bases [22]. As stated by Mason et al. [23], this pollen beetle species is a significant pest of oilseed rape in the Palearctic region and an invasive pest on this plant in Canada. Osborne [9] and Sorauer [24] considered this species to be the second most important pest of oilseed rape, with *B. aeneus* in the first place. This species is widespread [8], especially in disturbed habitats [19]. *B. viridescens* (Figure A2) causes damage in North America [17]. *B. aeneus* and *B. viridescens* are considered to be the most damaging species to cruciferous crops [25]. Zimmer et al. [26] explain that the pollen beetles select pollen-rich plants in both periods—adults in the spring before they lay their eggs and new beetles in the summer after they have hatched—and also feed on pollen from plants outside the Brassicaceae family. For overwintering, they migrate to places outside the field, especially to forests or similar habitats that they prefer [27]. Although *B. aeneus* is considered to be a pest of oilseed rape, Alford [28] states that it can also damage the flowers of fruit species in large numbers in an attempt to obtain pollen. In contrast, the benefits of *B. aeneus* and *B. viridescens* for raspberry pollination are reported by Levesque and Levesque [29].

Brassicogethes anthracinus (C. Brisout de Barneville, 1863) adults are 1.6–2.6 mm long, black, with dense fine punctuation on the pronotum and elytra, rather matte [8]. The distinguishing features are shown in Figure A3. This species is associated with *Isatis tinctoria* L. by its larval development [8,21]. This species occurs mainly in dry grassland stands, dry meadows, and also in disturbed habitats [19].

Brassicogethes coeruleovirens (Forster, 1849) is a species whose bionomy is not completely known yet. The adult is 1.8–2.5 mm long, oval-shaped, and black with a blue or blue-green metallic shine [8]. Distinguishing features are shown in Figure A4.

Brassicogethes coracinus (Sturm, 1845) occurs in xerothermic habitats [30], fields, meadow edges, river banks, and shady stands [10]. Adults are 1.5–2.7 mm long [8]. The body is black or black-brown, never green, blue, or violet metallic shine [10]. The distinguishing features are shown in Figure A5. In the Brassicaceae family, it feeds on *Barbarea* spp., *Sisymbrium* spp., *Brassica* spp., and *Sinapis* spp. [10,11]. The adults were found on *Sisymbrium loeselli* L., *Rorippa austriaca* (Crantz) Besser, and also on species of the Apiaceae family [30]. Larval development takes place on *Brassica* spp., *Sinapis* spp., and *Sisymbrium* spp. Audisio et al. [31] and Kurochkin [32] show only *S. loeselli* as the larval food plant. The simultaneous presence of *B. coracinus* and *B. aeneus* adults on plants of the Rosaceae family is reported by Kurochkin [32]. *B. coracinus* is common in central and northern Europe [10], and Mancini et al. [10] report that it occurs throughout Europe, Turkey, Central Asia, and Siberia. Differentiation between *B. coracinus* and *B. subaeneus* is difficult due to the genital similarity of both species [31].

Brassicogethes czwalinai (Reitter, 1871) adults are 2.3–3.1 mm long and habitually very similar to *B. viridescens*. The anterior tibia is widest at the level of the third tooth [8]. The distinguishing features are shown in Figure A6. This species occurs in mountain and foothill areas and the larvae develop on *Lunaria rediviva* L. [8].

Brassicogethes subaeneus (Sturm, 1845) adults are 1.8–2.2 mm long. The body is oval-shaped, and black with a green metallic shine. The legs are dark brown, with fine teeth on the front leg's tibia [8]. The distinguishing features are shown in Figure A7. Larvae feed on *Cardamine* species [31], *Cardaminopsis* species [33], especially *C. arenosa* (L.) Hayek [10,34]. Adults are found on the flowers of various plants. According to Lasoń [30], they are found on *Armoracia rusticana* P. Gaertn., B. Mey. & Scherb., *Geranium* spp., *Prunus* spp., *Filipendula ulmaria* (L.) Maxim., *Sorbus aucuparia* L., *Oenothera biennis* L., and flowers of the Apiaceae family. It is abundant in lower and middle altitudes [34]. This species is considered to inhabit xerothermic habitats and is widespread, occurring in northern, central, and eastern Europe [10].

Brassicogethes matronalis (Audisio & Spornraft, 1990). The imago of this species is 2.6 mm long and dark brown [35]. It is similar to *B. subaeneus* [36]. During its develop-

ment, larvae are associated with *Hesperis matronalis* L. [31]. It is similar in appearance to *B. subaeneus* [36]. The distinguishing features are shown in Figure A8.

Clypeogethes lepidii (Miller, 1852) is a fine-haired black beetle with a body length of 1.2–2.2 mm; antennae and legs are dark brown to black [8]. The distinguishing features are shown in Figure A9. The larvae develop on *Lepidium draba* L. [8]; *Alyssum* spp., *Aurinia* spp., *Moricandia* spp., *Hesperis* spp., and *Mathiola* spp. Baviera and Audisio [21] show it on *Isatis tinctoria* L. It occurs mainly in lowland meadows [19].

Boragogethes symphyti (Heer, 1841) adults are 2.2–3.0 mm long, the body is convex, oval-shaped, dark blue, rarely dark green colored, with brown legs, the front legs are lighter [8]. The distinguishing features are shown in Figure A10. This species is associated with plants of the Boraginaceae family, particularly *Symphytum* [7]. According to Nunberg [8], larvae develop on *Symphytum officinale* L.

The *Cychramus luteus* (Fabricius 1787) adult body is rusty brown; the pronotum and elytra with hairs in visible rows. [35]. The distinguishing features are shown in Figure A11. The larvae of this species develop in fungi of the Agaricaceae and Lycoperdaceae families, they are often present in species of the genus *Armillaria* and *Lycoperdon*, and less often, in fungi of the class Ascomycetes [37]. According to Rimšaitė [38] and Schigel [39], adults are raised from larvae present in *Armillaria* spp. Jelínek [34] states that larvae develop in the fruiting bodies of softer wood-destroying fungi and adults are present on flowers, especially of *Aruncus dioicus* (Walter) Fernald. It is abundant in Europe, adults feed on the pollen on the flowers of plants around the beehives [40]. Neumann and Ritter [41] reported finding adults in hives. However, *C. luteus* (Fabricius, 1787) did not leave holes in the cells of the honeycomb, and neither oviposition nor the presence of larvae on the combs was detected [41].

Epurea aestiva (Linnaeus, 1758) is 3 mm long, and rusty yellow [35]. The distinguishing features are shown in Figure A12. This species is widespread throughout Europe, where adults are found on plant flowers at the edge of forests [21] and they are abundant in deciduous forests [34]. Kurochkin [32] observed adults most frequently on woody plants of the family Rosaceae—*Cerasus fruticosa* Pall., *Malus domestica* (Suckow) Borkh., *Prunus avium* L., *Rosa majalis* Herrm., *Filipendula ulmaria* and *F. vulgaris* Moench, rarely on *Knautia arvensis* (L.) J.M. Coult. Majka and Klimaszewski [42] consider adults to be sap-feeders. Larvae develop in the nests of bumblebees and small mammals [19,34] and probably also on moldy substrates [34]. As noted by Arbogast et al. [40], the larvae are mycetophagous. This species is widespread in Europe, Asia, and the USA, and it has also been found in Canada [42].

Fabogethes nigrescens (Stephens, 1830) adults are 1.7–2.5 mm long; black with fine punctuation on pronotum and elytra; antennae and the legs are pitch brown; and the first, second, and fourth teeth of forelegs tibia are bigger [8,11]. The distinguishing features are shown in Figure A13. The larvae are associated with plants of the Fabaceae family, in particular *Trifolium* spp. [43], *Onobrychis* spp., *Ononis* spp., *Lotus* spp. [5], *Medicago* spp. [44]. Niezgodziński [45] considers it to be an insignificant pest of *Vicia faba* L. in Poland. It is found in open habitats [46]. It is an important pollinator of *Primula* [47,48] and *Rubus* [29]. Mifsud and Audisio [44] consider it to be a pest of medicinal plants in North America.

Genistogethes carinulatus (Förster, 1849) is 1.4–2.2 mm long, with black antennae and brown legs, and the forelegs tibia are relatively narrow [8]. The distinguishing features are shown in Figure A14. This species is associated with *Lotus corniculatus* L. by their larval development [11,21]. It is mainly found in meadows [19]. Niezgodziński [45] considers it to be an insignificant bean pest. Duke [48] considers it to be a pest of *Onobrychis viciifolia* Scop.

Lamiogethes atramentarius (Förster, 1849). The imago is 2.0–2.8 mm long, oval-shaped, and black with metallic blue or green shine. Pronotum and elytra are finely punctuated. Antennae and legs are reddish-yellow. Tibiae of the foreleg are finely toothed [8]. The distinguishing features are shown in Figure A15. The nutrient plants of larvae are *Galeobdolon luteum* Huds., *Lamium album* L., and *Galeopsis* spp., adults are present on the flowers of various woody plants, e.g., *Crataegus* spp. and *Prunus padus* L. [49].

Meligethes atratus (Olivier, 1790) is 2.4–3.8 mm long and brownish-black. The first antennal segment is darker [8]. The distinguishing features are shown in Figure A16. It occurs at the edges of forests, road ditches, and grassy areas. Audisio et al. [19] stated its presence in disturbed habitats. Its larvae develop on species of the genus *Rosa*, including *R. canina* L. [11]. According to Audisio et al. [7], its larval development is strictly associated with the genus *Rosa* spp. and *Rubus* spp. It most likely also develops on *Prunus* spp., *Pyrus* spp., and *Crataegus* spp. [6]. Adults are polyphagous [11] and it is widespread throughout Europe [8,50].

The *Pria dulcamare* (Scopoli, 1763) imago is 1.6–1.8 mm long and rusty brown. Its body is egg-shaped or oval, less convex, elytra are shortened and 1–3 abdominal tergites are visible. The fourth tarsal segment is always shorter than the others [10,11]. This species is associated with the *Solanum dulcamara* L. [8,11,51,52], as well as with *S. nigrum* L. [11] during its larval development. Adults are also found on flower species other than Solanaceae [44].

The *Sagitogethes maurus* (Sturm, 1845) imago is 2.0–3.0 mm long, black colored, the legs and antennae are dark brown, and the distal part of the tibia of the front legs is distinctly widened [8]. The distinguishing features are shown in Figure A17. All species of this genus are associated with plants of the family Lamiaceae [7]. This species is associated with *Salvia* spp. [43]. Adults are found on the flower of *Salvia pratensis* L., *S. verticillata* L., *Sambucus*, *Taraxacum*, and *Potentilla* [49].

The main contribution of this work was the identification of the species spectrum of the genus *Brassicogethes* present in oilseed rape stands and its representation in the samples. Determining the proportion of *B. aeneus* and *B. viridescens* in the samples was particularly important. The results could help to refine the control of pollen beetles in OSR crops with insecticides, increase their effectiveness, and reduce the selection pressure inducing resistance to insecticides in pollen beetle populations. Until now, only a few authors have dealt with this issue and the available information is not very comprehensive.

2. Materials and Methods

2.1. Sampling Design and Collection of Beetles

Beetles for species identification and ecological analysis were obtained during the monitoring of pollen beetle populations for insecticide resistance in the Czech Republic. They were collected and tested according to International Resistance Action Committee (IRAC) methods for lambda-cyhalothrin No. 011 [53], BISCAYA 240 OD No. 021 [54], chlorpyrifos No. 025 [55], and indoxacarb No. 027 [56]. Beetles were collected from oilseed rape plants at the BBCH 50–60 growth stage. Samples were taken by digging diagonally across the field to include the edge of the plot and the interior. The sample from a tested site contained at least 500 individuals. The beetles were inserted in polyethylene bags with absorbent paper (to prevent water vapor from condensing on the bag walls) and oilseed rape inflorescence or other pollen sources. After collection, the bags were used to ensure adequate air supply. After laboratory testing for resistance, individuals from each site were preserved in 70% alcohol. The coordinates of the locations are shown in Table 1.

2.2. Species Identification

The identification of beetles was performed based on morphometric characteristics and/or using the method of dissection of the genitalia. Individuals that could not be distinguished on the basis of external characteristics were determined according to the species-specific morphology of the genitals. The Olympus SZX-61 stereomicroscope was used for the determination process. The publications by Oliverio et al. [57] and Kirk-Spriggs [11] were used as references for species identification. The scientific names of pests and other animals mentioned in this work are taken from the Fauna Europaea database [58], and the names of the pollen beetles are taken from Audisio [59] and Jelínek [35].

Table 1. Coordinates of observed localities in the Czech Republic.

Year	Locality	Coordinate (North, East)
2011	Bratrušín	49.515422, 16.276741
	Zvole	49.839171, 16.903076
	Mořice	49.333717, 17.197566
	Moravské Knínice	49.287704, 16.497780
	Slavkov u Brna	49.140762, 16.879195
	Dambořice	49.023647, 16.938581
	Bystřice nad Perštejnem	49.517514, 16.255753
	Penčice	49.517401, 17.417763
2012	Popovice	49.103538, 16.612935
	Vranovice-Kelčice	49.391768, 17.087865
	Radvanice-Zaječí důl	49.507250, 17.475009
	Popovice	49.108677, 16.618786
	Bučovice	49.120002, 17.010604
	Rozsíčka	49.554447, 16.472949
	Vedrovice	49.013985, 16.382651
	Němčice	49.454515, 16.724829
	Krhov	49.458186, 16.579196
	Rozsochy	49.524742, 16.173599
2013	Prace u Brna	49.123929, 16.758711
	Česká Třebová	49.91026, 16.452306
	Radvanice	49.509015, 17.487607
	Rosice u Brna	49.182933, 16.382410
	Vyškov	49.287707, 16.996246
	Mokrá Hora	49.263479, 16.594937
	Popovice	49.106671, 16.610350
	Rajhrad	49.081618, 16.574252
	Žabčice	49.023025, 16.615007
	Rozsíčka	49.553857, 16.475463

2.3. Ecological Analysis

The basic ecological characteristics of the monitored (sub) populations species were the presence and absence of the species in the given collection and are utilized for a simple comparison of individual localities [60]. The frequency and regularity of species occurrence are not taken into account. The basic index calculated for each site is the dominance index (D).

Furthermore, the Jaccard index (Ja'), Shannon–Weiner index (H'), Hill index (N2), E—evennes, and E'—corrected evennes index were calculated. The ComEcoPaC 1.0. software was used to calculate the ecological characteristics [61]. The species were divided into five classes of the Tischler scale determined by the percentage in the collections (localities) [60]: Eudominant—representation > 10.1%, dominant—5.1–10%, subdominant—2.1–5%, recedent—1.1–2% and subrecedent—up to 1% of individuals. The dominance index makes it possible to determine whether there are strongly dominant species in the community or whether the community is more balanced. The abbreviations of indices are used by the ComEcoPack program. Explanation of abbreviations: S—number of species (species richness), N—number of specimens (abundance), S_E—number of eudominant species, S_D—number of dominant species, S_{Sd}—number of subdominant species, S_R—number of recedent species, S_{Sr}—number of subrecedent species, N_E—abundance of eudominant species, N_D—abundance of dominant species, N_{Sd}—abundance of subdominant species, N_R—abundance of recedent species, N_{Sr}—abundance of sub-recedent species, H'—Shannon–Wiener index, E—evennes, E'—corrected evennes, D—Simpson's index, N2—Hill's index (inverted Simpson's index).

Eudominant and subrecedent species predominate in anthropogenically influenced biocenoses [62]. Lasoń [37], in his work on the composition of populations of the families

Kateretidae and Nitidulidae, uses an extended range of dominance: this is a six-level scale and includes the following classes of dominance superdominant—over 30%, eudominant—10.0–29.9%, dominant—5.1–9.9%, subdominant—2.1–4.9%, recessive—1.1–2.0% and subrecessive—up to 1% of individuals. In this paper, this scale is only used as an alternative. The key factor in this work is the use of the Tischler scale, which is considered the standard. In the result tables, which are the output of the ComEcoPaC 1.0. software [61], the number of species represented by one (singleton), two (doubleton), or three (tripleton) individuals occurring in the collection at the given locality is also given. The Jaccard index is used to determine the faunistic similarity between pollen beetle samples collected at different localities [60]. The similarity of zoocenoses increases with an increasing index value, which can reach 1 or 100 when converted into percentages.

3. Results

3.1. Species Representation from 2011 to 2013

These pollen beetle species were present in all samples of (sub)populations collected during the years 2011 and 2013 in all collections at all localities: *Brassicogethes aeneus* (Fabricius, 1775), *B. subaeneus* (Sturm, 1845), *B. coracinus* (Sturm, 1845), and *B. viridescens* (Fabricius, 1787). *B. anthracinus* (C. Brisout de Barneville, 1863) was present in 2011 and 2013 years, *B. coeruleovirens* (Förster, 1849) in 2011–2013 years, and *B. czwalinai* (Reiter, 1871) only in 2013. Species with larval stages associated with non-cruciferous plants or hosted by non-plant organisms during their development were also present in some samples. *Boragogethes symphyti* (Heer 1841), *Cychramus luteus* (Fabricius 1787), *Fabogethes nigrescens* (Stephens, 1830), *Genistogethes carinulatus* (Förster, 1849), *Meligethes atratus* (Olivier, 1790) *Sagitogethes maurus* (Sturm, 1845) were present in all collections in each of the above years. In addition, *Lamiogethes atramentarius* (Förster, 1849) was present in 2011 and *Epurea aestiva* (Linnaeus, 1758) in 2012–2013.

3.1.1. Species Representation in 2011

In 2011, a total of 3348 individuals were identified. The representation of individual pollen beetle species in collections from 10 localities in 2011 is shown in Figure 1.

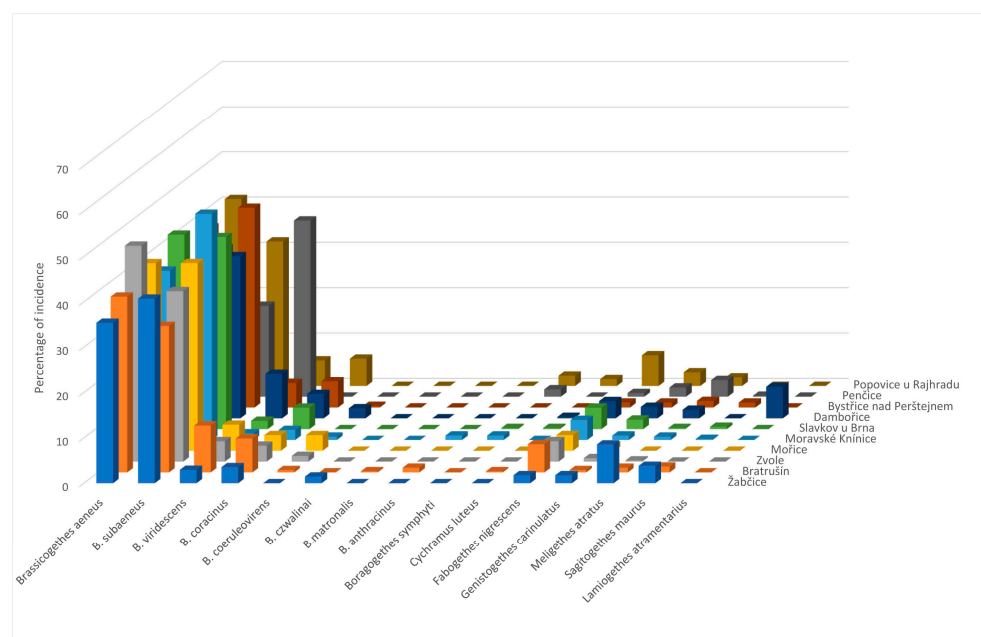


Figure 1. Species spectrum of pollen beetles in individual localities in 2011.

The eudominant species, according to the Tischler classification, were *Brassicogethes aeneus*, *B. subaeneus* in all localities, and *B. viridescens* in the localities of Bratrušín and

Pěnčice. The dominant species were *B. viridescens* in the localities of Mořice, Dambořice, Bystřice nad Pernštejnem, and Popovice u Rajhradu; *B. coracinus* in the localities Bratrušín, Dambořice, Popovice u Rajhradu; *Fabogethes nigrescens* in Bratrušín and Popovice u Rajhradu, *Meligethes atratus* in Žabčice and *Lamiogethes atramentarius* in Dambořice. Using Lason's [37] alternative scale, the superdominant species is *B. aeneus* in all localities, *B. subaeneus* in all localities except for Pěnčice, where *B. viridescens* was superdominant. The values of ecological indicators and indices for individual sampling sites are presented in Table 2. The Jaccard index values calculated for individual localities (Table 3) show that the species composition is the most similar in the localities: Slavkov u Brna and Popovice u Rajhradu (0.9), Slavkov u Brna and Pěnčice (0.8), Zvole and Mořice (0.875), Zvole and Dambořice (0.8), Zvole and Bystřice nad Pernštejnem (0.889), Žabčice and Bystřice nad Pernštejnem (0.8). The lowest value of the Jaccard index (0), was calculated for the localities Bratrušín and Žabčice.

3.1.2. Species Representation in 2012

A total of 5441 individuals were determined in 2012. Figure 2 shows the proportion of each species in the total sample of individual species. Eudominant species, according to Tischler's classification, were *Brassicogethes aeneus* and *B. subaeneus* in all monitored localities, *B. coracinus* in localities Krhov and Rozsochy, *Cychramus luteus* in localities Popovice u Rajhradu and Kojetín, *Meligethes atratus* in localities Vedrovice and Němčice. The dominant species represented in the collections with 5.1–10% were *B. viridescens* in the localities Vranovice, Rozsíčka, Rozsochy, and Kojetín; *B. coracinus* at Vranovice, Radvanice, Bučovice, Rozsíčka, and Němčice; *Boragogethes symphyti* at Kojetín; *Fabogethes nigrescens* at Rozsochy and *Cychramus luteus* at Vranovice-Kelčice and Radvanice.

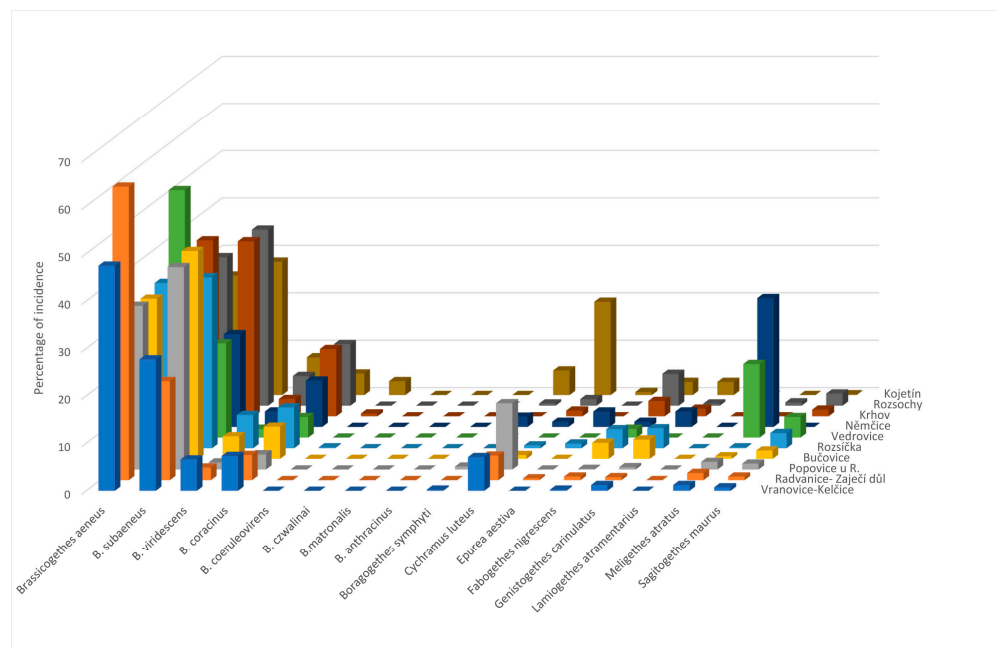
Table 2. Ecological characteristics counted by ComEcoPaC 1.0 software for individual localities in the Czech Republic in 2011.

	Bratrušín	Zvole	Mořice	Moravské Knínice	Slavkov u Brna	Dambořice	Bystřice nad Pernštejnem	Pěnčice	Popovice
S	12	8	7	11	10	10	9	8	9
N	387	399	87	407	380	316	277	489	267
S _E	3	2	2	2	2	2	2	3	2
S _D	2	0	1	0	0	3	2	0	3
S _{Sd}	0	3	3	2	3	3	0	2	2
S _R	3	1	1	1	1	1	4	1	2
S _{Sr}	4	2	0	6	4	1	1	2	0
N _E	315	340	72	355	324	212	232	448	195
N _D	53	0	5	0	0	70	31	0	49
N _{Sd}	0	50	9	27	44	27	0	28	14
N _R	13	5	1	6	7	6	13	8	9
N _{Sr}	6	4	0	19	5	1	1	5	0
H'	2.26	1.77	1.87	1.76	1.80	2.45	1.85	1.98	2.26
E	0.63	0.59	0.67	0.51	0.54	0.74	0.58	0.66	0.71
E'	0.60	0.56	0.59	0.47	0.51	0.71	0.54	0.64	0.69
D	0.28	0.37	0.35	0.39	0.37	0.25	0.36	0.30	0.28
N2	3.63	2.68	2.86	2.56	2.71	4.06	2.79	3.33	3.52

Explanations: S—number of species (species richness), N—number of specimens (abundance), S_E—number of eudominant species, S_D—number of dominant species, S_{Sd}—number of subdominant species, S_R—number of recedent species, S_{Sr}—number of subrecedent species, N_E—abundance of eudominant species, N_D—abundance of dominant species, N_{Sd}—abundance of subdominant species, N_R—abundance of recedent species, N_{Sr}—abundance of subrecedent species, H'—Shannon—Wiener index, E—evennes, E'—corrected evennes, D—Simpson's index, N2—Hill's index (inverted Simpson's index).

Table 3. Jaccard index value of compared CZ localities in 2011.

	Bratrušín	Zvole	Mořice	Moravské Knínice	Slavkov u Brna	Dambořice	Bystřice nad Pernštejnem	Penčice	Popovice u Rajhradu
Žabčice	0.62	0.70	0.60	0.67	0.73	0.58	0.80	0.70	0.64
Bratrušín		0.67	0.58	0.77	0.69	0.69	0.75	0.54	0.62
Zvole			0.88	0.73	0.64	0.80	0.89	0.60	0.70
Mořice				0.64	0.55	0.70	0.78	0.50	0.60
Moravské Knínice					0.75	0.62	0.82	0.73	0.67
Slavkov u Brna						0.67	0.73	0.80	0.90
Dambořice							0.73	0.50	0.73
Bystřice nad Pernštejnem								0.70	0.64
Penčice									0.70

**Figure 2.** Species spectrum of pollen beetles in individual localities in 2012.

Using the alternative Lason's scale, the superdominant species (more than 30% of the collection) are *B. aeneus* in all localities except Němčice and Kojetín and *B. subaeneus* in the localities Popovice u Rajhradu, Bučovice, Rozsčicka, Krhov and Rozsochy. The values of the representation of individual species of pollen beetles and the values of ecological indicators and indices for individual collection sites are given in detail (Table 4). A comparison of Jaccard index values calculated for individual localities (Table 5) shows that the species composition clearly coincides with the localities with the index value 1, namely Vranovice-Kelčice with the localities Popovice u Rajhradu, Bučovice, and Rozsochy; then Popovice u Rajhradu with the localities Bučovice and Rozsochy. The lowest value of the Jaccard index is 0.5 for the localities Vedrovice and Kojetín.

Table 4. Ecological characteristics counted by ComEcoPaC 1.0 software for individual localities in the Czech Republic in 2012.

	Vranovice-Kelčice	Radvanice-Zaječí důl	Popovice	Bučovice	Rozsíčka	Vedrovice	Němčice	Krhov	Rozsochy	Kojetín
S	10	10	10	10	11	7	10	9	10	11
N	815	790	808	737	499	161	92	493	431	615
S _E	2	2	3	2	2	3	3	3	3	3
S _D	3	2	0	1	2	0	1	0	2	2
S _{Sd}	0	1	1	3	3	2	4	2	1	4
S _R	2	1	3	1	1	2	2	3	1	0
S _{Sr}	3	4	3	3	3	0	0	1	3	2
N _E	613	654	737	572	354	141	70	435	351	449
N _D	172	83	0	50	78	0	9	0	56	81
N _{Sd}	0	21	26	90	57	14	11	34	11	80
N _R	20	12	35	13	5	6	2	21	6	0
N _{Sr}	10	20	10	12	5	0	0	3	7	5
H'	2.08	1.76	1.97	2.10	2.32	1.98	2.56	2.10	2.29	2.69
E	0.63	0.53	0.59	0.63	0.67	0.70	0.77	0.66	0.69	0.78
E'	0.61	0.51	0.58	0.62	0.65	0.67	0.70	0.64	0.67	0.77
D	0.32	0.43	0.32	0.32	0.27	0.34	0.21	0.30	0.26	0.19
N2	3.15	2.31	3.10	3.16	3.72	2.94	4.72	3.36	3.81	5.13

Explanations: S—number of species (species richness), N—number of specimens (abundance), S_E—number of eudominant species, S_D—number of dominant species, S_{Sd}—number of subdominant species, S_R—number of recedent species, S_{Sr}—number of subrecedent species, N_E—abundance of eudominant species, N_D—abundance of dominant species, N_{Sd}—abundance of subdominant species, N_R—abundance of recedent species, N_{Sr}—abundance of subrecedent species, H'—Shannon—Wiener index, E—evennes, E'—corrected evennes, D—Simpson's index, N2—Hill's index (inverted Simpson's index).

Table 5. Jaccard index value of compared CZ localities in 2012.

	Radvanice-Zaječí důl	Popovice	Bučovice	Rozsíčka	Vedrovice	Němčice	Krhov	Rozsochy	Kojetín
Vranovice-Kelčice	0.82	1.00	1.00	0.75	0.70	0.82	0.73	1.00	0.75
Radvanice-Zaječí důl		0.82	0.82	0.91	0.70	0.82	0.73	0.82	0.75
Popovice			1.00	0.75	0.70	0.82	0.73	1.00	0.75
Bučovice				0.75	0.70	0.82	0.73	1.00	0.75
Rozsíčka					0.64	0.75	0.82	0.75	0.83
Vedrovice						0.55	0.60	0.70	0.50
Němčice							0.58	0.82	0.75
Krhov								0.73	0.82
Rozsochy									0.75

3.1.3. Species Representation in 2013

A total of 5779 individuals were identified in 2013. Figure 3 shows a representation of individual species in the total sample. Based on the Tischler's classification, eudominant species in all monitored localities were *Brassicogethes aeneus* and *B. subaeneus*, *B. viridescens* in Prace u Brna, Rajhrad, Žabčice and Tuřany, *B. coracinus* in the localities Česká Třebová, Radvanice, Rosice u Brna, Vyškov, Popovice u Rajhradu and Rozsíčka and *Genistogethes carinulatus* in the locality Rozsíčka. The dominant species were *B. coracinus* in the locality of Mokrý Hora; *Boragogethes symphyti* in the localities of Rosice u Brna and Popovice u Rajhradu; *Fabogthes nigrescens* in the localities of Rosice u Brna, Vyškov, Mokrý Hora, Popovice u Rajhradu, Rajhrad, and Žabčice. The superdominant species using the alternative Lasoň's scale [36] is *B. aeneus* in all localities except Rosice u Brna and Popovice u Rajhradu (there these species are eudominant according to Lasoň's scale), *B. subaeneus* is superdominant in

Česká Třebová, Radvanice, Rosice u Brna, Vyškov, Mokrý Hora and Popovice u Rajhradu. The values of the representation of individual species and ecological indicators and indices for individual collection sites are shown in Table 6. As the comparison of the values of the Jaccard index calculated for individual localities (Table 7) shows, it is clear that Radvanice and Rosice u Brna are identical with the value of index 1. The localities of Radvanice, Vyškov and Mokrý Hora (0.916), Rosice u Brna, Vyškov and Mokrý Hora (0.916), Popovice u Rajhradu and Vyškov (0.916) and Mokrý Hora and Žabčice (0.916) are very similar. The lowest value of the Jaccard index is 0.4 for localities Tuřany and Rozsčicka, and as the calculated values show, Tuřany is the locality with the lowest degree of similarity to other localities, Ja values reach 0.4–0.416, only when comparing Tuřany with Rajhrad is Ja 0.625.

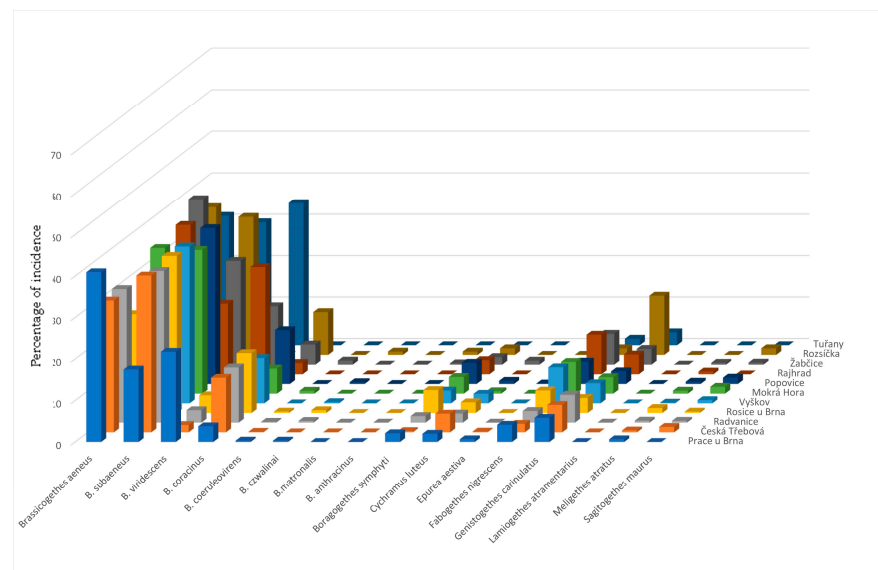


Figure 3. Species spectrum of pollen beetles in individual localities in 2013.

Table 6. Ecological characteristics counted by ComEcoPaC 1.0 software for individual localities in the Czech Republic in 2013.

	Prace u Brna	Česká Třebová	Radvanice	Rosice u Brna	Vyškov	Mokrý Hora	Popovice	Rajhrad	Žabčice	Rozsčicka	Tuřany
S	12	12	12	12	11	11	12	8	12	9	5
N	293	898	944	316	538	700	827	147	926	126	64
S _E	3	3	3	3	3	2	3	3	3	4	3
S _D	1	1	1	2	2	2	2	1	2	0	0
S _{Sd}	4	3	3	3	2	3	2	3	1	0	1
S _R	0	1	1	1	1	1	1	0	2	3	1
S _{Sr}	4	4	4	3	3	3	4	1	4	2	0
N _E	235	745	776	241	421	500	639	116	726	118	61
N _D	17	58	66	34	77	92	93	14	118	0	0
N _{Sd}	35	74	73	33	27	82	63	16	35	0	2
N _R	0	11	15	4	6	13	14	0	27	6	1
N _{Sr}	6	10	14	4	7	13	18	1	20	2	0
H'	2.43	2.29	2.34	2.56	2.37	2.37	2.50	2.36	2.44	2.19	1.82
E	0.68	0.64	0.65	0.71	0.68	0.68	0.70	0.79	0.68	0.69	0.79
E'	0.64	0.62	0.64	0.68	0.67	0.67	0.68	0.75	0.67	0.63	0.73
D	0.25	0.27	0.26	0.23	0.26	0.27	0.24	0.24	0.25	0.27	0.31
N2	3.95	3.71	3.82	4.31	3.90	3.71	4.18	4.18	3.97	3.70	3.28

Explanations: S—number of species (species richness), N—number of specimens (abundance), S_E—number of eudominant species, S_D—number of dominant species, S_{Sd}—number of subdominant species, S_R—number of recedent species, S_{Sr}—number of subrecedent species, N_E—abundance of eudominant species, N_D—abundance of dominant species, N_{Sd}—abundance of subdominant species, N_R—abundance of recedent species, N_{Sr}—abundance of subrecedent species, H'—Shannon—Wiener index, E—evenness, E'—corrected evenness, D—Simpson's index, N2—Hill's index (inverted Simpson's index).

Table 7. Jaccard index value of compared CZ localities in 2013.

	Česká Třebová	Radvanice	Rosice u Brna	Vyškov	Mokrá Hora	Popovice	Rajhrad	Žabčice	Rozsívka	Tuřany
Prace u Brna	0.85	0.85	0.85	0.77	0.77	0.85	0.67	0.71	0.50	0.42
Česká Třebová		0.85	0.85	0.77	0.92	0.85	0.67	0.85	0.50	0.42
Radvanice			1.00	0.92	0.92	0.85	0.67	0.85	0.62	0.42
Rosice u Brna				0.92	0.92	0.85	0.67	0.85	0.62	0.42
Vyškov					0.83	0.92	0.73	0.77	0.67	0.45
Mokrá Hora						0.77	0.73	0.92	0.54	0.45
Popovice							0.67	0.71	0.62	0.42
Rajhrad								0.67	0.55	0.63
Žabčice									0.62	0.42
Rozsívka										0.40

4. Discussion

Brassicogethes aeneus (Fabricius, 1775) is considered a key pest of oilseed rape and turnip rape (*B. rapa*) in Europe [4]; another significant species is *B. viridescens* (Fabricius, 1787), which is harmful in both Europe and North America. Not only is *B. aeneus* present in oilseeds, but other species are also common [62–64]. To our knowledge, few studies have focused on the species spectrum and abundance of individual pollen beetle species in oilseed rape. In Croatia Gotlin Čuljak and Juran [5] dealt with the species spectrum of pollen beetles in oilseed rape, they reported the presence of *Brassicogethes aeneus*, *B. viridescens*, *B. coracinus* (Sturm, 1845), *Clypeogethes lepidii* (L. Miller, 1851), and *Fabogethes nigrescens* (Stephens, 1830). *B. aeneus* was the eudominant species [5], the same results we obtained in 2011 and 2012. Interestingly, *Clypeogethes lepidii* was not present in any of the samples we analyzed. The reason for this remains unknown as we were unable to find any relevant information. *B. aeneus* and *B. viridescens* are among the most common species in the UK [3,9], both these species are also considered to be important in Sweden [65]. In Estonia, *B. viridescens* is very common in oilseed rape, more so in winter oilseed rape [66]. As stated by Finch et al. [67], both species mentioned above can also damage cauliflower and broccoli, reducing their market value. On the other hand, none of the listed pollen beetle species are known to be a pest of cruciferous vegetables in the Czech Republic. The species composition of pollen beetle populations present in oilseed rape fields after overwintering was studied in Hungary by Marczali [68], who found *Brassicogethes aeneus* in all collections, *B. coracinus* was in 78%, *B. viridescens* in 50%, *M. picipes* (Sturm, 1845) in 58%, *M. nigrescens* (Stephens, 1830) in 29%, *Sagitogethes maurus* (Sturm, 1845) in 43%, *M. atratus* (Olivier, 1790) in 21%, *Odontogethes denticulatus* (Heer, 1841) in 14% and *Genistogethes carinulatus* (Förster, 1849) in 7% of collections. Although *M. picipes* and *M. nigrescens* have been incorrectly reported as two species [68], they are in fact only one species—*Fabogethes nigrescens* [59]. As in the work of Marczali [68], *B. aeneus* was present in 100% of our collections in 2011–2013. The situation is slightly different for other species. *B. coracinus* was present in 90% of the samples in 2011 and 2013 and in 100% in 2012. *B. viridescens* was present in 100% of samples in 2011 and 2012 and in 90% of samples in 2013, *Fabogethes nigrescens* was present in 100% of samples in all the years observed. *Sagitogethes maurus* (Sturm, 1845) was present in 60% of samples in 2011, 90% in 2012, and 80% in 2013; *M. atratus* was present in 90% of samples in 2011, 80% in 2012, and 90% in 2013. *Genistogethes carinulatus* was present in 100% of samples in 2011 and 2013, and in 90% of samples in 2012. *Meligethes denticulatus* was absent in all samples during subsequent years. In their next study, Marczali and Keszthelyi [69] reported the presence of four pollen beetle species—*M. aeneus*, *M. coracinus*, *M. viridescens* and *F. nigrescens* in oilseed rape in Hungary. Thieme et al. [70] reported the presence of *B. viridescens*, *F. nigrescens*, *B. coeruleovirens* (Förster, 1849), and *B. coracinus* (Sturm, 1845). When studying the migration of pollen beetles from hibernacula to oilseed

rape fields, Juhel et al. [71] found 99% *B. aeneus* and the presence of only two individuals of *B. viridescens*, they did not specify the species affiliation of the remaining proportion.

In other European countries, several pollen beetle species are found in oilseed rape fields like in the Czech Republic [62–64]. *Brassicogethes aeneus* is the eudominant species in the Czech Republic, but in some localities, *B. subaeneus* is also eudominant [62]. The treatment of oilseed rape against pollen beetles is based on reaching some of the economic threshold values. All specimens of pollen beetles present in oilseed rape are considered to be *Brassicogethes aeneus* (Fabricius, 1775). However, a whole complex of pollen beetles present in oilseed rape has been identified.

One of the first evaluations of the species spectrum of pollen beetles was carried out by us in 2010 [71], where *B. aeneus* (Fabricius, 1775) was found to be a eudominant species. *B. subaeneus* (Sturm, 1845), *B. viridescens* (Fabricius, 1787), and *B. erythropus* (Marsham, 1802) were also eudominant species in several localities as well. In most cases, *B. subaeneus* and *B. viridescens* were dominant or subdominant species. In the following years, pollen beetle populations were again analyzed to determine their species composition. Several pollen beetle species were present in the samples collected from 2011 to 2013 in oilseed rape in different regions of the Czech Republic. The eudominant species were usually *B. aeneus*, *B. subaeneus*, and *B. viridescens*. These results largely correspond to those obtained in subsequent years [62,64].

In reality, the presence of individual species is not taken into account, although the common occurrence of several pollen beetle species in oilseed rape fields has long been known, e.g., [72,73]. The determination of individual species is very time-consuming, and, with a few exceptions, requires the preparation of male and female genitalia. Knowledge of the species spectrum of pollen beetles and their bionomy could be one of the components of anti-resistance strategies. The degree of resistance of pollen beetles to insecticide active ingredients is investigated for population samples containing different species. Some authors claimed that it is not essential to know the level of resistance of other species [74]. Others, however, have considered this issue in more detail. *B. viridescens* is not resistant to insecticides [72]. According to Spaar et al. [22], *B. aeneus* is the most common species in cruciferous oilseeds fields, followed by *B. viridescens*, *B. coracinus* (Sturm, 1845), and *Fabogethes nigrescens* (Stephens, 1830). According to this author, only a few single specimens of *B. coeruleovirens* (Förster, 1849), *Meligethes atratus* (Olivier, 1790), *Lamiogethes bidens* (C. Brisout de Barneville, 1882), *Sagittgethes maurus* (Sturm, 1849), *Meligethes flavimanus* (Stephens, 1830), and *Lamiogethes pedicularius* (Gyllenhal, 1808) were found.

Brassicogethes aeneus is the dominant species together with *B. subaeneus* and *B. viridescens*. The genus *Brassicogethes* was represented in the collections from 81.8 to 90.5% of the pollen beetle population. A similar representation is also mentioned by some authors, e.g., Ouvrard et al. [3], where the representation of *B. aeneus* is 95%. In Lithuania, the representation is 98.2% to 98.8% [75]. In Romania, Talmaciu and Talmaciu [76] examined the fauna of pollen beetles on oilseed rape, and they reported only *B. aeneus*. Up to 1% of *Brassicogethes coracinus* and *Fabogethes nigrescens* were present in growth, as observed by Ouvrard et al. [3]. The presence of these species in spring and winter oilseed rape growths in Lithuania is reported—0.15% *B. coracinus* and 0.04% *F. nigrescens* [77]. In the populations collected from winter oilseed rape fields in the Czech Republic between 2011 and 2013, *B. coracinus* was represented by 4.21%, 7.72%, and 8.41%, (sorted by years ascending) and *F. nigrescens* was 3.75%, 2.42%, and 5.11%, 5.45 (sorted by years ascending). *Brassicogethes viridescens* occurs on all yellow-flowering cruciferous plants, but it is not as abundant as *B. aeneus* [11]. As stated by Derron et al. [72], its relative representation in the stands is highly variable. Ouvrard et al. [3] stated its representation in oilseed rape stands at 4%. Makūnas [77] showed its representation (average from winter and spring oilseed rape) at 0.35%, but later Makūnas [75] performed a genetic analysis of pollen beetles in Lithuania and stated the representation of this species in spring oilseed rape fields at 1.8%. The proportion of *B. viridescens* in our collections was 8.66% in 2011, 4.55% in 2012, and 10.51% in 2013. In 2012, it is close to the value that is reported by Derron et al. [72]. Overall,

however, our results confirm the variability reported by Derron et al. [72]. In Spain, the presence of *B. aeneus*, *B. viridescens*, *B. coeruleovirens*, and *B. coracinus* in oilseed rape fields was reported by Moradillo [78].

The presence of adult *Meligethes atratus* in oilseed rape stands is probably due to the frequent occurrence of rose hips, a nutrient plant for larvae of this species, at field margins. In our collections, *M. atratus* was represented by 1.97% in 2011, 4.85% in 2012, and 0.48% in 2013. Pollen beetles actively fly into oilseed rape stands, but they also use the wind to occupy fields [79]. The pollen beetles can fly up to 13.5 km and can actively reach a distance of up to 300 m [80]. They are often more abundant at the edges of stands. They are also the first to be colonized by pollen beetles [81]. Pollen beetles are more abundant on the windward side of the field [82] and near overwintering sites [71]. The main reason for the presence of pollen beetle species associated with their development on non-cruciferous plants in oilseed stands is sufficient pollen as a food source for adults. Furthermore, as described by Ouvrard et al. [3], they can also occur here randomly if they can be transported over relatively long distances by air currents.

5. Conclusions

Several *Brassicogethes* species occur in oilseed rape stands. Among them, *B. aeneus* (Fabricius, 1775) is the eudominant species in all the sampling sites during all the years monitored. Other eudominant species, but with isolated fluctuations in abundance in some localities and some years, are *B. subaeneus* (Sturm, 1845), *B. viridescens* (Fabricius, 1787), and *B. coracinus* (Sturm, 1845). All species of this genus are associated with cruciferous plants by their larval development.

Thus, as our collection analysis shows, the pollen beetle species associated with cruciferous plants clearly predominated in individual years (representation in the collections was 83.7–93.4%), of which more than half were *B. aeneus* and *B. viridescens*. The pollen beetle species, whose larvae are not associated with the Brassicaceae family by their development, were represented in the collections between 9.6% and 16.3%.

From the point of view of protection of oilseed rape against pollen beetles, it is possible to ignore the fact that there are several species of pollen beetles and to work with this complex genus *Brassicogethes* as one species. To determine the critical number of beetles in the stand for protection purposes, it is not necessary to distinguish between pollen beetle species. On the other hand, when pollen beetle populations sampled in distinct localities are tested on susceptibility to insecticides, it would be good to know the differences in the species composition among them.

The presence of accompanying species can be beneficial, as they host some antagonists of harmful pollen beetle species, such as parasitoids, and can also be a reservoir for insect pathogens, thus indirectly contributing to bioregulation.

At the same time, as *B. aeneus* is treated with insecticides, other pollen beetle species present in the stand are also affected. However, as in the case of *B. aeneus* or the *Brassicogethes* species complex, it can be assumed that resistance to the insecticides used is also selected in the associated species.

Nowadays, it is important to monitor the spectrum of pollen beetle species in oilseed rape fields, but also in mustard or poppy fields. In particular, it provides early detection of harmful species of the Nitidulidae family, such as *Aethina tumida* Murray, 1867, an invasive species harmful to beehives. Species monitoring is also important from an ecological point of view, as it allows us to detect the effects of insecticides on non-target species and to take timely measures against the negative effects of pesticides.

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Appendix A

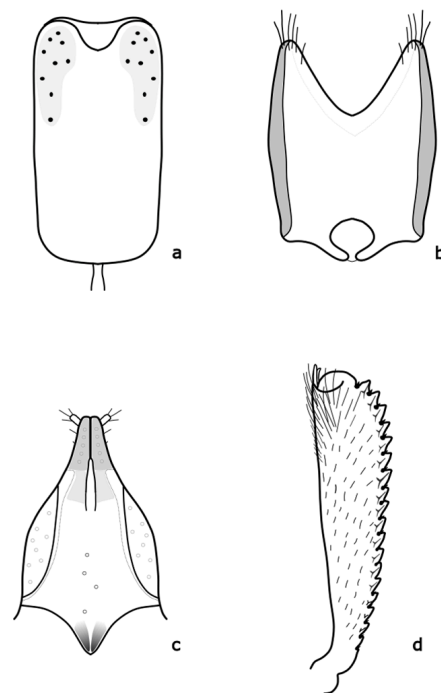


Figure A1. *Brassicogethes aeneus*: (a) penis; (b) tegmen; (c) female genitalia; (d) foreleg tibia. Adapted after Kirk-Spriggs (1996) [11] and Nunberg (1976) [8].

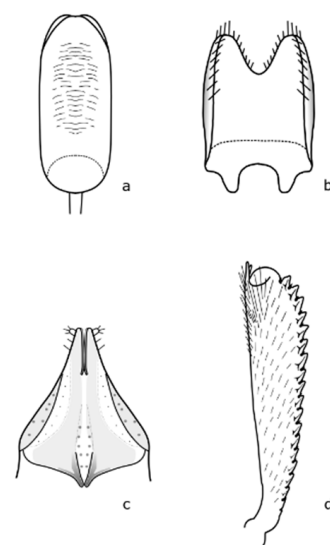


Figure A2. *B. viridescens*: (a) penis; (b) tegmen; (c) female genitalia; (d) foreleg tibia. Adapted after Nunberg (1976) [8].

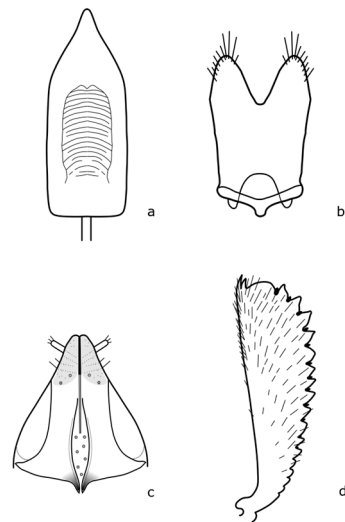


Figure A3. *B. anthracinus*: (a) penis; (b) tegmen; (c) female genitalia; (d) foreleg. Adapted after Nunberg (1976) [8].

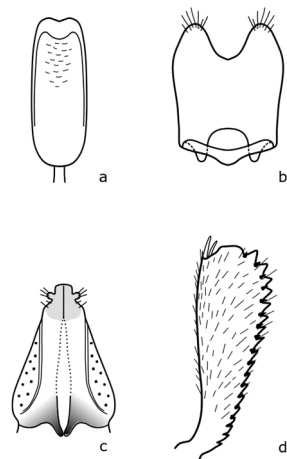


Figure A4. *B. coeruleovirens*: (a) penis; (b) tegmen; (c) female genitalia; (d) foreleg. Adapted after Nunberg (1976) [8].

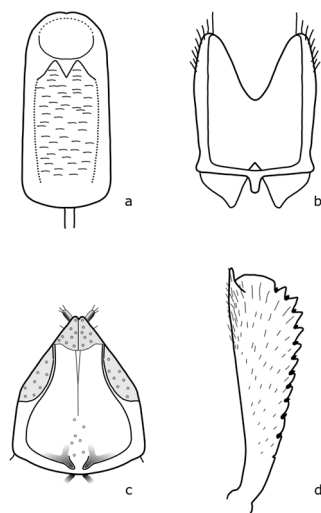


Figure A5. *B. coracinus*: (a) penis; (b) tegmen; (c) female genitalia; (d) foreleg tibia. Adapted after Nunberg (1976) [8].

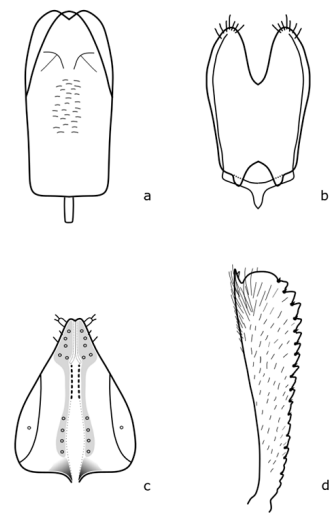


Figure A6. *B. czwalinai*: (a) penis; (b) tegmen; (c) female genitalia; (d) foreleg tibia. Adapted after Nunberg (1976) [8].

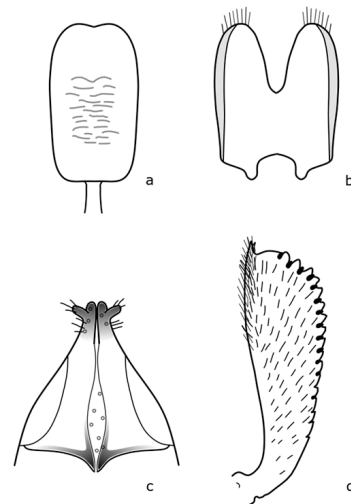


Figure A7. *B. subaeneus*: (a) penis; (b) tegmen; (c) female genitalia; (d) foreleg tibia. Adapted after Nunberg (1976) [8].

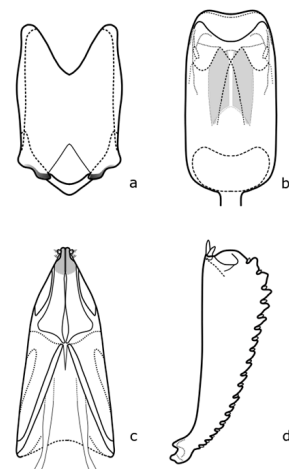


Figure A8. *B. matronalis*: (a) penis; (b) tegmen; (c) female genitalia; (d) foreleg tibia. Adapted after Nunberg (1976) [8].

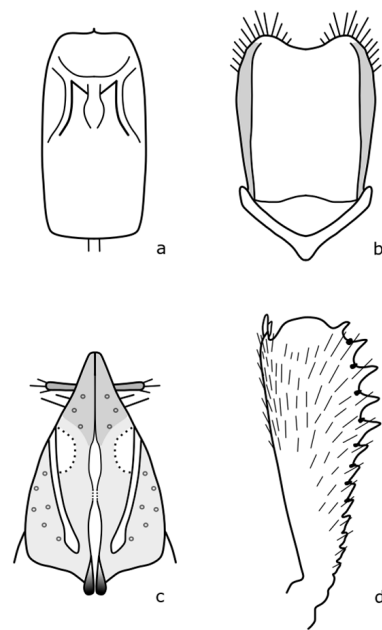


Figure A9. *B. lepidii*: (a) penis; (b) tegmen; (c) female genitalia; (d) foreleg tibia. Adapted after Nunberg (1976) [8].

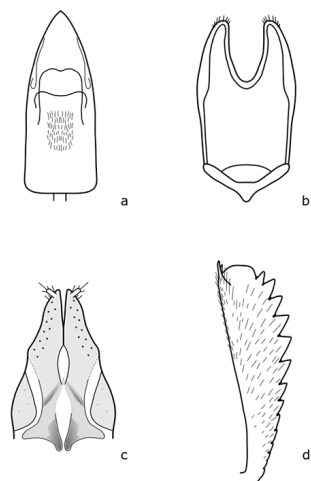


Figure A10. *Boragogethes symphyti*: (a) penis; (b) tegmen; (c) antenna, (d) foreleg tibia. Adapted after Nunberg (1976) [8].

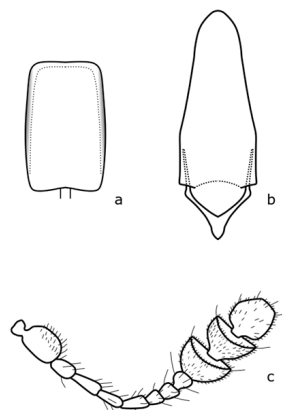


Figure A11. *Cychramus luteus*: (a) penis; (b) tegmen; (c) antenna. Adapted after Nunberg (1976) [8].

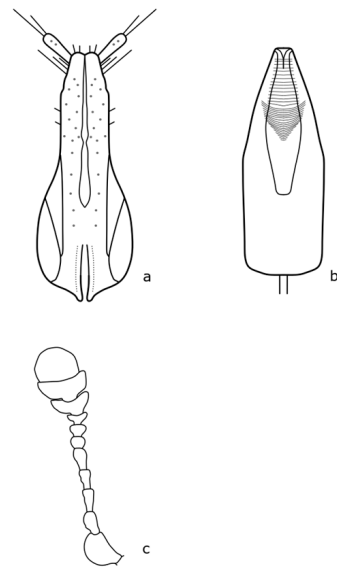


Figure A12. *Epuraea aestiva*: (a) female genitalia; (b) tegmen; (c) antenna. Adapted after Nunberg (1976) [8].

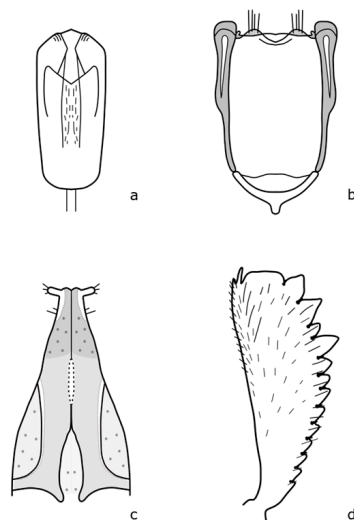


Figure A13. *Fabogethes nigrescens*: (a) penis; (b) tegmen; (c) female genitalia; (d) foreleg tibia. Adapted after Nunberg (1976) [8].

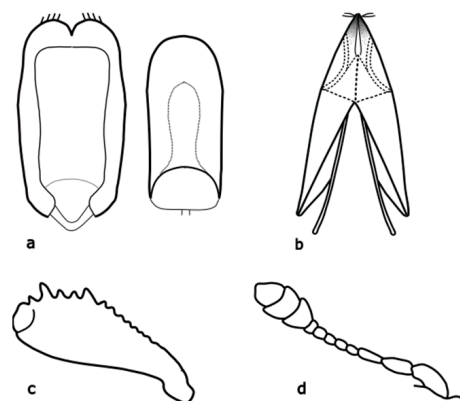


Figure A14. *Genistogethes carinulatus*: (a) penis and tegmen; (b) female genitalia; (c) foreleg tibia; (d) antenna. Adapted after Von Arved Lompe [83].

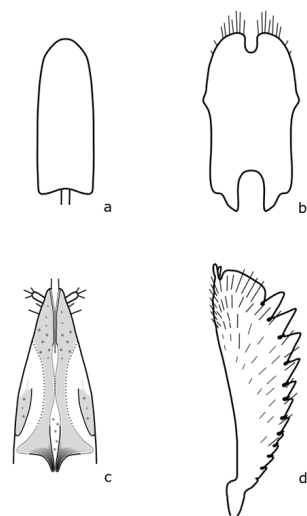


Figure A15. *Lamiogethes atramentarius*: (a) penis; (b) tegmen; (c) female genitalia; (d) foreleg tibia. Adapted after Nunberg (1976) [8].

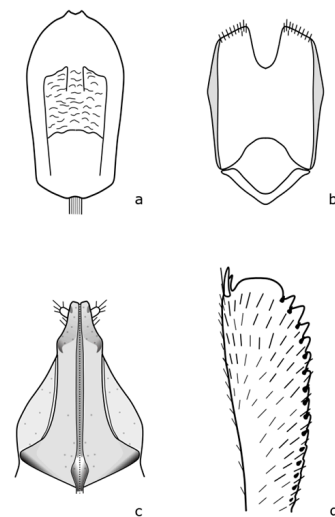


Figure A16. *Meligethes atratus*: (a) penis; (b) tegmen; (c) female genitalia; (d) foreleg tibia. Adapted after Nunberg (1976) [8].

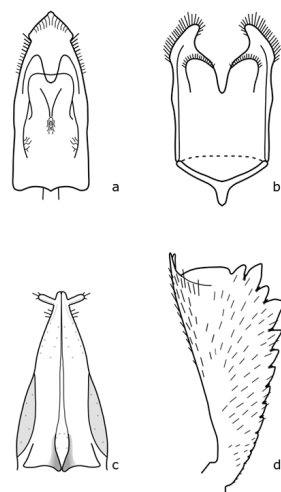


Figure A17. *Sagitogethes maurus*: (a) penis; (b) tegmen; (c) female genitalia; (d) foreleg tibia. Adapted after Nunberg (1976) [8].

References

- Seidenglanz, M.; Poslušná, J.; Rotrekl, J.; Kolařík, P.; Hrudová, E.; Tóth, P.; Havel, J.; Plachká, E.; Tancik, J.; Hudec, K. *Meligethes aeneus* (Coleoptera: Nitidulidae) resistance to lambda-cyhalothrin in the Czech Republic in 2012 and 2013. *Plant Protect. Sci.* **2015**, *51*, 94–107. [\[CrossRef\]](#)
- Rubil, N.; Seidenglanz, M.; Hrudová, E.; Tancik, J.; Ruseňáková, M. Description of the situation regarding pollen beetle resistance to insecticides in the Czech Republic and Slovakia. *IOBC-WPRS Bull.* **2018**, *36*, 78–88.
- Ouvrard, P.; Hicks, D.M.; Moulard, M.; Nicholls, J.A.; Baldock, K.C.; Goddard, M.A.; Kunin, W.E.; Potts, S.G.; Thieme, T.; Veromann, E.; et al. Molecular taxonomic analysis of the plant associations of adult pollen beetles (Nitidulidae: Meligethinae), and the population structure of *Brassicogethes aeneus*. *Genome* **2016**, *59*, 1101–1116. [\[CrossRef\]](#) [\[PubMed\]](#)
- Reddy, G.V.P. *Integrated Management of Insect Pests on Canola and Other Brassica Oilseed Crops*; CABI: Wallingford, UK, 2017; Volume 408.
- Gotlin Čuljak, T.; Juran, I. Raznolikost vrsta potporodice Meligethinae u usjevima uljane repice u Hrvatskoj. *Glas. Biljne Zaštite* **2014**, *14*, 443–449.
- Audisio, P.; Sabatelli, S.; Jelinek, J. Revision of the pollen beetle genus *Meligethes* (Coleoptera: Nitidulidae). *Fragm. Entomol.* **2014**, *46*, 19–112. [\[CrossRef\]](#)
- Audisio, P.; Cline, A.R.; De Biase, A.; Antonini, G.; Mancini, E.; Trizzino, M.; Costantini, L.; Strika, S.; Lamanna, F.; Cerretti, P. Preliminary re-examination of genus-level taxonomy of the pollen beetle subfamily Meligethinae (Coleoptera: Nitidulidae). *Acta Entomol. Entomol. Entomol. Musei Natl. Pragae* **2009**, *49*, 341–504.
- Nunberg, M. Lyszczynkowate—Nitidulidae. Klucze do oznaczania owadów Polski. *Chrzaszczce—Coleopt.* **1976**, *XIX*, 1–91.
- Osborne, P. *Life History, Bionomics and Morphology of the Genus Meligethes (Coleoptera, Nitidulidae), Particularly M. aeneus (F.) and M. viri-descens (F.) and of Associated Parasites*; The University of Edinburgh: Edinburgh, UK, 1957; p. 254.
- Mancini, E.; De Biase, A.; Cline, A.R.; Antonini, G.; Trizzino, M.; Clayhills, T.; Sabatelli, S.; Cerretti, P.; Audisio, P. Morphological, genetic and host-plant diversification in pollen-beetles of the *Brassicogethes coracinus* group (Coleoptera: Nitidulidae: Meligethinae). *Rend. Lincei* **2016**, *27*, 321–339. [\[CrossRef\]](#)
- Kirk-Spriggs, A.H. Pollen beetles Coleoptera: Kateretidae and Nitidulidae: Meligethinae. In *Handbooks for identification of British Insects*; Royal Entomological Society: Wales, UK, 1996; Volume 5.
- Borjesdotter, D. *Barbarea verna* and *Barbarea vulgaris* as host plants for the pollen beetle (*Meligethes aeneus*). *J. Agric. Sci.* **2000**, *134*, 213–220. [\[CrossRef\]](#)
- Cook, S.M.; Rasmussen, H.B.; Birkett, M.A.; Murray, D.A.; Pye, B.J.; Watts, N.P.; Williams, I.H. Behavioural and chemical ecology underlying the success of turnip rape (*Brassica rapa*) trap crops in protecting oilseed rape (*Brassica napus*) from the pollen beetle (*Meligethes aeneus*). *Arthropod-Plant Interact.* **2007**, *1*, 57–67. [\[CrossRef\]](#)
- Borg, A. Oviposition Behaviour of Two Pollen Beetles (*Meligethes aeneus* and *M. viridescens*) on Different Host Plants. In *Department of Entomology*; Swedish University of Agricultural Sciences: Uppsala, Sweden, 1996.
- Kaasik, R.; Kovács, G.; Toome, M.; Metspalu, L.; Veromann, E. The relative attractiveness of *Brassica napus*, *B. rapa*, *B. juncea* and *Sinapis alba* to pollen beetles. *BioControl* **2014**, *59*, 19–28. [\[CrossRef\]](#)
- Veromann, E.; Kaasik, R.; Kovács, G.; Metspalu, L.; Williams, I.H.; Mänd, M. Fatal attraction: Search for a dead-end trap crop for the pollen beetle (*Meligethes aeneus*). *Arthropod-Plant Interact.* **2014**, *8*, 373–381. [\[CrossRef\]](#)
- Noronha, C.; Mason, P.G. Biology, Ecology and Management of Pollen Beetle *Brassicogethes viridescens* (Coleoptera: Nitidulidae). In *Integrated Management of Insect Pests on Canola and Other Brassica Oilseed Crops*; CABI: Wallingford, UK, 2017; p. 88.
- Hoebeker, E.; Wheeler, A. *Meligethes viridescens* (F.) (Coleoptera: Nitidulidae) in Maine, Nova Scotia, and Prince Edward Island: Diagnosis, distribution, and bionomics of a Palearctic species new to North America. *Proc. Entomol. Soc. Wash.* **1996**, *98*, 221–227, ISSN 0013-8797.
- Audisio, P.; Jelinek, J.; Mariotti, A.; De Biase, A. The Coleoptera Nitidulidae and Kateretidae from Anatolian, Caucasian and Middle East regions. *Biogeogr.-J. Integr. Biogeogr.* **2000**, *21*, 115. [\[CrossRef\]](#)
- Horowitz, A.R.; Ishaaya, I. *Insect Pest Management: Field and Protected Crops*; Springer: Berlin/Heidelberg, Germany, 2013; Volume 344.
- Baviera, C.; Audisio, P. The Nitidulidae and Kateretidae (Coleoptera: Cucujoidea) of Sicily: Recent records and updated checklist. *Atti Della Accad. Peloritana Pericolanti-Cl. Sci. Fis. Mat. Nat.* **2014**, *92*.
- Spaar, D.; Kleinhempel, H.; Fritzsche, R. *Öl-und Faserpflanzen*; Springer: Berlin/Heidelberg, Germany, 2013; Volume 248.
- Mason, P.; Olfert, O.; Sluchinski, L.; Weiss, R.; Boudreaux, C.; Grossrieder, M.; Kuhlmann, U. Actual and potential distribution of an invasive canola pest, *Meligethes viridescens* (Coleoptera: Nitidulidae), in Canada. *Can. Entomol.* **2003**, *135*, 405–413. [\[CrossRef\]](#)
- Sorauer, P. *Handbuch der Pflanzenkrankheiten: 3. Band-Die Tierischen Feinde*; PACs Verlag GmbH: Breisgau, Germany, 2013.
- McKinlay, R.G. *Vegetable Crop Pests*; Palgrave Macmillan: London, UK, 1992.
- Zimmer, C.T.; Kohler, H.; Nauen, R. Baseline susceptibility and insecticide resistance monitoring in European populations of *Meligethes aeneus* and *Ceutorhynchus assimilis* collected in winter oilseed rape. *Entomol. Exp. Appl.* **2014**, *150*, 279–288. [\[CrossRef\]](#)
- Rusch, A.; Valantin-Morison, M.; Roger-Estrade, J.; Sarthou, J.-P. Local and landscape determinants of pollen beetle abundance in overwintering habitats. *Agric. For. Entomol.* **2011**, *14*, 37–47. [\[CrossRef\]](#)
- Alford, D.V. *Pests of Fruit Crops: A Colour Handbook*, 2nd ed.; CRC Press: Boca Raton, FL, USA, 2016.

29. Levesque, C.; Levesque, G.-Y. Epigeal and flight activity of Coleoptera in a commercial raspberry plantation and adjacent sites in southern Quebec (Canada): Introduction and Nitidulidae. *Great Lakes Entomol.* **1992**, *25*, 271.
30. Lasoń, A. *Meligethes jelineki* AUDISIO, 1976: Nowy dla fauny Polski gatunek chrząszcza oraz nowe dane o rozszedleniu przedstawicieli rodziny Nitidulidae (Coleoptera) na Podlasiu. *Wiadomości Entomol.* **2002**, *21*, 205–212.
31. Audisio, P.; Belfiore, C.; De Biase, A.; Antonini, G. Identification of *Meligethes matronalis* and *M. subaeneus* based on morphometric and ecological characters (Coleoptera: Nitidulidae). *Eur. J. Entomol.* **2001**, *98*, 87–97. [\[CrossRef\]](#)
32. Kurochkin, A.S. Fauna and bionomy of sap beetles (Coleoptera, Nitidulidae) and kateretid beetles (Coleoptera, Kateretidae) of Krasnosamarskoe forestry farm (Samara region, Russia). *Vestn. Samara Univ. Nat. Sci. Ser.* **2007**, *8*, 120–128.
33. De Biase, A.; Antonini, G.; Mancini, E.; Trizzino, M.; Cline, A.; Audisio, P.A. Discordant patterns in the genetic, ecological, and morphological diversification of a recently radiated phytophagous beetle clade (Coleoptera: Nitidulidae: Meligethinae). *Rendiconti Lince-Sci. Fis. Nat.* **2012**, *23*, 207–215. [\[CrossRef\]](#)
34. Jelínek, J. *Lesknáčkovi brouci* (Coleoptera: Brachypteridae, Nitidulidae) Chraněné krajinné oblasti Orlické hory. *Acta Mus. Richmov. Sect. Natur.* **1998**, *5*, 67–73.
35. Jelínek, J. *Icones Insectorum Europae Centralis* (Coleoptera: Sphindidae, Kateretidae, Nitidulidae). *Folia Heyrovskyana* **2014**, *21*, 1–29.
36. Lasoń, A. *Epuraea* (*Epuraea*) *muehli* REITTER, 1908 i *Meligethes matronalis* AUDISIO et SPORNRAFT, 1990—Nowe dla Polski gatunki chrząszczy oraz nowe dane o rozmieszczeniu Kateretidae i Nitidulidae (Coleoptera) w Polsce. *Wiadomości Entomol. (Entomol. News)* **2004**, *23*, 21–28.
37. Lasoń, A. Zmiany składu gatunkowego i liczebności Kateretidae i Nitidulidae [Coleoptera] jako element monitoringu ekologicznego na terenie Puszczy Białowieskiej. *Leśne Pr. Badaw.* **2004**, *4*, 25–35.
38. Rimšaitė, J. Contribution to the knowledge of insects humificators of fungi in Lithuania. *Acta Zool. Litu.* **2000**, *10*, 95–99. [\[CrossRef\]](#)
39. Schigel, D.S. Fleshy fungi of the genera *Armillaria*, *Pleurotus*, and *Grifola* as habitats of Coleoptera. *Karstenia* **2007**, *47*, 37–48. [\[CrossRef\]](#)
40. Arbogast, R.T.; Torto, B.; Willms, S.; Teal, P.E.A. Trophic Habits of *Aethina tumida* (Coleoptera: Nitidulidae): Their Adaptive Significance and Relevance to Dispersal. *Environ. Entomol.* **2009**, *38*, 561–568. [\[CrossRef\]](#)
41. Neumann, P.; Ritter, W. A scientific note on the association of *Cychramus luteus* (Coleoptera: Nitidulidae) with honeybee (*Apis mellifera*) colonies. *Apidologie* **2004**, *35*, 665–666. [\[CrossRef\]](#)
42. Majka, C.G.; Klimaszewski, J. *Biodiversity, Biosystematics, and Ecology of Canadian Coleoptera*; Pensoft Publishers: Sofia, Bulgaria, 2008; Volume 402.
43. Audisio, P. The Nitidulidae and Kateretidae of Sardinia: Recent data and updated checklist (Coleoptera). In *Biodiversity of Marganai and Montimannu (Sardinia). Research in the Framework of the ICP Forests Network*; Nardi, G., Whitmore, D., Bardiani, M., Birtele, D., Mason, F., Spada, L., Cerretti, P., Eds.; Conservazione Habitat Invertebrati: Marmirolo, Italy, 2011; Volume 5, pp. 447–460.
44. Mifsud, D.; Audisio, P. The Kateretidae and Nitidulidae of the Maltese Archipelago (Coleoptera). *Bull. Entomol. Soc. Malta* **2008**, *1*, 15–37.
45. Niezgodziński, P. New possibilities of controlling some pests of field and broad beans. *Ochr. Roślin* **1988**, *32*, 6–9.
46. Majka, C.G. Beetles in old growth forests: Perspectives from the Townshend Woodlot, Prince Edward Island. *J. Acadian Entomol. Soc.* **2010**, *6*, 39–43.
47. Ford, E.B. *Ecological Genetics*; Springer: Dordrecht, The Netherlands, 2012; Volume 442.
48. Duke, J. *Handbook of LEGUMES of World Economic Importance*; Springer: Greer, SC, USA, 2012; Volume 346.
49. Burakowski, B.; Mroczkowski, M.; Stefanska, J. Chrząszcze, Coleoptera, Cucujoidea, część 1. In *Katalog Fauny Polski*; PWN: Warszawa, Poland, 1986; Volume 23.
50. Löbl, I.; Smetana, A. *Elateroidea, Derodontoidea, Bostrichoidea, Lymexyloidea, Cleroidea and Cucujoidea*; Brill: Leiden, The Netherlands, 2007.
51. Kempenaar, C. *Ecologie en Biologische Bestrijding van Bitterzoet (Solanum Dulcamara): [Deel II]*; AB-DLO: Wageningen, The Netherlands, 1997.
52. Calf, O.W.; van Dam, N.M. Bittersweet bugs: The Dutch insect community on the nightshade *Solanum dulcamara*. *Entomol. Ber.* **2012**, *72*, 193–198.
53. IRAC. Method No. 011. Version 3. IRAC Susceptibility Test Methods Series. 2009. Available online: http://www.irac-online.org/content/uploads/Method_011_v3_june09.pdf (accessed on 5 May 2017).
54. IRAC. Method No. 021. Version: 3.4. IRAC Susceptibility Test. 2011. Available online: https://irac-online.org/content/uploads/Method_021_v3.4_Oct11.pdf (accessed on 5 May 2017).
55. IRAC. Method No. 025. Version: 2. IRAC Susceptibility Test. 2014. Available online: <http://www.irac-online.org/methods/meligethes-species-adults-2/> (accessed on 5 May 2017).
56. IRAC. Method No. 027. Version: 2.0. IRAC Susceptibility Test. 2012. Available online: <http://www.irac-online.org/methods/meligethes-aeneus-adults-2/> (accessed on 5 May 2017).
57. Oliverio, M.; Audisio, P.; Belfiore, C.; Antonini, G.; De Biase, A. Morphological, molecular and ecological evidence of a new Euro-Anatolian species of the *Meligethes coracinus* complex (Coleoptera: Nitidulidae). *Insect Syst. Evol.* **2000**, *31*, 361–385. [\[CrossRef\]](#)
58. De Jong, Y. Fauna Europaea—All European animal species on the web. *Biodivers. Data J.* **2014**, *2*, e4034. [\[CrossRef\]](#)

59. Audisio, P. Fauna Europaea: Coleoptera: Nitidulidae. Fauna Europaea Version 2.6. Available online: <http://www.fauna-eu.org> (accessed on 6 December 2016).
60. Losos, B. *Ekologie živočichů*; Státní pedagogické nakladatelství: Czechoslovakia, Praha, Czech Republic, 1984.
61. Drozd, P. ComEcoPaC—Community Ecology Parameter Calculator. Version 1. 2010. Available online: <http://prf.osu.cz/kbe/dokumenty/sw/ComEcoPaC/ComEcoPaC.xls> (accessed on 7 February 2017).
62. Tóth, P.; Hrudová, E.; Sapáková, E.; Závadská, E.; Seidenglanz, M. Species of the genus *Meligethes* occurring in oil-seed crop fields in the Czech Republic. *Plant Prot. Sci.* **2013**, *49*, 177–186. [\[CrossRef\]](#)
63. Tóth, P.; Hrudová, E.; Sapáková, E.; Seidenglanz, M.; Poslušná, J. Species spectrum of pollen beetles from genus *Meligethes* at selected localities of the Czech Republic in year 2010. In *MendelNet 2011*; Mendel University in Brno: Brno, Czech Republic, 2011.
64. Hrudová, E.; Seidenglanz, M.; Kolařík, P.; Havel, J. Druhové spektrum blýskáčků v porostech řepky na jižní Moravě. The species spectrum of pollen beetles occurring in oilseed crops in the region of South Moravia. In *Prosperující Olejniný*; ČZU v Praze: Skalka, Czech Republic, 2016.
65. Billqvist, A.; Ekbom, B. The influence of host plant species on parasitism of pollen beetles (*Meligethes* spp.) by *Phradis morionellus*. *Entomol. Exp. Appl.* **2001**, *98*, 41–47. [\[CrossRef\]](#)
66. Veromann, E.; Luik, A.; Metspalu, L.; Williams, I. Key pests and their parasitoids on spring and winter oilseed rape in Estonia. *Entomol. Fenn.* **2006**, *17*, 400. [\[CrossRef\]](#)
67. Finch, S.; Collier, R.H.; Elliot, M.S. Seasonal variations in the timing of attacks of bronzed blossom beetles (*Meligethes aeneus*/*Meligethes viridescens*) on horticultural brassicas. In *Brighton Crop Protection Conference, Pests and Diseases*; British Crop Protection Council: Brighton, UK, 1990; pp. 349–354.
68. Marczali, Z.; Keszthelyi, S. A study on *Meligethes* species in Keszthely, 2002. *J. Cent. Eur. Agric. (Online)* **2003**, *4*, 237–244.
69. Marczali, Z.; Keszthelyi, S. Data of the ecology of the four most common Hungarian *Meligethes* species. *Novenyvedelem* **2006**, *42*, 135–139.
70. Thieme, T.; Drbal, U.; Gloyna, K.; Hoffmann, U. Different methods of monitoring susceptibility of oilseed rape beetles to insecticides. *EPPO Bull.* **2008**, *38*, 114–117. [\[CrossRef\]](#)
71. Juhel, A.S.; Barbu, C.M.; Franck, P.; Roger-Estrade, J.; Butier, A.; Bazot, M.; Valantin-Morison, M. Characterization of the pollen beetle, *Brassicogethes aeneus*, dispersal from woodlands to winter oilseed rape fields. *PLoS ONE* **2017**, *12*, e0183878. [\[CrossRef\]](#) [\[PubMed\]](#)
72. Derron, J.O.; Le Clech, E.; Bezencon, N.; Goy, G. Resistance of the pollen beetles (*Meligethes* spp.) to pyrethroids in Western Switzerland. *Rev. Suisse D'agriculture* **2004**, *36*, 237–242.
73. Eickermann, M.; Delfosse, P.; Hoffmann, L.; Beyer, M. A note on the insecticide sensitivity status of *Meligethes* species (Coleoptera: Nitidulidae) in Luxemburg. *J. Plant Dis. Prot.* **2011**, *118*, 134–140. [\[CrossRef\]](#)
74. Čuljak, T.G.; Pernar, R.; Juran, I.; Ančić, M.; Bažok, R. Impact of oilseed rape crop management systems on the spatial distribution of *Brassicogethes aeneus* (Fabricius 1775): Implications for integrated pest management. *Crop. Prot.* **2016**, *89*, 129–138. [\[CrossRef\]](#)
75. Makūnas, V. Identification of pollen beetle (*Brassicogethes* spp.) species using molecular (sequencing) method and GENETIC diversity assesment. *Optim. Ornam. Gard. Plant Assortment Technol. Environ.* **2014**, *5*, 94–103.
76. Talmaciu, M.; Talmaciu, N. Aspects regarding the biodiversity of coleopterofauna in the rape crop. *Cercet. Agron. Mold.* **2011**, *44*, 51–58. [\[CrossRef\]](#)
77. Makūnas, V. Species diversity of pollen beetles (*Meligethes* sl: Coleoptera, Nitidulidae) in oilseed rape and resistance of (*Meligethes aeneus* (F.) to pyrethroids. In *Institute of Agriculture*; Aleksandras Stulginskis University: Akademija, Lithuania, 2012.
78. Moradillo, J.L.V. *El Cultivo Rentable de la Colza: Como Recurso Sostenible del Biodiesel*; Ediciones Agrotécnicas: Madrid, Spain, 2011.
79. Kaasik, R.; Watts, N.P.; Murray, D.A.; Veromann, E.; Cook, S.M. *Effects of Monitoring Position and Time of Day on Pollen Beetle Numbers in Crops of Oilseed Rape*; IOBC-WPRS Bulletin: Göttingen, Germany, 2013; Volume 96, pp. 123–131.
80. Mauchline, A.L.; Cook, S.M.; Powell, W.; Chapman, J.W.; Osborne, J.L. Migratory flight behaviour of the pollen beetle *Meligethes aeneus*. *Pest Manag. Sci.* **2017**, *73*, 1076–1082. [\[CrossRef\]](#)
81. Williams, I.H. *The Infestation of Oil-Seed Rape (Brassica napus L.) by the Pests Meligethes aeneus Fab. and Ceuthorrhynchus assimilis Payk*; University of London: London, UK, 1977; p. 409.
82. Williams, I.H.; Frearson, D.; Barari, H.; McCartney, A. Migration to and dispersal from oilseed rape by the pollen beetle, *Meligethes aeneus*, in relation to wind direction. *Agric. For. Entomol.* **2007**, *9*, 279–286. [\[CrossRef\]](#)
83. Von Lompe, A. Käfer Europas (Coleoptera, Nitidulidae) Gattung *Meligethes*—Untergattung *Genistogethes* (*Meligethes-Erythropus*-Gruppe). Available online: <https://coleonet.de/coleo/texte/genistogethes.htm> (accessed on 4 April 2023).

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