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Faunistic study of vespid wasps in Zanjan Province (Northwest of Iran) with some ecological measures

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Abstract

The order Hymenoptera, with more than 115000 described species, comprise about 10% of the species diversity of the planet. Vespidae, one of the major families of this order, plays an important role in biological control of plant pests. In the present study, a faunistic investigation with estimation of some ecological indices of interspecific associations of vespid wasps was carried out in the northern part of Zanjan province (NW of Iran). The specimens were identified using available keys, and final identification confirmed by Dr. Josef Gusenleitner from Austria which resulted into 23 species as follow identically would according:

Ancistrocerus auctus, *Antepipona deflenda*, *A. vagabunda**, *Eumenes dubius crimensis**, *E. mediterraneus*, *E. papillarius*, *Euodynerus disconotatus sulfuripes**, *E. fastidiosus**, *E. posticus**, *Eustenancistrocerus amadanensis*, *E. israelensis**, *Katamenes dimidiatus*, *Knemodynerus excellens*, *Parodontodynerus ephippium**, *Stenodynerus chevrieranus*, *S. chitgarensis*, *Polistes dominula*, *P. Dominulus bucharensis**, *P. Gallicus*, *P. Iranus*, *P. Nimpha irakensis**, *Vespa orientalis*, *Vespula germanica*

These species and taxa which were marked with an asterisk regarded as the first records for Zanjan province and Iran respectively. Interspecific association indices were determined for all species. Results showed that *Ancistrocerus auctus* with *Euodynerus posticus*, *Antepipona vagabunda* with *Euodynerus fastidiosus* & *Eustenancistrocerus israelensis* & *Parodontodynerus ephippium*, *Euodynerus fastidiosus* with *Eustenancistrocerus israelensis* & *Parodontodynerus ephippium*, *Eustenancistrocerus israelensis* with *Parodontodynerus ephippium*, and *Polistes dominulus bucharensis* with *Eumenes mediterraneus* had maximum positive interspecific association

Keywords: Fauna, interspecific association, new record, Vespidae, Zanjan province, Iran

مطالعه فونستیک زنبورهای Vespidae در استان زنجان (شمال غرب ایران) به همراه برخی سنجش‌های اکولوژیک

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چکیده

راسته بال غشائیان، با بیش از ۱۱۵۰۰۰ گونه توصیف شده، در برگرنده حدود ۱۰٪ تنوع زیستی سیاره می باشد. Vespidae یکی از خانواده های مهم این راسته بوده که نقش مهمی را در کنترل بیولوژیک آفات گیاهی بازی می کند. در مطالعه حاضر، بررسی فونستیک زنبور های Vespidae به همراه تخمین برخی شاخصهای اکولوژیک همبستگی بین گونه ای در نیمه شمالی استان زنجان صورت گرفته است. نمونه ها با استفاده از کلیدهای شناسایی موجود شناسایی شده و توسط دکتر Josef Gusenleitner از اتریش مورد تایید نهایی به شرح زیر قرار گرفت.

Ancistrocerus auctus, *Antepipona deflenda*, *A. vagabunda**, *Eumenes dubius crimensis**, *E. mediterraneus*, *E. papillarius*, *Euodynerus disconotatus sulfuripes**, *E. fastidiosus**, *E. posticus**, *Eustenancistrocerus amadanensis*, *E. israelensis**, *Katamenes dimidiatus*, *Knemodynerus excellens*, *Parodontodynerus ephippium**, *Stenodynerus chevrieranus*, *S. chitgarensis*, *Polistes dominula*, *P. Dominulus bucharensis**, *P. Gallicus*, *P. Iranus*, *P. Nimpha irakensis**, *Vespa orientalis*, *Vespula germanica*

تمام گونه های مذکور برای اولین بار از استان زنجان معرفی می شوند و تاکنون های ستاره دار ثبت جدید برای ایران می باشند. شاخصهای همبستگی بین گونه ای بین تمام گونه ها تعیین شد. نتایج نشان داد که *Ancistrocerus auctus* با *Euodynerus posticus*، *Antepipona vagabunda* با *Euodynerus fastidiosus* & *Eustenancistrocerus israelensis*، *Euodynerus fastidiosus* با *Eustenancistrocerus israelensis* & *Parodontodynerus ephippium*، *Eustenancistrocerus israelensis* با *Parodontodynerus ephippium*، *Eustenancistrocerus israelensis* با *Parodontodynerus ephippium* و *Polistes dominulus bucharensis* با *Eumenes mediterraneus* دارای بیشترین همبستگی بین گونه ای مثبت بودند.

کلید واژه ها: فون، همبستگی بین گونه ای، ثبت جدید، Vespidae، استان زنجان، ایران

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Introduction

The Vespidae is a rather large family, represented in all parts of the world and consisting of six subfamilies and about 5000 known species (Carpenter, 1982). Studies on vespid wasps of Iran are very limited. Esmaili, M. & Rastegar, R. (1974) were the first in-country entomologists to have published on the vespid wasps of Iran. Systematic studies in Iran have since been carried out in Tehran (Hosseini M., 2002), Markazi (Sobhani M., 2003), Kurdistan (Soleimani B., 2003) and East Azerbaijan (Abbasi Yanbolagh A., 2004) provinces. Some indices such as biodiversity, association and habitat selection are particularly useful in ecological studies when a series is being compared (Clifford and Stephenson, 1975). In the present study, interspecific association and habitat selection indices have been evaluated for all species.

Materials and Methods

Study site

Eight localities with different altitudes and climatological conditions in Zanjan province have been selected as sampling sites in study area which are listed in table 1. The Pari, Mahnehan, Anguran and Zanjan stations are in a cold region that receives 330 mm of precipitations per year, has a relative humidity 43-61 percent and 110 ice days per year. Chörak-e-sofla and Nikpey are in a temperate region. Darram and Gilvan are in a semitropical region which receives 260 mm.of precipitation per year, and has maximum and minimum temperatures of 42°C and 8.5°C respectively.

Sampling method

Sampling of wasps carried out in equal condition about time and measure of sampling plots using sweep net (Bíró, 2003) with 1 mm pores from the 18May to 2September 2005 in eight localities with different altitudes and climatological conditions in Zanjan province in three sampling periods. Sampling periods composed of T1=18May-27 May, T2=16 July-6 August and T3= 23 August-2 September. The collected wasps were killed by ethyl acetate or potassium cyanide. Identifications were made mainly with Carpenter’s identification keys (personal communication) and some specimens were sent to Dr. J. Gusenleitner (Pfitznerstrasse 31, A-4020, Linz- Austria) for further confirmation. All specimens are deposited in the collection of the Hick Mirzayans Insect Museum of Iranian research institute of plant protection, Tehran- Iran.

Morphology of vespidae

Identification characters of vespid wasps have been showed in figure 1 and 2.

Statistical analyses

The indices of Jaccard, Ochiai, and Dice were used for species association based on neglecting conjoint absence of species (Clifford and Stephenson, 1975; Ludwig and Reynolds, 1988). Presence and absence of each species at each station was only considered totally (3 times combined). This procedure was selected to facilitate the interpretation of the data, and in this way the effects of sampling times are obviated. The software programs SPASSOCI.BAS (Ludwig and Reynolds, 1988) were used.

Table 1- Information on the localities.

	<i>Locality</i>	<i>Altitude(m)</i>	<i>Longitude</i>	<i>Latitude</i>
1	Pari	1780	47/25 E	36/53 N
2	Mahneshan	1280	47/39 E	36/45 N
3	Anguran	1500	47/39 E	36/35 N
4	Chörak-e-sofla	1180	47/61 E	37/07 N
5	Nikpey	1370	48/11 E	36/49N
6	Zanjan	1670	48/29 E	36/41N
7	Darram	620	48/47 E	37/02N
8	Gilvan	480	49/08 E	36/48N

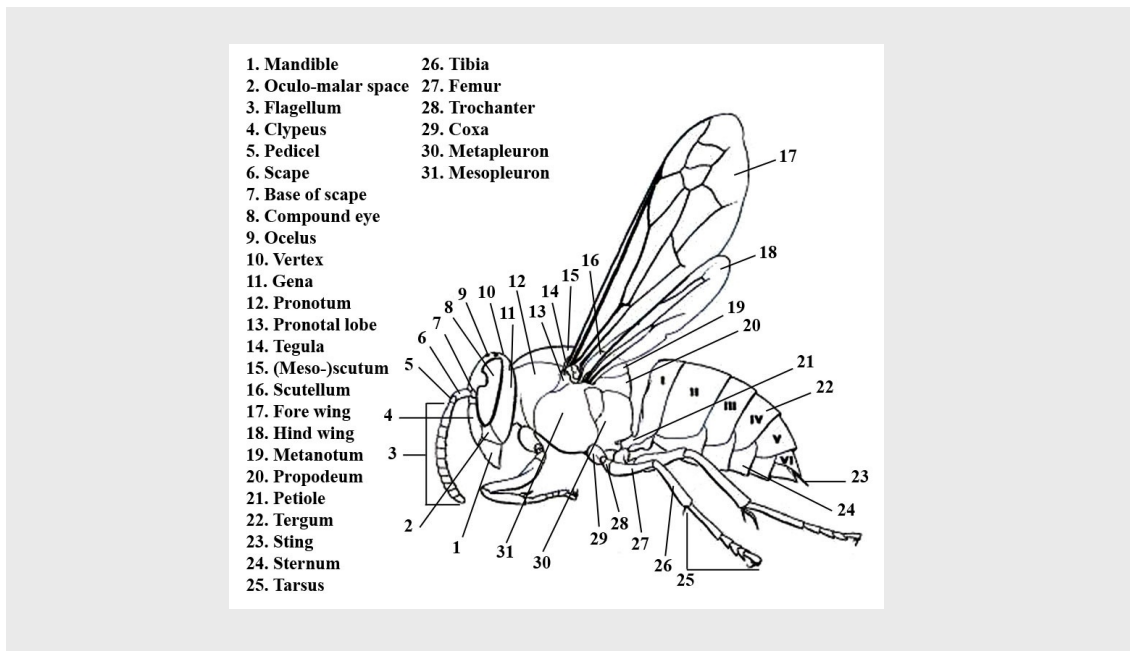


Figure 1- Common characters of vespid wasps

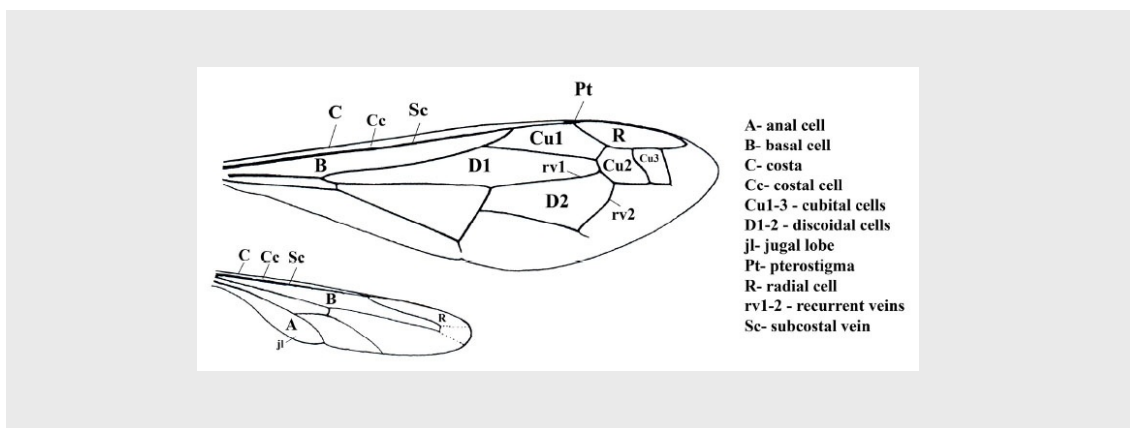


Figure 2- Characters of fore and hind wings

Conclusion

Our study was performed in Zanjan province and adds 11 new records to the vespid fauna of Iran. From all collected samples 23 species belonging to 3 subfamilies were identified as follows:

Subfamily: Eumeninae

Ancistrocerus auctus, *Antepipona deflenda*, *Antepipona vagabunda**, *Eumenes dubius crimensis**, *Eumenes mediterraneus*, *Eumenes papillarius*, *Euodynerus disconotatus sulfuripes**, *Euodynerus fastidiosus**, *Euodynerus posticus**, *Eustenancistrocerus amadanensis*, *Eustenancistrocerus israelensis**, *Katamenes dimidiatus*, *Knemodynerus excellens*, *Parodontodynerus ephippium**

Stenodynerus chevrieranus, *Stenodynerus chitgarensis*

Subfamily: Polistinae

Polistes dominulus, *Polistes dominula buharensis**, *Polistes gallicus*, *Polistes iranus*, *Polistes nimpha irakensis**

Subfamily: Vespinae

Vespa orientalis, *Vespula germanica*

All of these species are recorded for the first time from Zanjan province and based on previous studies (Esmaili, M. & Rastegar, R., 1974, Hosseini M., 2002, Sobhani M., 2003, Soleimani B., 2003, Abbasi Yanbolagh A., 2004) the taxa marked with an asterisk must be regarded as new records for Iran.

Description of species

1. *Ancistrocerus auctus* (Fabricius, 1793):

Metasoma not petiolate, segment I with width more than half that of II, much less than twice as long as wide, forewing with recurrent veins both received in second submarginal cell, second submarginal cell not petiolate anteriorly, tegula not evenly rounded posteriorly, emarginate adjoining parategula and surpassing apex of latter; male antennae apically hooked or simple, metasomal tergum I (TI) with transverse carina, TI without broad groove; mesepisternum without epicnemial carina; male antenna hooked apically; female cephalic foveae closely spaced, nearer occipital margin than posterior ocelli, submarginal carina not extended posteriorly as pointed process above valvula. Body length in studied sample 12 mm.

Antepipona de Saussure, 1855:

Metasoma not petiolate: segment I with width more than half that of II, much less than twice as long as wide, forewing with recurrent veins both received in second submarginal cell, second submarginal cell not petiolate anteriorly, tegula not evenly rounded posteriorly, emarginate adjoining parategula and usually reaching or surpassing apex of latter; male antennae apically hooked, TI without carina, metasomal tergum II (TII) without distinct lamella, apex not much thinner than disc, propodeum without superior carinae; TI without border, pretegular carina present, scutum and scutellum punctate, metanotum bidentate, metanotum laterally with short spines, flat between these.

2. *Antepipona deflenda* (Saunders, 1853):

Scutum and scutellum punctate, metanotum laterally with short spines, flat in between, clypeus yellow and with deep apical fossa, pronotum black near tegula, metasomal tergum VII (TVII) and sternum VII (SVII) in male completely black. Body length in studied sample 9 mm.

3. *Antepipona vagabunda* (Dalla Torre, 1889):

Pronotum completely yellow, TI with round black spot anteriorly, black spot on TII in this species has less extension laterally than *A. deflenda*. Body length in studied sample 13 mm.

Eumenes Latreille, 1802:

Metasoma petiolate: segment I in dorsal view with width half or less that of II, and at least twice as long as wide, usually longer, forewing with recurrent veins both received in second submarginal cell, midtibia with one spur, propodeum not toothed, TII with translucent apical lamella, clearly separated from disc by preapical thickening; epicnemial carina absent.

4. *Eumenes dubius crimensis* (Blüthgen, 1938):

Body yellow with black spots, TII in dorsal view with width three times as much TI or less, posterior segment of abdomen completely black. Body length in studied sample 18 mm.

5. *Eumenes mediterraneus* (Kriechbaumer, 1879):

Body black with yellow spots, TII in dorsal view with width twice that of anterior part of TI, segment between compound eyes in female yellow with black spots in inferior part, TII with translucent apical lamella, body narrower than *E. dubius crimensis* and *E. papillarius*. Body length in studied sample 15 mm.

6. *Eumenes papillarius* (Christ, 1791):

Pronotum black near tegula, scutellum in middle part with black band, abdomen with width more than in *E. mediterraneus*. Body length in studied sample 13 mm.

Euodynerus Dalla Torre, 1904:

Metasoma not petiolate: segment I with width more than half that of II, much less than twice as long as wide, forewing with recurrent veins both received in second submarginal cell, second submarginal cell not petiolate anteriorly, tegula not evenly rounded posteriorly, emarginate adjoining parategula and surpassing apex of latter; male antennae apically hooked, TI without carina, TII without distinct lamella, apex not much thinner than disc, TI with transparent or translucent apical border; propodeum often with superior carinae well developed, more or less lamelliform, propodeum with carinae or lamellae behind the metanotum, tegula apically not bent inwards, pronotum with lamellate dorsal carina clearly developed; metasoma dorsally with little pubescence, only visible apically; male with midfemur not flattened and hindtibia not apically swollen, metanotum transversely cristate along declivity; propodeum with superior carinae not approaching metanotum closely, submarginal carina short, rounded; occipital carina not strongly lamellate on tempora; color yellow and black, male midfemur not angulate.

7. *Euodynerus disconotatus sulfuripes* (Morawitz, 1885):

Scutum and scutellum punctate, first tergum with abrupt declivity, pronotum yellow, mesonotum black with yellow quadrangular spot in between, Body length in studied sample 12 mm.

8. *Euodynerus fastidiosus* (Sauss., 1853):

This species is one of large species of genus *Euodynerus*, mesonotum without yellow spot. Body yellow, tegula with oval yellow spot, yellow scutellum divided by a black band, face completely yellow. Body length in studied sample 17 mm.

9. *Euodynerus posticus* (Herrich-Schäffer, 1841):

Pronotum narrow and black near tegula, antenna black excepting dorsal surface of initial segments, inter antennal interval yellow, scutellum and TII black. Body length in studied sample 16 mm.

Eustenancistrocerus Blüthgen, 1938:

Metasoma not petiolate: segment I with width more than half that of II, much less than twice as long as wide, forewing with recurrent veins both received in second submarginal cell, second submarginal cell not petiolate anteriorly, tegula not evenly rounded posteriorly, emarginate adjoining parategula and reaching apex of latter; male antennae apically hooked, TI with transverse carina, TI without broad groove; mesepisternum without epicnemial carina; male antenna hooked apically; female cephalic foveae closely spaced, nearer occipital margin than posterior ocelli, submarginal carina extended posteriorly as pointed process above valvula, pretegular carina absent, epicnemial carina present, TI short, much wider than long; carina at about middle of tergum.

10. *Eustenancistrocerus amadanensis* (de Saussure, 1855):

Mesonotum black with yellow quadrangular spot in between, TII yellow with two transverse black band which sometimes join with narrow part, antenna yellow, body yellow with black spots. Body length in studied sample 9 mm.

11. *Eustenancistrocerus israelensis* Giordani Soika, 1952:

The male antennal hook of *E. israelensis* differs from the similar species *blanchardianus* and *tegaris* in being evenly broadened apically, so that it is slightly paddle-shaped. In *blanchardianus*, it is broader apically but unevenly, so that it almost appears emarginate, while in *tegaris* it is narrowly rounded (Gusenleitner, 1970). The female has the clypeal emargination slightly narrower than *blanchardianus*, and the interantennal space and base of the legs are black (Giordani Soika, 1970).

12. *Katamenes dimidiatus* (Brullé, 1832):

Metasoma petiolate: segment I in dorsal view with width half or less that of II, and at least twice as long as wide, usually longer, forewing with recurrent veins both received in second submarginal cell, midtibia with one spur, propodeum not toothed, TII with apical lamella not preceded by thickening; epicnemial carina present or absent, TI not or little longer than mesosoma, apically swollen; pronotum in dorsal view convex anteriorly, clypeus apically bluntly angular (female) or flatly convex (male); tempora in dorsal view as long as eye; male with SVII broadly depressed.

13. *Knemodynerus excellens* (Pérez, 1907):

Metasoma not petiolate: segment I with width more than half that of II, much less than twice as long as wide, forewing with recurrent veins both received in second submarginal cell, second submarginal cell not petiolate anteriorly, tegula not evenly rounded posteriorly, emarginate adjoining parategula and usually reaching or surpassing apex of latter; male antennae apically hooked or simple, TI without carina, TII without distinct lamella, apex not much thinner than disc, TI with transparent or translucent apical border; propodeum often with superior carinae well developed, more or less lamelliform, propodeum with carinae or lamellae behind the metanotum, parategula absent; tegula very narrow and apically bent somewhat inwards.

14. *Parodontodynerus ephippium* (Klug, 1817):

Metasoma not petiolate: segment I with width more than half that of II, much less than twice as long as wide, forewing with recurrent veins both received in second submarginal cell, second submarginal cell not petiolate anteriorly, tegula not evenly rounded posteriorly, emarginate adjoining parategula and reaching apex of latter; male antennae apically hooked, TI without carina, TII without distinct lamella, apex not much thinner than disc, propodeum without superior carinae; TI without border, pretegular carina absent, metanotum with lateral lamellae, posteriorly cristate; tegula smooth and much smaller than scutellum (epicnemial carina present below; female with single cephalic fovea), second submarginal cell not petiolate anteriorly, tegula not evenly rounded posteriorly, TI without carina, propodeum without superior carina, pretegular carina absent, metanotum with lateral lamellae, posteriorly cristate; tegula smooth and much smaller than scutellum, epicnemial carina present below, female with single cephalic fovea. *Parodontodynerus rufinus* and *P. ephippium* differ in the former having the punctation sparser and the body thus shinier. It is also ferruginous, with all of the metasomal terga bordered with yellow (Kostylev, 1940).

Polistes Latreille, 1802:

Metasomal segment I subsessile, evenly conical in dorsal view; propodeum with orifice dorsally acute, head relatively small and body narrow, body black with yellow or brown spots (in some species yellow with black spots), wings brown to reddish, clypeus in female is convex with relatively sharp apex, but in male flat with rounded apex, legs long and usually hanging down

during flight, claws simple, midtibia with two spurs, malar space relatively large (Richards, 1980).

15. *Polistes dominula* (Christ, 1791):

Genal area yellow, body black with yellow spots, antenna yellow excepting dorsal part of articles I, II and middle part of III which are black, mandible with black spots, scutellum with two small yellow bands, TII black with two yellow oval spots in lateral sides. Body length in studied sample 15 mm.

16. *Polistes dominulus bucharensis* (Erichson, 1849):

Genal area yellow, body yellow with black spots, antenna yellow excepting dorsal part of articles I, II and middle part of III which are black, mandible with black spots, scutellum with two small yellow bands, TII yellow with black spot shaped like a flowerpot. Body length in studied sample 15 mm.

17. *Polistes gallicus* (Linnaeus, 1767):

Genal area black and in some cases with small yellow spots, antenna yellow, last metasomal sternum yellow. Body length in studied sample 13 mm.

18. *Polistes iranus* (Guiglia, 1976):

Antenna yellow with small black spots in initial parts of articles I and II, mandible yellow, TII yellow with a vertical black band in between and two black spot in lateral sides, mesoscutum with two large yellow band in lateral sides. Body length in studied sample 15 mm.

19. *Polistes nimpha irakensis* (Gusenleitner, 1976):

Genal area yellow, antenna on dorsal surface of article II completely black and in other parts yellow, metasoma yellow with a T-shaped band on TII. Body length in studied sample 15 mm.

Stenodynerus de Saussure, 1863:

Metasoma not petiolate: segment I with width more than half that of II, much less than twice as long as wide, forewing with recurrent veins both received in second submarginal cell, second submarginal cell not petiolate anteriorly, tegula not evenly rounded posteriorly, emarginate adjoining parategula and reaching apex of latter; male antennae apically hooked, TI without carina, TII without distinct lamella, apex not much thinner than disc, propodeum without superior carinae; TI without border, pretegular carina present, scutum and scutellum punctate, metanotum not bidentate, anterior face of pronotum with two small, close set, deeply impressed medial foveae; tegula abruptly expanded.

20. *Stenodynerus chevrieranus* (de Saussure, 1855):

Body black, TII black with a yellow band in posterior part, antenna black excepting segment I and II that are

yellow, abdomen fusiform. Body length in studied sample 10 mm.

21. *Stenodynerus chitgarensis* (Giordani Soika, 1970):

Segment I of abdomen width and shorter than that in *S. chevrieranus*, relative size of head to body larger than *S. chevrieranus*. Body length in studied sample 9 mm.

22. *Vespa orientalis* Linnaeus, 1771:

Vertex long, distance between posterior ocelli and occiput twice the distance between posterior ocelli and compound eye, body reddish with yellow marks on the head and metasoma, triangular spot between antenna and clypeus yellow, clypeus with deep ventral groove and sharp rims laterally, border covered with short hair, antenna reddish excepting ventral surface of article I which is yellow, vertex and genal area width and distance between posterior ocelli and occiput long, wings reddish, TIII and TIV and SIII yellow with reddish spots in lateral sides, SII and SV with yellow spots, legs relatively long, usually hanging down during flight. Body length in studied sample 20 mm.

23. *Vespula germanica* (Fabricius, 1793):

Vertex short, distance between posterior ocelli and occiput shorter than or equal to distance between posterior ocelli and compound eye, pronotal carina absent; malar space shorter than the last antennal article, when viewed from above, head not greatly extended posteriorly behind the eyes; distance from posterior rim of a lateral ocellus to posterior margin of vertex less than twice the distance from lateral rim of same ocellus to nearest point of eye, lateral surfaces of thorax (episternum) and propodeum either entirely black or black with a yellow spot, clypeus bright yellow, often with a median black marking and, in females, with long hairs uniformly distributed over its surface, metasoma with black and yellow bands. malar space very short, clearly considerably less than half the width of the mandible base, in lateral view pronotum without a vertical ridge, TI of female with white or pale golden hairs, posterior margin of SVII of male broadly truncate, with a shallow notch, ocular sinus yellow, metanotum with a pair of large yellow spots, black stripe extending from antennal socket to upper portion of eye narrowed medially, mandibular margin immediately posterior to second tooth weakly emarginate (beware of worn mandibles), median triangular black mark on TII long, its apex reaching well beyond posterior rim of a lateral black spot, in queens lateral black spot on TII remote from anterior transverse black band, yellow, vertical band of female gena entire; yellow, longitudinal band of pronotum very broad and angular posteriorly, female clypeus

usually with three small, black spots arranged in the form of a triangle. Body lengths: queen 17-20 mm; worker 12-15 mm; male 14-17 mm.

Interspecific association indices were evaluated for the 23 species. The results showed that *Ancistrocerus auctus* with *Euodynerus posticus*, *Antepipona vagabunda* with *Euodynerus fastidiosus* & *Eustenancistrocerus israelensis* & *Parodontodynerus ephippium*, *Euodynerus fastidiosus* with *Eustenancistrocerus israelensis* & *Parodontodynerus ephippium*, *Eustenancistrocerus*

israelensis with *Parodontodynerus ephippium*, and *Polistes dominulus bucharensis* with *Eumenes mediterraneus* had maximum positive interspecific association (=1) (Table 2).

The results of this study showed that, as we expected, the subfamily Eumeninae are the most species-rich group of these wasps in the study area, comprising 70% (16 of 23 species) of captured wasps. The subfamily Polistinae with 22% (5 of 23 species) and Vespinae with 8% (2 of 23 species) rank next.

Table 2 - Interspecific association (No. of species are according to Fig.1).

Species Pair		Association (+ or -)	Chi-Square *=biased	Chi-Square (Continuity correction)	Association Indices		
					Ochiai	Dice	Jaccard
1	2	-	*0.686	0.076	0	0	0
1	3	-	*0.163	1.469	0	0	0
1	4	-	*0.381	0.381	0	0	0
1	5	-	*1.905	0.076	0	0	0
1	6	-	*0.381	0.381	0	0	0
1	7	-	*0.686	0.076	0	0	0
1	8	-	*0.163	1.469	0	0	0
1	9	+	*8	1.469	1	1	1
1	10	-	*0.686	0.076	0	0	0
1	11	-	*0.163	1.469	0	0	0
1	12	-	*0.163	1.469	0	0	0
1	13	-	*0.163	1.469	0	0	0
1	14	-	*0.163	1.469	0	0	0
1	16	-	*0.163	1.469	0	0	0
1	19	-	*0.163	1.469	0	0	0
1	20	-	*0.163	1.469	0	0	0
1	21	-	*0.163	1.469	0	0	0
2	3	-	*0.686	0.076	0	0	0
2	4	+	*0.178	0.178	0.408	0.4	0.25
2	5	+	*2.88	0.889	0.775	0.75	0.6
2	6	+	*0.178	0.178	0.408	0.4	0.25
2	7	+	*1.742	0.32	0.667	0.667	0.5
2	8	-	*0.686	0.076	0	0	0
2	9	-	*0.686	0.076	0	0	0
2	10	-	*0.036	0.32	0.333	0.333	0.2
2	11	-	*0.686	0.076	0	0	0
2	12	+	*1.905	0.076	0.577	0.5	0.333
2	13	+	*1.905	0.076	0.577	0.5	0.333
2	14	-	*0.686	0.076	0	0	0
2	16	+	*1.905	0.076	0.577	0.5	0.333
2	19	-	*0.686	0.076	0	0	0
2	20	+	*1.905	0.076	0.577	0.5	0.333
2	21	-	*0.686	0.076	0	0	0
3	4	+	*3.429	0.381	0.707	0.667	0.5
3	5	+	*0.686	0.076	0.447	0.333	0.2
3	6	-	*0.381	0.381	0	0	0
3	7	-	*0.686	0.076	0	0	0
3	8	+	*8	1.469	1	1	1
3	9	-	*0.163	1.469	0	0	0
3	10	+	*1.905	0.076	0.577	0.5	0.333
3	11	+	*8	1.469	1	1	1
3	12	-	*0.163	1.469	0	0	0

Table 2: Interspecific association (No. of species in species pair column are according to the number of species in description of species part)

Species Pair		Association (+ or -)	Chi-Square *= <i>biased</i>	Chi-Square (Continuity correction)	Association Indices		
					Ochiai	Dice	Jaccard
3	13	-	*0.163	1.469	0	0	0
3	14	+	*8	1.469	1	1	1
3	16	-	*0.163	1.469	0	0	0
3	19	-	*0.163	1.469	0	0	0
3	20	-	*0.163	1.469	0	0	0
3	21	-	*0.163	1.469	0	0	0
4	5	+	*1.6	0.178	0.632	0.571	0.4
4	6	+	*0.889	0	0.5	0.5	0.333
4	7	+	*0.178	0.178	0.408	0.4	0.25
4	8	+	*3.429	0.381	0.707	0.667	0.5
4	9	-	*0.381	0.381	0	0	0
4	10	+	*4.444	1.6	0.816	0.8	0.667
4	11	+	*3.429	0.381	0.707	0.667	0.5
4	12	-	*0.381	0.381	0	0	0
4	13	+	*3.429	0.381	0.707	0.667	0.5
4	14	+	*3.429	0.381	0.707	0.667	0.5
4	16	-	*0.381	0.381	0	0	0
4	19	-	*0.381	0.381	0	0	0
4	20	-	*0.381	0.381	0	0	0
4	21	-	*0.381	0.381	0	0	0
5	6	+	*1.6	0.178	0.632	0.571	0.4
5	7	+	*2.88	0.889	0.775	0.75	0.6
5	8	+	*0.686	0.076	0.447	0.333	0.2
5	9	-	*1.905	0.076	0	0	0
5	10	+	*2.88	0.889	0.775	0.75	0.6
5	11	+	*0.686	0.076	0.447	0.333	0.2
5	12	+	*0.686	0.076	0.447	0.333	0.2
5	13	+	*0.686	0.076	0.447	0.333	0.2
5	14	+	*0.686	0.076	0.447	0.333	0.2
5	16	+	*0.686	0.076	0.447	0.333	0.2
5	19	-	*1.905	0.076	0	0	0
5	20	+	*0.686	0.076	0.447	0.333	0.2
5	21	+	*0.686	0.076	0.447	0.333	0.2
6	7	+	*4.444	1.6	0.816	0.8	0.667
6	8	-	*0.381	0.381	0	0	0
6	9	-	*0.381	0.381	0	0	0
6	10	+	*4.444	1.6	0.816	0.8	0.667
6	11	-	*0.381	0.381	0	0	0
6	12	-	*0.381	0.381	0	0	0
6	13	+	*0.429	0.381	0.707	0.667	0.5
6	14	-	*0.381	0.381	0	0	0
6	16	-	*0.381	0.381	0	0	0
6	19	-	*0.381	0.381	0	0	0
6	20	-	*0.381	0.381	0	0	0
6	21	+	*3.429	0.381	0.707	0.667	0.5
7	8	-	*0.686	0.076	0	0	0
7	9	-	*0.686	0.076	0	0	0
7	10	+	*1.742	0.32	0.667	0.667	0.5
7	11	-	*0.686	0.076	0	0	0
7	12	+	*1.905	0.076	0.577	0.5	0.333
7	13	+	*1.905	0.076	0.577	0.5	0.333
7	14	-	*0.686	0.076	0	0	0
7	16	-	*0.686	0.076	0	0	0
7	19	-	*0.686	0.076	0	0	0
7	20	-	*0.686	0.076	0	0	0
7	21	+	*1.905	0.076	B. 577	0.5	0.333
8	9	-	*0.163	1.469	0	0	0
8	10	+	*1.905	0.076	0.577	0.5	0.333
8	11	+	*8	1.469	1	1	1

Table 2 - Interspecific association (No. of species are according to Fig.1).

Species Pair		Association (+ or -)	Chi-Square *= <i>biased</i>	Chi-Square (Continuity correction)	Association Indices		
					Ochiai	Dice	Jaccard
8	12	-	*0.163	1.469	0	0	0
8	13	-	*0.163	1.469	0	0	0
8	14	+	*8	1.469	1	1	1
8	16	-	*0.163	1.469	0	0	0
8	19	-	*0.163	1.469	0	0	0
8	20	-	*0.163	1.469	0	0	0
8	21	-	*0.163	1.469	0	0	0
9	10	-	*0.686	0.076	0	0	0
9	11	-	*0.163	1.469	0	0	0
9	12	-	*0.163	1.469	0	0	0
9	13	-	*0.163	1.469	0	0	0
9	14	-	*0.163	1.469	0	0	0
9	16	-	*0.163	1.469	0	0	0
9	19	-	*0.163	1.469	0	0	0
9	20	-	*0.163	1.469	0	0	0
9	21	-	*0.163	1.469	0	0	0
10	11	+	*1.905	0.076	0.577	0.5	0.333
10	12	-	*0.686	0.076	0	0	0
10	13	+	*1.905	0.076	0.577	0.5	0.333
10	14	+	*1.905	0.076	0.577	0.5	0.333
10	16	-	*0.686	0.076	0	0	0
10	19	-	*0.686	0.076	0	0	0
10	20	-	*0.686	0.076	0	0	0
10	21	+	*1.905	0.076	0.577	0.5	0.333
11	12	-	*0.163	1.469	0	0	0
11	13	-	*0.163	1.469	0	0	0
11	14	+	*8	1.469	1	1	1
11	16	-	*0.163	1.469	0	0	0
11	19	-	*0.163	1.469	0	0	0
11	20	-	*0.163	1.469	0	0	0
11	21	-	*0.163	1.469	0	0	0
12	13	-	*0.163	1.469	0	0	0
12	14	-	*0.163	1.469	0	0	0
12	16	-	*0.163	1.469	0	0	0
12	19	-	*0.163	1.469	0	0	0
12	20	-	*0.163	1.469	0	0	0
12	21	-	*0.163	1.469	0	0	0
13	14	-	*0.163	1.469	0	0	0
13	16	-	*0.163	1.469	0	0	0
13	19	-	*0.163	1.469	0	0	0
13	20	-	*0.163	1.469	0	0	0
13	21	-	*0.163	1.469	0	0	0
14	16	-	*0.163	1.469	0	0	0
14	19	-	*0.163	1.469	0	0	0
14	20	-	*0.163	1.469	0	0	0
14	21	-	*0.163	1.469	0	0	0
14	23	-	*0.163	1.469	0	0	0
16	19	-	*0.163	1.469	0	0	0
16	20	+	*8	1.469	1	1	1
16	21	-	*0.163	1.469	0	0	0
19	20	-	*0.163	1.469	0	0	0
19	21	-	*0.163	1.469	0	0	0
20	21	-	*0.163	1.469	0	0	0

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