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## ***Hoplitis (Hoplitis) galichicae* spec. nov., a new osmiine bee species from Macedonia with key to the European representatives of the *Hoplitis adunca* species group (Megachilidae, Osmiini)**

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### **Abstract**

*Hoplitis (Hoplitis) galichicae* spec. nov., a new European osmiine bee species belonging to the *Hoplitis adunca* species group (Osmiini) is described and diagnosed. It is currently known only from the Galichica mountain range in southwestern Macedonia. Analysis of pollen contained in the metasomal scopae revealed that all females of the type series collected pollen on the flowers of *Sedum* (Crassulaceae), which is unexpected as most other members of the *Hoplitis adunca* species group are oligolectic or mesolectic on flowers of Boraginaceae and/or Fabaceae. An identification key including all European representatives of the *Hoplitis adunca* species group is given.

**Key words:** Apiformes, Galichica national park, host plant choice, Hymenoptera, *Sedum*

### **Introduction**

Osmiine bees constitute a tribe within the family Megachilidae (Michener 2007; Praz *et al.* 2008). Including taxa from the Canary Islands, Cyprus and the Caucasus, about 270 Osmiini species have been recorded so far in Europe (Müller 2015). Recently, 15 new European osmiine bee species mainly from Spain, Sicily or Greece have been described (Müller 2012). This indicates that the bee fauna of southwestern, southern and southeastern Europe is still incompletely known and that remote and undersampled regions might harbour hitherto overlooked species, even of the Megachilidae, which are among the best studied bee taxa in Europe. Recent examination of megachilid bee material from Macedonia revealed the existence of a further undescribed osmiine bee species, which belongs to the *Hoplitis adunca* species group of *Hoplitis (Hoplitis)*. In the present publication, this new species is described and diagnosed against its closest relatives. In addition, a key is given for all 25 European representatives of the *Hoplitis adunca* species group, which is one of the taxonomically most challenging osmiine bee taxon due to the high morphological uniformity among its species, especially in the female sex.

### **Material and methods**

Morphological terminology and definitions for body measurements follow Michener (2007) with the following specifications, which refer to the species description and the identification key: i) the distance between lateral ocellus and preoccipital ridge was measured in top view rather than in lateral view; ii) the diameter of an ocellus was measured under inclusion of the ocellar border, which is often of the same colour as the surrounding cuticle thereby differing from the usually light colour of the central part of the ocellus; iii) the length of a segment of the labial palpus was measured from its sclerotized base to the sclerotized base of the subsequent segment; iv) the length of an antennal segment was measured along its lower margin, while its width corresponds to the maximal width of the segment. Numbering of antennal segments starts from the scape, which is antennal segment 1. The number of a segment belonging to a segmented body part is put into parentheses if a character of that segment is

not developed in all individuals; thus, “terga 1–4(5) with apical white hair bands” means that tergum 5 sometimes lacks apical hair bands. Measurements to the nearest 0.1mm or 0.5mm (for body length) were taken using an ocular micrometer on an Olympus VMT stereomicroscope. Photomicrographs were taken with the digital microscope Keyence VHX-2000. To assess the pollen hosts of the species, scopal pollen contents of all available females were analysed by light microscopy applying the method of Sedivy *et al.* (2013b).

## Species description

### *Hoplitis (Hoplitis) galichicae* Müller spec. nov.

**Holotype.** MACEDONIA: N.P. Galicica, 600–1500m, 26.6.2014, ♂ (leg. J. Halada & M. Fabianová). Deposited in the private collection of M. Schwarz (Ansfelden).

**Paratypes.** MACEDONIA: N.P. Galicica, 600–1500m, 26.6.2014, 25♀, 6♂ (leg. J. Halada & M. Fabianová). Deposited in the Entomological Collection of ETH Zurich and the private collections of M. Schwarz (Ansfelden) and the author.

**Diagnosis.** With a body length of only 5–6.5mm, *H. galichicae* is the smallest representative of the *Hoplitis adunca* species group in Europe, where all other species of that group attain a body length of at least 6–6.5mm. The female is further characterized by the only weakly convex clypeus (Fig. 1) in combination with the long and slender, almost straight and apically pointed hind tibial spurs (Fig. 3), the short antennal segment 3, which is about 1.5x as long as wide, and the sparse pilosity of the supraclypeal area (Fig. 1). The male is additionally characterized by the oval, laterally rounded and evenly haired lobes of the membraneous appendage of sternum 6, which are directed laterally and separated from each other by an angle of almost 120° (Fig. 6), in combination with the slender, almost straight and apically pointed hind tibial spurs.

**Description.** FEMALE: Body length 5–6.5mm. *Head:* Head about 0.95x as long as wide (Fig. 1). Distance between lateral ocellus and preoccipital ridge about 1.6x as long as ocellar diameter. Maximal width of genal area about 0.6x as long as maximal width of compound eye. Second segment of labial palpus 1.75–1.85x as long as first segment. Antennal segment 3 about 1.5x as long as wide. Clypeus weakly convex (Fig. 1); in profile, clypeal surface not or only slightly projecting above surface of supraclypeal area. Punctuation of clypeus and supraclypeal area very dense with interspaces rarely exceeding the diameter of half a puncture except sometimes for a small polished area at the clypeal base (Fig. 1). Face rather sparsely covered with long white hairs, which do not hide the cuticular surface neither on clypeus and paraocular nor on supraclypeal area (Fig. 1). *Mesosoma:* Punctuation of scutum and scutellum dense with interspaces usually not exceeding the diameter of one puncture except for the lateral parts of the scutum, where the interspaces may reach the diameter of one and a half to two punctures. Punctuation of mesepisternum dense with interspaces varying in size between the diameter of half a puncture and the diameter of one to one and a half punctures. Tibial spur of fore leg with short and pointed tooth, which is about as long as its basal width. Inner tibial spur of hind leg yellowish and long and slender, its apex pointed and only very slightly curved (Fig. 3). Pilosity on inner side of hind basitarsus yellowish-white. Tegula blackish in its anterior third and yellowish-brown in its posterior two thirds. Stigma and veins of fore wing (dark) brown to black. *Metasoma:* Punctuation of tergal discs rather scattered with interspaces varying in size between the diameter of one and a half to one puncture (laterally) and the diameter of two to three, rarely four punctures (medially). Punctuation of marginal zones of terga distinctly finer and denser than on discs and restricted to the basal half. Terga 1–4(5) with short apical white hair bands, which are medially interrupted in older specimens. Longest hairs on median half of tergum 1 less than half as long as maximal length of lateral hair tuft. Discs of terga 5–6 with very sparse appressed white pilosity. Sternum 6 densely punctured and dull except usually for a narrow unpunctured median zone; its apical carina very weak, evenly rounded, of constant height throughout and continuous or only narrowly interrupted medially (Fig. 2). Scopa whitish except sometimes for some blackish hairs at its base.

MALE: Body length 5–6mm. *Head:* Head about 0.85x as long as wide. Distance between lateral ocellus and preoccipital ridge about 1.45x as long as ocellar diameter. Maximal width of genal area about 0.5x as long as maximal width of compound eye. Second segment of labial palpus 1.7–1.8x as long as first segment. Antennal segment 3 1.1x, segment 4 0.7x, segments 5–11 0.75x, segment 12 1x and segment 13 1.6x as long as wide (Fig. 4). Anterior side of antennal segments (3)4–12 and posterior side of segments (5)6–12 yellowish except sometimes for



the slightly darkened upper margin (Fig. 4). *Mesosoma*: Punctuation of scutum, scutellum and mesepisternum similar to that of the female albeit slightly finer and less dense on scutum and scutellum. Tibial spurs of hind leg yellowish and slender, almost straight and apically pointed. Colour of tegula and of wing venation as in the female. *Metasoma*: Punctuation of terga similar to that of the female. Terga 1–4(5) with short apical white hair bands, which are medially interrupted in older specimens. Apical margin of tergum 6 medially crenulate and laterally with distinct tooth (Fig. 5). Apical margin of tergum 7 evenly rounded (Fig. 5). Sterna 2–3 with strong transverse swellings, which are almost devoid of punctures and narrowly interrupted medially (Fig. 7). Transverse swelling of sternum 4 distinctly less strongly developed than on sterna 2–3, sparsely punctured and broadly interrupted medially (Fig. 7). Apical margins of sterna 2–4 almost straight and beset with white hairs, which are much longer laterally than medially (Fig. 7). Sternum 5 strongly shagreened in its basal half, rather coarsely and densely punctured in its preapical part with interspaces reaching the diameter of up to one and a half to two punctures, and very finely and densely punctured along its marginal zone; its apical margin slightly emarginated medially (Fig. 6). Base of sternum 6 with a pair of large translucent flaps (Fig. 6). Lateral lobes of the bilobed membranous appendage of sternum 6 oval (about 1.6x as wide as long), laterally rounded to truncate, densely covered with hairs slightly directed backwards and separated from each other by an angle of almost 120° (Fig. 6).

**Distribution.** Known so far only from the Galichica national park in southwestern Macedonia.



**FIGURE 1–7.** *Hoplitis galichicae*. 1: Head of female. 2: Sterna 5–6 of female. 3: Inner hind tibial spur of female. 4: Antenna of male. 5: Terga 4–7 of male. 6: Sterna 5–6 of male. 7: Sterna 2–5 of male.

**Pollen hosts.** The pollen loads of six females of the type series all consisted exclusively of pollen of an unknown species of *Sedum* (Crassulaceae). Interestingly, the pollen masses in the metasomal scopae of all females were noticeably moist, indicating that the females had added nectar to the collected pollen probably in order to facilitate the transport of the minute *Sedum* pollen grains, which were found to have a diameter of only about 15µm. If *H. galichicae* should turn out to have a clear or even exclusive preference for the flowers of Crassulaceae as pollen hosts, it would be an exception within the *Hoplitis adunca* species group as most of its members are oligolectic or mesolectic on flowers of Boraginaceae (mostly *Echium*) and/or Fabaceae (Sedivy *et al.* 2013b; Müller 2015; Tab. 1). However, Crassulaceae pollen was found to be rarely collected also by *H. loti* and *H. ravouxi*, two mesolectic species of the *Hoplitis adunca* species group, which otherwise show a clear preference for the pollen of Loteae (Fabaceae) (Sedivy *et al.* 2013b).

**Nesting biology.** Unknown. As most species of the *Hoplitis adunca* species group nest in depressions or cavities of stones and rocks and build their brood cells with mud often combined with small pebbles (Sedivy *et al.* 2013a; Müller 2015), *H. galichicae* is expected to exhibit an analogous nesting behaviour as its relatives.

**Etymology.** *galichicae* = from the Galichica mountain range in southwestern Macedonia.

## Key to the European species of the *Hoplitis adunca* species group

Based on a molecular phylogeny of the genus *Hoplitis*, Sedivy *et al.* (2013b) merged the former *Hoplitis* subgenera *Annosmia* Warncke, *Bytinskia* Mavromoustakis, *Coloplitis* Griswold and *Hoplitis* Klug into a single subgenus *Hoplitis*. This enlarged taxon is currently divided into five species groups (Müller 2015). Two of these groups occur in Europe, i.e. the *Hoplitis adunca* species group and the *Hoplitis annulata* species group, which correspond to the former subgenera *Hoplitis* and *Annosmia*, respectively (Michener 2007). The males of these two groups distinctly differ by i) the shape of tergum 7, which is evenly rounded to truncate in the *Hoplitis adunca* species group but deeply bifid in the *Hoplitis annulata* species group, ii) the form of the mandible, which is usually two-toothed in the former but always three-toothed in the latter, and iii) the shape of the last antennal segment, which is apically hooked down in the *Hoplitis annulata* species group but only rarely so in the *Hoplitis adunca* species group. In contrast, no clear morphological characters are known that unambiguously separate the females of the two species groups. The following identification key comprises all 25 species of the *Hoplitis adunca* species group known to occur in Europe including the Canary Islands and Cyprus but excluding the Caucasus.

Compared to the males, which are rather well characterized by the shape of both the antenna and the membranous appendage of sternum 6, the females of the *Hoplitis adunca* species group are morphologically highly uniform and notoriously difficult to identify. To facilitate identification, the European distribution area and the pollen host preferences are detailed for each species in Table 1. However, our present knowledge on the distribution of numerous species is far from complete and might partly even contain errors. In fact, due to the difficult identification of numerous species, which has resulted in many misidentifications on the one hand and in substantial amounts of undetermined material in collections on the other hand, much work is still needed to clarify the exact distribution of the representatives of the *Hoplitis adunca* species group in Europe. The key is tailored to European populations. As North African and Asian populations of several species slightly differ morphologically from those of Europe, the proper identification of females from outside Europe might not always be possible.

Two females and two males of *Hoplitis adunca* all collected at the same day and locality in western Sardinia are unusually small and have a shorter proboscis and a narrower vertex compared to mainland individuals of *H. adunca*, from which they otherwise do not differ morphologically. Similarly, a single *Hoplitis* male from Crete differs from males of *Hoplitis pici*, which it otherwise closely resembles, by the shape of both the genitalia and the last antennal segment. More material from Sardinia and Crete is needed to judge whether these specimens are merely aberrant specimens of *H. adunca* and *H. pici*, respectively, or whether they should be assigned to new (sub)species. These two still enigmatic taxa are not included in the key.

### Females

- |      |  |                                  |
|------|--|----------------------------------|
| 1    | Galea of proboscis with specialized pollen-harvesting bristles, which are curved at an angle of 45–90° in their apical third. Tibial spur of fore leg apically truncate or rounded, without projecting tooth ..... | 2                                |
| -    | Galea of proboscis with unspecialized bristles, which are straight along their whole length. Tibial spur of fore leg apically prolonged into a shorter or longer tooth .....                                       | 3                                |
| 2(1) | Curved bristles limited to the basal half of the galea. Tibial spur of fore leg apically truncate. Body length 8–9mm .....   | <i>Hoplitis lithodora</i> Müller |



- Curved bristles covering the whole galea except for a short apical zone. Tibial spur of fore leg apically rounded. Body length 7.5–9mm ..... *Hoplitis pici* (Friese)
- 3(1) Clypeus densely covered with specialized suberect pollen-harvesting bristles, which have a strong basal part of brownish colour and a thin and slightly wavy apical part of whitish colour. Punctuation of clypeus coarse and rather scattered with interspaces reaching the diameter of one puncture. Body length 6–7mm ..... *Hoplitis bihamata* (Costa)
- Clypeus covered with unspecialized whitish pilosity. Punctuation of clypeus fine and dense with interspaces usually not reaching the diameter of one puncture except for the median or basal part of the clypeus in some species, where the punctuation is more scattered ..... 4
- 4(3) Lateral lobes of pronotum distinctly inflated and sparsely punctured with polished interspaces. Punctuation of anterior half of scutum on both sides of the median impression scattered with interspaces reaching the diameter of up to one and a half to two punctures. Punctuation between lateral ocellus and compound eye scattered with interspaces reaching the diameter of up to two, rarely more punctures. Pilosity of mesosoma and terga very long and scrubby. Body length 8.5–10.5mm ..... *Hoplitis strymonia* Tkalcu
- Lateral lobes of pronotum not inflated and usually densely punctured and dull. Punctuation of anterior half of scutum on both sides of the median impression as well as between lateral ocellus and compound eye usually dense with interspaces rarely exceeding the diameter of one puncture except for the Canarian endemite *H. perambigua*, where the punctuation is less dense. Pilosity of mesosoma and terga often shorter and less scrubby ..... 5
- 5(4) Proboscis very long, second segment of labial palpus about 2.9x as long as first segment; in repose, proboscis slightly surpasses trochanter of hind leg. Body length 6.5–8mm ..... *Hoplitis holmboei* (Mavromoustakis)
- Proboscis shorter, second segment of labial palpus less than 2.5x as long as first segment; in repose, proboscis does not reach trochanter of hind leg ..... 6
- 6(5) Apical margin of sternum 6 medially prolonged into a distinct and well delimited tooth of narrowly triangular to linear shape. Body length often exceeding 8–9mm ..... 7
- Apical margin of sternum 6 medially rounded to tapering, but never with distinct and well delimited tooth. Body length usually less than 9–10mm except for *H. lepeletieri* ..... 13
- 7(6) Sternum 6 lateroapically without or with very weak carina, almost plane and densely punctured and dull. Antennal segment 3 more than 2.5x as long as wide. Discs of terga 2–5 with long pilosity. Body length 10.5–12.5mm .. *Hoplitis mucida* (Dours)
- Sternum 6 lateroapically with very strong carina, zone adjacent to the carina sparsely punctured and polished. Antennal segment 3 about 2x as long as wide. Discs of terga 2–5 with short pilosity ..... 8
- 8(7) Pilosity of inner side of basitarsus of hind leg brownish at least apically. Scopa often more or less smoky brown. When seen from behind, longest hairs on median half of tergum 1 almost as long as maximal length of lateral hair tuft. Inner tibial spur of hind leg apically distinctly curved (only slightly curved in north African specimens). Apical tooth of tibial spur of fore leg about as long as its basal width (often longer in north African specimens) and acute. Body length 8–10.5mm ..... *Hoplitis fertoni* (Pérez)
- Pilosity of inner side of basitarsus of hind leg yellowish-white to yellowish-red. Scopa whitish except for its base, which is occasionally smoky brown. When seen from behind, longest hairs on median half of tergum 1 distinctly shorter than maximal length of lateral hair tuft. Inner tibial spur of hind leg apically only slightly curved. Apical tooth of tibial spur of fore leg longer than its basal width or rounded ..... 9
- 9(8) Apical tooth of tibial spur of fore leg more or less rounded. Punctuation of lateral parts of clypeus less dense with distinct polished interspaces. Punctuation of supraclypeal area scattered with interspaces reaching the diameter of one to one and a half, rarely two punctures. Second segment of labial palpus 1.5–1.6x as long as first segment. Body length 8–10mm. No morphological characters are known to distinguish the following two species. However, identification should be possible based on the apparently almost non-overlapping distribution areas (see Tab. 1) .. *Hoplitis fabrei* Zanden and *Hoplitis pallicornis* (Friese)
- Apical tooth of tibial spur of fore leg acute. Punctuation of lateral parts of clypeus very dense lacking distinct polished interspaces. Punctuation of supraclypeal area dense with interspaces rarely reaching the diameter of one puncture. Second segment of labial palpus at least 1.7x as long as first segment ..... 10
- 10(9) Distance between lateral ocellus and preoccipital ridge more than 3x as long as ocellar diameter. Tibial spurs of hind leg reddish-brown to black. Body length 10.5–13.5mm ..... *Hoplitis manicata* (Morice)
- Distance between lateral ocellus and preoccipital ridge less than 3x as long as ocellar diameter. Tibial spurs of hind leg black, reddish-brown or yellowish-red. Body length rarely exceeding 10.5mm ..... 11
- 11(10) Distance between lateral ocellus and preoccipital ridge 1.8–2x as long as ocellar diameter. Second segment of labial palpus 1.7–1.8x as long as first segment. Punctuation of discs of terga 1–3(4) rather dense: largest interspaces on the two longitudinal fifths adjacent to each side of the median fifth rarely exceeding the diameter of one and a half punctures. Tibial spurs of hind leg reddish-brown to black. Body length 8–10.5mm ..... *Hoplitis benoisti* (Alfken)
- Distance between lateral ocellus and preoccipital ridge at least 2.4x as long as ocellar diameter. Second segment of labial palpus at least 2.2x as long as first segment. Punctuation of discs of terga 1–3(4) very scattered: largest interspaces on the two longitudinal fifths adjacent to each side of the median fifth usually reaching the diameter of three to four, sometimes even more punctures. Tibial spurs of hind leg black or yellowish-red ..... 12
- 12(11) Tibial spurs of hind leg mostly black to dark reddish-brown. Outer marginal zone of tegula without punctures on its posterior half or with broadly interrupted row(s) of punctures. Second segment of labial palpus slightly less than 2.3x as long as first segment. Interspaces between punctures on vertex usually without or with few micropunctures. Marginal zones of terga mostly black. Body length 9–11mm ..... *Hoplitis adunca* (Panzer)
- Tibial spurs of hind leg yellowish-red. Outer marginal zone of tegula often punctured along its whole length. Second segment of labial palpus slightly more than 2.3x as long as first segment. Interspaces between punctures on vertex usually with many micropunctures. Marginal zones of terga often more or less reddish-brown. Body length 9–11mm ..... *Hoplitis submanicata* Zanden

- 13(6) Apex of inner tibial spur of hind leg acute and almost straight to slightly bent at an angle of less than 45° ..... 14
- Apex of inner tibial spur of hind leg blunt or strongly curved at an angle of more than 45° ..... 19
- 14(13) Antennal segment 3 longer, 1.75–2x as long as wide. When seen from behind, longest hairs on median half of tergum 1 almost as long as maximal length of lateral hair tuft ..... 15
- Antennal segment 3 shorter, about 1.5x as long as wide. When seen from behind, longest hairs on median half of tergum 1 about half as long as maximal length of lateral hair tuft or shorter ..... 17
- 15(14) Pilosity of inner side of hind basitarsus (dark) greyish-brown. Apical white hair bands of terga 1–4 broadly interrupted. Punctuation of anterior half of scutum moderately dense with interspaces often reaching or exceeding the diameter of one puncture. Punctuation of median half of tergal discs 1–3 very fine and widely scattered. Body length 6–7.5mm ..... *Hoplitis perambigua* (Peters)
- Pilosity of inner side of hind basitarsus yellowish-white. Apical white hair bands of terga 1–4 not interrupted in fresh specimens. Punctuation of anterior half of scutum very dense with interspaces rarely exceeding the diameter of half a puncture. Punctuation of median half of tergal discs 1–3 distinctly coarser and denser. Body length at least 8mm ..... 16
- 16(15) Pilosity of terga shorter: when seen in profile, longest hairs on median half of tergal disc 2 about 2x as long as maximal width of antennal flagellum, on tergal discs 3–4 less than 1.5x as long as maximal width of antennal flagellum. Sternum 6 lateroapically usually with weak carina. Body length 8–9mm ..... *Hoplitis anthocopoides* (Schenck)
- Pilosity of terga longer: when seen in profile, longest hairs on median half of tergal disc 2 about 3x as long as maximal width of antennal flagellum, on tergal discs 3–4 about 2x as long as maximal width of antennal flagellum. Sternum 6 lateroapically usually with rather strong carina. Body length 9.5–11mm ..... *Hoplitis lepeletieri* (Pérez)
- 17(14) Clypeus weakly convex (Fig. 1); in profile, clypeal surface not or only slightly projecting above surface of supraclypeal area. Supraclypeal area with sparse pilosity, which never hides its surface (Fig. 1). Body length 5–6.5mm ..... *Hoplitis galichicae* spec. nov.
- Clypeus strongly convex; in profile, clypeal surface distinctly projecting above surface of supraclypeal area. Supraclypeal area with rather dense pilosity, which partly hides its surface. Body length at least 6.5mm ..... 18
- 18(17) Apical tooth of tibial spur of fore leg as long as its basal width or shorter. Distance between lateral ocellus and preoccipital ridge about 1.5x as long as ocellar diameter. Second segment of labial palpus about 1.4x as long as first segment. Head slightly shorter than wide. Carina along apical margin of sternum 6 weakly developed, medially usually not interrupted and here only slightly lower than laterally. Punctuation of mesepisternum and mesosternum moderately dense with interspaces often exceeding the diameter of one puncture. Body length 6.5–7.5mm ..... *Hoplitis hilbera* Müller
- Apical tooth of tibial spur of fore leg longer than its basal width. Distance between lateral ocellus and preoccipital ridge 1.8–1.9x as long as ocellar diameter. Second segment of labial palpus about 1.7x as long as first segment. Head slightly longer than wide. Carina along apical margin of sternum 6 well developed, medially usually interrupted or laterally distinctly higher than medially. Punctuation of mesepisternum and mesosternum dense with interspaces rarely exceeding the diameter of one puncture. Body length 7–8mm ..... *Hoplitis marchali* (Pérez)
- 19(13) Inner tibial spur of hind leg short and stout, 4–5x as long as its maximal width (including marginal teeth). Teeth along upper margin of inner hind tibial spur distinct, rather long and well separated from each other. Hind tibial spurs yellowish. Clypeus medially with very sharp and narrow longitudinal carina. Second segment of labial palpus about 1.4x as long as first segment. Anterior side of antennal segments (5,6)7–11(12) light reddish-brown. Body length 6.5–8mm ... *Hoplitis carinata* (Stanek)
- Inner tibial spur of hind leg longer, at least 6x as long as its maximal width (including marginal teeth). Teeth along upper margin of inner hind tibial spur often indistinct, short and not well separated from each other. Hind tibial spurs yellowish or blackish. Clypeus medially either with or without longitudinal carina or polished midline. Second segment of labial palpus at least 1.5x as long as first segment. Anterior side of antennal segments usually blackish, some segments occasionally partly dark reddish-brown ..... 20
- 20(19) Punctuation of anterior third of scutum fine and very dense with interspaces usually smaller than the diameter of half a puncture. Disc of tergum 5 covered with rather dense and appressed whitish pilosity. Pilosity of terga longer: when seen in profile, longest hairs on median half of tergal discs 2–4 1.3–1.5x as long as maximal width of antennal flagellum. Body length 7–9mm ..... *Hoplitis loti* (Morawitz)
- Punctuation of anterior third of scutum coarser and less dense with interspaces usually reaching the diameter of half a puncture to one puncture. Disc of tergum 5 without dense and appressed whitish pilosity. Pilosity of terga shorter: when seen in profile, longest hairs on median half of tergal discs 2–4 at most as long as maximal width of antennal flagellum ..... 21
- 21(20) Hind tibial spurs dark brown to black. Apex of inner hind tibial spur almost blunt and bent at right angles. Second segment of labial palpus 1.7–1.8x as long as first segment. Body length 6.5–7.5mm ..... *Hoplitis insularis* (Schmiedeknecht)
- Hind tibial spurs yellowish. Apex of inner hind tibial spur either almost blunt and bent at right angles or tapering and evenly curved. Second segment of labial palpus at most 1.7x as long as first segment ..... 22
- 22(21) Clypeus strongly convex; in profile, clypeal surface distinctly projecting above surface of supraclypeal area. Apex of inner hind tibial spur regularly tapering, evenly curved at an angle of 50–60° and rather long. Second segment of labial palpus about 1.7x as long as first segment. Clypeus (always?) with rather indistinct and more or less polished longitudinal midline. Body length 7–7.5mm ..... *Hoplitis ochraceicornis* (Ferton)
- Clypeus weakly convex; in profile, clypeal surface only slightly projecting above surface of supraclypeal area. Apex of inner hind tibial spur more or less blunt, abruptly curved at an angle of 60–90° and usually very short. Second segment of labial palpus 1.5–1.6x as long as first segment. Clypeus medially either with or without polished longitudinal midline or carina ... 23
- 23(22) Clypeus usually densely punctured throughout, sometimes with indistinct polished longitudinal midline on its basal half. Body length 6.5–7.5mm ..... *Hoplitis jheringii* (Ducke)
- Clypeus usually with distinct, uninterrupted and polished longitudinal midline or carina. Body length 7–8.5mm ..... *Hoplitis ravouxi* (Pérez)

## Males

- 1 Sternum 6 without membranous appendage clearly separated from its apical margin, but with almost hairless medioapical impression of roughly triangular shape ..... 2
- Sternum 6 with membranous appendage at its apical margin, which is usually bilobed and densely haired ..... 5
- 2(2) Medioapical impression of sternum 6 neither with preapical hair pencil nor median projection, its punctation mediobasally coarse and extremely dense without any interspaces. Body length 8–10mm ..... *Hoplitis benoisti* (Alfken)
- Medioapical impression of sternum 6 with preapical hair pencil or median projection, its punctation lacking or very fine ... 3
- 3(2) Medioapical impression of sternum 6 with long preapical hair pencil projecting at right angles from the sternal surface. Apical margin of medioapical impression of sternum 6 medially prolonged into a long and narrow process. Body length 9–12mm ... *Hoplitis adunca* (Panzer)
- Medioapical impression of sternum 6 with narrow median projection, which is formed by two longitudinal and apically fused keels and consists of a lower anterior and a higher posterior part. Apical margin of medioapical impression of sternum 6 medially emarginate ..... 4
- 4(3) Posterior part of median projection of sternum 6 about three times as high as anterior part, its maximal height roughly equaling length of anterior part. Distance between lateral ocellus and preoccipital ridge at least 3x as long as ocellar diameter. Preapical lateral swellings of sternum 5 weakly developed and rounded. Body length 12–15mm ..... *Hoplitis manicata* (Morice)
- Posterior part of median projection of sternum 6 about twice as high as anterior part, its maximal height distinctly shorter than length of anterior part. Distance between lateral ocellus and preoccipital ridge at most 2.5x as long as ocellar diameter. Preapical lateral swellings of sternum 5 well developed and edged. Body length 10–12mm ..... *Hoplitis submanicata* Zanden
- 5(1) Apex of last antennal segment curved downwards ..... 6
- Apex of last antennal segment not curved downwards ..... 7
- 6(5) Last antennal segment apically with short projection of roughly triangular shape, which is directed downwards. Apical margin of tergum 6 with two triangular teeth on each side. Antennal segment 3 distinctly longer than segment 4. Body length 10.5–12.5mm ..... *Hoplitis mucida* (Dours)
- Last antennal segment narrowed towards its apex, which is pointed and curved downwards. Apical margin of tergum 6 with one triangular tooth on each side. Antennal segment 3 slightly shorter than segment 4. Body length 7–9mm ..... *Hoplitis pici* (Friese)
- 7(5) Lower margin of antennal segment 3 apically broadened and detached from base of segment 4. Membranous appendage at apical margin of sternum 6 medially without uninterrupted transverse hair stripe ..... 8
- Lower margin of antennal segment 3 neither broadened nor detached from base of segment 4; if slightly detached, membranous appendage at apical margin of sternum 6 medially with uninterrupted transverse hair stripe ..... 9
- 8(7) Antennal segment 4 as long as and larger than segment 3, about three quarters as long as wide. Membranous appendage at apical margin of sternum 6 consisting of two roughly triangular lobes densely covered with appressed long pilosity, which is directed inwards and completely conceals the membranous surface. Inner spur of hind tibia stout, its apex short and strongly curved. Body length 7–8.5mm ..... *Hoplitis carinata* (Stanek)
- Antennal segment 4 distinctly shorter and smaller than segment 3, about half as long as wide. Membranous appendage at apical margin of sternum 6 consisting of two roughly quadrangular lobes beset with inconspicuous short hairs, which are suberect and do not completely conceal the membranous surface. Inner spur of hind tibia slender, its apex long and slightly curved. Body length 6.5–7.5mm ..... *Hoplitis ochraceicornis* (Ferton)
- 9(7) Membranous appendage at apical margin of sternum 6 V-shaped, i.e. consisting of two slender lobes, which are at least twice as long as wide and only basally fused; these lobes are directed backwards rather than laterally and diverge from each other by an angle of less than 90° ..... 10
- Membranous appendage at apical margin of sternum 6 of other shape ..... 13
- 10(9) Apical margin of sternum 6 medially with small roundish excision. Membranous appendage of sternum 6 mediobasally without roundish tuft of hairs. Lower half of anterior side of antennal segments (3)4–12(13) and posterior side of antennal segments (6)7–12(13) yellowish. Last antennal segment slightly twisted with upper and lower margin being in different planes. Body length 8–10mm ..... *Hoplitis fertoni* (Pérez)
- Apical margin of sternum 6 deeply and widely excised. Membranous appendage of sternum 6 mediobasally with roundish tuft of hairs. Antenna uniformly dark except sometimes for its lower margin, which is partly yellowish-brown. Last antennal segment not modified ..... 11
- 11(10) Apical margin of sternum 5 laterally emarginate. Preapical swellings of sterna 2–4 strongly developed, transition between their anterior and posterior part edged. Body length 10–11.5mm ..... *Hoplitis lepeletieri* (Pérez)
- Apical margin of sternum 5 laterally evenly rounded. Preapical swellings of sterna 2–4 less strongly developed, transition between their anterior and posterior part rounded ..... 12
- 12(11) Pilosity of inner side of hind basitarsus yellowish-white. Antennal segment 3 about 1.7x as long as segment 4. Punctuation of scutum dense with interspaces usually smaller than the diameter of one puncture on each side of the medioapical suture. Punctuation of terga rather coarse and dense with interspaces rarely exceeding the diameter of two to three punctures on tergal sides. Body length 7.5–10mm ..... *Hoplitis anthocopoides* (Schenck)
- Pilosity of inner side of hind basitarsus (dark) greyish-brown. Antennal segment 3 about 1.4x as long as segment 4. Punctuation of scutum less dense with interspaces usually exceeding the diameter of one puncture on each side of the medioapical suture. Punctuation of terga very fine and scattered with interspaces reaching the diameter of four to five punctures on tergal sides. Body length 6–7.5mm ..... *Hoplitis perambigua* (Peters)
- 13(9) Antennal segment 3 distinctly longer than wide. Membranous appendage of sternum 6 consisting of a roughly quadrangular



- plate, which bears apicolaterally two oval lobes beset with long hairs. Apical margin of tergum 7 medially with small but distinct triangular emargination. Pilosity of mesosoma and terga very long and tousled. Terga without dense, short and appressed apical white hair bands. Body length 7.5–8mm ..... *Hoplitis strymonia* Tkalcu
- Antennal segment 3 as long as wide or shorter; if slightly longer than wide, membranous appendage of sternum 6 of other shape. Apical margin of tergum 7 evenly rounded or truncate, rarely with very shallow and inconspicuous median emargination. Pilosity of mesosoma and terga shorter and less tousled. Terga with dense, short and appressed albeit often interrupted apical white hair bands ..... 14
- 14(13) Membranous appendage of sternum 6 medially with uninterrupted and well limited transverse stripe of brownish hairs and medioapically with small and densely haired buttonlike projection. Second last antennal segment with slightly converging margins, last antennal segment tapering towards the apex ..... 15
- Membranous appendage of sternum 6 neither with uninterrupted transverse stripe of brownish hairs nor medioapically with densely haired buttonlike projection. Last two antennal segments usually almost parallel-sided ..... 16
- 15(14) Antennal segment 4 about 0.8x as long as wide, slightly shorter than segment 3 and as long as segment 5. Body length 8–10mm ..... *Hoplitis fabrei* Zanden
- Antennal segment 4 about 0.6x long as wide, shorter than segments 3 and 5. Body length 8–10mm ..... *Hoplitis pallicornis* (Friese)
- 16(14) Lateral lobes of the bilobed membranous appendage of sternum 6 of oval to oblong shape (i.e. distinctly wider than long) and separated from each other by an angle of 90° or more ..... 17
- Lateral lobes of the bilobed membranous appendage of sternum 6 of roundish to quadrangular shape (i.e. about as wide as long or slightly longer) and separated from each other by an acute angle ..... 21
- 17(16) Spurs of hind tibia short and stout, almost blunt and usually of dark brown to blackish colour. Lateral margin of sternum 6 with conspicuous bristles, which are directed backwards and about as long as maximal width of lateral lobe of membranous appendage of sternum 6. Body length 7–8.5mm ..... *Hoplitis insularis* (Schmiedeknecht)
- Spurs of hind tibia long and slender, pointed and of yellowish-brown to yellowish-white colour. Lateral margin of sternum 6 with inconspicuous bristles, which are not distinctly directed backwards and less than half as long as maximal width of lateral lobe of membranous appendage of sternum 6 ..... 18
- 18(17) Proboscis very long, second segment of labial palpus about 2.8x as long as first segment; in repose, proboscis reaches trochanter of hind leg. Ventral surface of mesosoma between fore and mid coxa sparsely haired. Body length 6.5–8mm ..... *Hoplitis holmboei* (Mavromoustakis)
- Proboscis shorter, second segment of labial palpus 1.6–1.8x as long as first segment; in repose, proboscis does not reach trochanter of hind leg. Ventral surface of mesosoma between fore and mid coxa with dense white pilosity ..... 19
- 19(18) Lateral lobes of membranous appendage of sternum 6 laterally rounded to truncate and of regularly oval shape (Fig. 6). Inner spur of hind tibia almost straight. Body length 5–6mm ..... *Hoplitis galichicae* spec. nov.
- Lateral lobes of membranous appendage of sternum 6 laterally prolonged into a distinct and more or less acute tip. Inner spur of hind tibia usually slightly to distinctly curved apically ..... 20
- 20(19) Antennal segments 4–5 0.8–0.9x as long as wide with straight lower margin. Posterior side of antennal segments 8–10 with distinct tubercle. Sternum 5 more or less densely punctured in front of preapical swelling. Lateral margin of sternum 6 apically rounded. Body length 7.5–10mm ..... *Hoplitis loti* (Morawitz)
- Antennal segments 4–5 about 0.6x as long as wide with convex lower margin. Posterior side of antennal segments 8–10 almost flat. Sternum 5 almost unpunctured in front of preapical swelling. Lateral margin of sternum 6 apically toothed. Body length 6.5–9mm ..... *Hoplitis ravouxi* (Pérez)
- 21(16) Antennal segment 4 shorter than segment 3. Pilosity along hypostomal carina uniformly short and sheared in appearance. Body length 6.5–7mm ..... *Hoplitis bihamata* (Costa)
- Antennal segment 4 as long as antennal segment 3 or longer. Pilosity along hypostomal carina more irregular and increasing in length towards foramen magnum ..... 22
- 22(21) Antennal segment 4 about 0.75x as long as wide. Preapical swellings of sternum 5 well developed and almost unpunctured. Impressed area behind preapical swellings of sternum 5 medially sparsely punctured with interspaces reaching the diameter of up to three punctures. Body length 7–9mm ..... *Hoplitis marchali* (Pérez)
- Antennal segment 4 as long as wide or slightly longer. Preapical swellings of sternum 5 weakly developed and moderately dense to densely punctured. Impressed area behind preapical swellings of sternum 5 medially densely punctured with interspaces not exceeding the diameter of one to two punctures ..... 23
- 23(22) Second segment of labial palpus about 1.75x as long as first segment. Anterior side of antennal segments 4–12 yellowish in its lower third and blackish in its upper two thirds, the two colours being sharply separated. Posterior side of antennal segments 8–12 entirely yellowish. Body length 7–9mm ..... *Hoplitis lithodora* Müller
- Second segment of labial palpus at most 1.6x as long as first segment. Antenna dark to reddish-brown, neither with sharp separation between yellowish and black colour on its anterior side nor with entirely yellowish coloured segments on its posterior side ..... 24
- 24(23) Lateral lobes of membranous appendage of sternum 6 laterally rounded. Apex of inner spur of hind tibia distinctly curved. Apical margin of sternum 6 laterally with narrow pencil of hairs. Punctuation of mesopleura dense with interspaces rarely exceeding the diameter of one puncture. Body length 6–7mm ..... *Hoplitis jheringii* (Ducke)
- Lateral lobes of membranous appendage of sternum 6 laterally extended into a short rounded tip. Apex of inner spur of hind tibia very slightly curved. Apical margin of sternum 6 laterally without narrow pencil of hairs. Punctuation of mesopleura less dense with interspaces often exceeding the diameter of one puncture. Body length 6–8mm ..... *Hoplitis hilbera* Müller

**TABLE 1.** European distribution area and pollen host preferences of the 25 European representatives of the *Hoplitis adunca* species group. Information on distribution and pollen hosts are based on Müller (2006, 2012, 2015, and references therein) and Sedivy *et al.* (2013b). Definitions for categories of pollen host range are according to Cane & Sipes (2006) and Müller & Kuhlmann (2008).

| Species                                    | European distribution area   | Pollen host preferences   |
|--|--|---|
| <i>Hoplitis adunca</i> (Panzer)            | entire Europe except for Great Britain, Ireland and Scandinavia  | oligolectic on <i>Echium</i> (Boraginaceae)   |
| <i>Hoplitis anthocopoides</i> (Schenck)    | entire Europe except for Great Britain, Ireland and Scandinavia (but recent record in southernmost Sweden)   | oligolectic on <i>Echium</i> (Boraginaceae)   |
| <i>Hoplitis benoisti</i> (Alfken)          | southwestern Europe (Iberian peninsula, southern France, Corsica, Sardinia and possibly Sicily)  | oligolectic on <i>Echium</i> (Boraginaceae)   |
| <i>Hoplitis bihamata</i> (Costa)           | Corsica, Sardinia  | mesolectic on <i>Echium</i> (Boraginaceae), Lamiaceae and Fabaceae                                      |
| <i>Hoplitis carinata</i> (Stanek)          | southeastern Europe (Croatia, Macedonia, Bulgaria, Greece)   | oligolectic on Fabaceae with strong preference for Hedysareae (e.g. <i>Onobrychis</i> )                 |
| <i>Hoplitis fabrei</i> Zanden              | southwestern Macedonia and Greece excluding Aegean Islands   | polylectic with preference for <i>Echium</i> (Boraginaceae), Campanulaceae and Fabaceae                 |
| <i>Hoplitis fertoni</i> (Pérez)            | Spain, Sicily  | oligolectic on <i>Echium</i> (Boraginaceae)   |
| <i>Hoplitis galichicae</i> spec. nov.      | Macedonia  | possibly oligolectic on <i>Sedum</i> (Crassulaceae)   |
| <i>Hoplitis hilbera</i> Müller             | western Spain from Cataluna southwards to Andalucia  | mesolectic on Fabaceae, <i>Echium</i> (Boraginaceae) and possibly Brassicaceae                          |
| <i>Hoplitis holmboei</i> (Mavromoustakis)  | Cyprus   | oligolectic on Boraginaceae ( <i>Onosma</i> , <i>Echium</i> , <i>Lithodora</i> )                        |
| <i>Hoplitis insularis</i> (Schmiedeknecht) | southwestern Europe (Spain, Balearic Islands, Sardinia, Sicily)  | mesolectic on <i>Echium</i> (Boraginaceae) and Fabaceae with strong preference for <i>Echium</i>        |
| <i>Hoplitis jheringii</i> (Ducke)          | southeastern Europe (northeastern Italy, Slovenia, Croatia, Macedonia, Greece)   | oligolectic on Fabaceae with strong preference for Loteae   |
| <i>Hoplitis lepeletieri</i> (Pérez)        | Alps (France, Italy, Switzerland, Germany, Austria, Slovenia), some low mountain ranges in southern Germany, Pyrenees (France, Spain) and possibly Hungary   | oligolectic on <i>Echium</i> (Boraginaceae)   |
| <i>Hoplitis lithodora</i> Müller           | southwestern Spain to southern France  | probably oligolectic on <i>Lithodora</i> (Boraginaceae)   |
| <i>Hoplitis loti</i> (Morawitz)            | Alps (France, Italy, Switzerland, Germany, Austria, Slovenia) and Pyrenees (Spain, France)   | mesolectic on Fabaceae, Crassulaceae and <i>Echium</i> (Boraginaceae) with strong preference for Loteae |
| <i>Hoplitis manicata</i> (Morice)          | eastern and southeastern Europe (easternmost Austria, Czech Republic, Slovakia, Hungary, Romania, Ukraine, eastern and northeastern Italy, Croatia, Serbia, Montenegro, Albania, Macedonia, Greece including Aegean Islands, Bulgaria) | oligolectic on <i>Echium</i> (Boraginaceae)   |
| <i>Hoplitis marchali</i> (Pérez)           | Iberian Peninsula, Corsica, Sicily   | oligolectic on <i>Echium</i> (Boraginaceae)   |
| <i>Hoplitis mucida</i> (Dours)             | southwestern Europe (Iberian peninsula, southern France, Sicily, northern Italy, southern Switzerland)   | oligolectic on <i>Echium</i> (Boraginaceae)   |
| <i>Hoplitis ochraceicornis</i> (Ferton)    | southwestern Europe (Iberian peninsula, Andorra, French Pyrenees and French Alps, northwestern Italy)  | mesolectic on <i>Echium</i> (Boraginaceae), Fabaceae and Lamiaceae                                      |

.....continued on the next page

**TABLE 1.** (Continued)

| Species                              | European distribution area  | Pollen host preferences   |
|--------------------------------------|---|---|
| <i>Hoplitis pallicornis</i> (Friese) | southeastern Europe except mainland Greece (eastern and northeastern Italy, Slovenia, Croatia, Albania, Macedonia, Aegean Islands, Bulgaria)  | polylectic with preference for Boraginaceae (mainly <i>Echium</i> ), Fabaceae and Campanulaceae         |
| <i>Hoplitis perambigua</i> (Peters)  | Canary Islands (Fuerteventura, Lanzarote, Tenerife)   | possibly oligolectic on <i>Echium</i> (Boraginaceae)  |
| <i>Hoplitis pici</i> (Friese)        | southeastern Europe (Romania, Croatia, Montenegro, Greece including Aegean Islands)   | oligolectic on <i>Muscari</i> (Hyacinthaceae)   |
| <i>Hoplitis ravouxi</i> (Pérez)      | southwestern, western, central and eastern Europe (Iberian Peninsula, France, Italy, Luxembourg, Belgium, Netherlands, Germany, Switzerland, Austria, Slovenia, Czech Republic, Slovakia, Hungary, Romania, Belarus); the species seems to be absent from southeastern Europe, rendering literature records from Croatia and Macedonia doubtful | mesolectic on Fabaceae, <i>Echium</i> (Boraginaceae) and Crassulaceae with strong preference for Loteae |
| <i>Hoplitis strymonia</i> Tkalcu     | Bulgaria  | possibly oligolectic on Fabaceae (e.g. <i>Trifolium</i> )   |
| <i>Hoplitis submanicata</i> Zanden   | Sicily  | probably oligolectic on <i>Echium</i> (Boraginaceae)  |

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