

Systematical Studies on *Megabombus* (Apidae: Hymenoptera) Species in Central Anatolia

A. Murat AYTEKİN and Neşe ÇAĞATAY
Hacettepe University, Faculty of Science, Department of Biology, 06532 Beytepe, Ankara - TURKEY
e-mail: ama@hacettepe.edu.tr

Received: 25.06.2002

Abstract: Some species from the genus *Megabombus* in Central Anatolia were considered. Eight species were determined from the subgenera *Thoracobombus*, *Rhodobombus* and *Megabombus* (s. str.) by both classical and morphometrical systematics. Synonymies, Turkish and general distributions and detailed drawings of the dorsal view of the male genitalia were given. As a result of the phenograms obtained from 39 different morphological characters examined statistically, the subgenus *Megabombus* was shown to be a natural group.

Key Words: Hymenoptera, Apidae, *Megabombus*, systematics, morphometry, phenetics.

İç Anadolu Bölgesi *Megabombus* (Apidae: Hymenoptera) Türleri Üzerinde Sistemik Araştırmalar

Özet: Bu çalışmada İç Anadolu Bölgesi'nde bulunan bazı *Megabombus* türleri ele alınmıştır. *Thoracobombus*, *Rhodobombus* and *Megabombus* (s. str.) altcinslerine ait sekiz tür hem klasik hem de morfometrik sistemik yöntemleri kullanılarak incelenmiştir. Bu türlere ait sinonimler, Türkiye ve Dünya'daki yayılışları ile erkek genital organ yapısının dorsal yönden çizimleri sunulmuştur. 39 morfolojik karakterin istatistiksel olarak incelenmesi sonucu elde edilen fenogramlar, *Megabombus* altcinsinin doğal bir grup özelliğinde olduğunu göstermiştir.

Anahtar Sözcükler: Hymenoptera, Apidae, *Megabombus*, sistemik, morfometri, fenetik.

Introduction

Bumblebees are commonly pleasing, large, fluffy-haired pollinating insects with a characteristic flight (Pawlikowski, 1999). Because of their unique role in human culture, mythology, agriculture, economy and general ecology there have been many studies on their systematics, taxonomy and biology (Engel, 2001). Nevertheless, there is still no agreement on their systematics among taxonomists. In particular, the position and taxonomic importance of the subgenera remain of great interest (Aytekin and Çağatay, 2002). Although morphological studies have made some progress in this subject, new techniques and approaches have been commonly used over the last 30 years. These started morphometrically with Medler (1962) and, according to Ito (1985a), biochemically with Stephen and Cheldelin. The lack of sufficient morphological key characters, and the determination of very important

variations in morphological discrimination criteria are the basic reasons for these efforts.

When combined with traditional taxonomy, classical morphometry appears to give better indications of the naturality of the subgenera in *Megabombus* (s. lato). In this paper our aim was to show these relationships with the morphology, color variation of the body hairs and the male genitalia of the species in alternative perspectives.

Materials and Methods

Specimens from the subgenera *Megabombus* (s. str.) Dalla Torre, 1880, *Thoracobombus* Dalla Torre, 1880 and *Rhodobombus* Dalla Torre, 1880 of the genus *Megabombus* (s. lato) were analyzed by classical morphometry as well as by traditional methods. Three hundred and twenty-two specimens from eight different species of the genus *Megabombus* were collected from

This study was part of the requirements for a PhD degree submitted to Hacettepe University on 22-03-2002

Central Anatolia in Turkey between 1996 and 2000, including Ankara, Aksaray, Çankırı, Eskişehir, Karaman, Kayseri, Kırıkkale, Kırşehir, Konya, Nevşehir, Niğde, Sivas and Yozgat provinces, a total area of 178,080 km². The specimens were all caught on plants while they were searching for nectar or pollen. The bumblebees were put in small labeled boxes and kept in an mobile ice box in order to bring them to the laboratory alive. They were kept alive in the Hacettepe University Bumblebee Rearing Room until dissection; therefore all the specimens studied were fresh. The nomenclature preferred here follows that used by Rasmont (1983) and Pawlikowski (1999).

Classical Analysis

Specimens were labeled and pinned after extracting the male genitalia. The male genitalia were then preserved in glycerine. For the study of the genitalia the technique and terminology follow those proposed by Prys-Jones and Corbet (1987) and Özbek (1983). Although they were found and examined in the study area, because they were given by the same authors before (Aytekin and Çağatay, 1999), the genitalia and general morphology of two species *Megabombus argillaceus* and *M. zonatus* were not illustrated and described here again. The females of *M. humilis* and *M. armeniacus* and males of *M. mesomelas* were not included in the same way. For the other species the morphology, color variation and the male genitalia were examined.

Morphometric Analysis

All specimens were examined for the presence of known ecto- and endo-parasites to prevent the morphometric data from possible traumatic variation (Mayr and Ashlock, 1991). The body parts were then removed from each specimen with pliers and mounted in Entellan on numbered slides. Of the paired organs the one on the right was measured (Pekkarinen, 1979). By using an Olympus monitored stereoscopic zoom dissection microscope a total of 39 characters were measured directly on the screen. Twenty of these were chosen following previous studies (Medler, 1962; Plowright and Stephen, 1973; Pekkarinen, 1979; Ito, 1987; Danforth, 1989) while 19 were defined by the authors. In the morphometrical analysis the following variables were used: 13 sets of length data from the wings (front wing: whole wing length and width; length of the marginal cell,

radial sector, opposite corners of second cubital cell, the corners of first and second submarginal cells, second submarginal cell, and first submarginal cell; hind wing: whole wing length and width; length of medio + cubitus, radial sector, and cubitus-anal vein); 10 geometric angles formed by the veins (front wing: second cubital cell angles, angle of the corner below the second cubital cell, angle of the corner between the third and second submarginal cells, angle of the corner between the second submarginal cell and the first medial cell, angle of the corner between the second submarginal cell with both the first medial and first submarginal cells; hind wing: angle of the corner between the medial and radial sectors, angle of the corner between the anal and cubito-anal veins); eight sets of length data from the legs (front leg: length of the tibia and basitarsus; mid-leg: length of the tibia and basitarsus; hind leg: length and width of the tibia and basitarsus); the length of the prementum, glossa, mandible, labrum and head; the width of the head; the length of the malar area; and the compound eye. As the glossa is stretchable (Pekkarinen, 1979), it was first removed before being folded (Harder, 1982). In the statistical analysis of the morphometric data, phenograms of the samples were constructed using the Mahalanobis distances among centroids of groups in a discriminant function by UPGMA in NTSYS-pc 1.80 (Rohlf, 1992).

Abbreviations Used in the Figures

crd	cardo
lcn	lacinia
sgt	sagitta
spt	spatha
sqm	squama
stp	stipes

Results

Traditional taxonomy

Subgenus *Megabombus* (s. str.) Dalla Torre, 1880

Syn. *Hortobombus* Vogt, 1911

***Megabombus* (*Megabombus*) *argillaceus* (Scopoli, 1763)**

Syn. *Bombus sichelii* (Radoszkowski), 1859

Material examined: 9-VII-1996, Beynam (Ankara), 2♀, 3♀, 5♂ (1100 m); 25-VI-1997, Deştiğin (Konya),

5♂♂ (1310 m); 25-VI-1997, Kazımkarabekir (Karaman), 1♀, 2♀♀, 5♂♂ (1000 m); 24-VII-1997, Mahmatlar (Kayseri), 1♀, 3♀♀, 3♂♂ (1110 m); 24-VII-1997, Hacibektaş (Nevşehir), 5♂♂ (1290 m); 25-VII-1997, Kesikköprü (Kırşehir), 2♀♀, 2♀♀, 1♂ (600 m); 20-VIII-1997, Karakaya (Eskişehir), 3♀♀, 3♂♂ (980 m); 15-VII-1998, Çeltik (Sivas), 1♀, 5♀♀, 9♂♂ (1600 m); 6-VII-1999, Bor (Niğde), 1♀, 6♀♀, 9♂♂ (900 m); 8-VII-1999, Tepesidelik (Aksaray), 3♂♂ (1200 m); 14-VII-1999, Eldivan (Çankırı), 1♀, 2♀♀, 5♂♂ (1200 m); 4-VIII-2000, Akbenli (Yozgat), 1♀, 3♂♂ (1200 m); 11-IX-2000, Beytepe (Ankara), 2♂♂ (900 m).

General Distribution: USSR (Skorikow, 1928); Bulgaria (Atanassov, 1975); France, Italy, Austria, Hungary, Soviet Union, Iran, Spain, Caucasia (Rasmont, 1983); Italy (Williams, 1985); Poland (Pawlikowski, 1996).

Distribution in Turkey: Emirdağ, Sultan Dağı (Konya), Baba Dağı (Zonguldak), Uludağ (Bursa) (Reinig, 1967); Karabük, Kastamonu, Çankırı (Reinig, 1968); Van, Hattuşaş (Yozgat) (Reinig, 1971); Kayseri, Ayazma (Çanakkale), Mazıkıran, Ürgüp, Çayırbaşı (Reinig, 1973); Tavas, Kazıklı, Isparta, Ağlasun (Burdur), Cevizli (Antalya), Beyşehir, Ulukışla (Niğde) (Reinig, 1974); Erzurum (Özbek, 1983); Ankara (Aytekin and Çağatay, 1999); Adana, Adıyaman, Afyon, Ağrı, Aksaray, Ankara, Antalya, Ardahan, Artvin, Bayburt, Bingöl, Bitlis, Bolu, Burdur, Bursa, Çankırı, Çorum, Denizli, Elazığ, Erzincan, Erzurum, Eskişehir, Gümüşhane, Hakkari, Hatay, Iğdır, Isparta, İstanbul, Kahramanmaraş, Karaman, Kars, Kayseri, Kırıkkale, Kırşehir, Konya, Malatya, Muş, Nevşehir, Niğde, Rize, Samsun, Sivas, Tokat, Trabzon, Tunceli, Van, Yozgat (Özbek, 2002).

***Megabombus (Megabombus) hortorum* (L., 1761)**

Syn. *Apis paludosa* Müller, 1776

Female

Body of the queen 18-21 mm, worker 8-14 mm; head long, queen 4.76 ± 0.77 mm (Art. Avr. \pm SD), worker 3.71 ± 0.38 mm; head with black hairs; basal of the labrum with large spots, labral hollow deep and narrow; the clypeal line reaches 1/3 of the clypeus, surface little but dense punctuated; malar area long, queen 0.73 ± 0.12 mm, worker 0.67 ± 0.11 mm; collar and scutellum with yellow hairs, interalar band with black

ones; first tergal hairs (T_1) yellow, T_2 with yellow ones at latero-proximal and black distally, T_3 with black, T_4 - T_6 with white hairs.

Male

11-16 mm; head long, 3.91 ± 0.25 mm; the length of the first antennal flagellum (F_1) and F_2 are nearly the same, both longer than F_3 ; malar area very long, 1.12 ± 0.15 mm; head generally with black hairs, yellow and black ones mixed at vertex; collar and scutellum with yellow hairs, interalar band with black ones; T_1 with yellow hairs, T_2 with yellow at latero-proximal and black distally, T_3 with black, T_4 - T_5 with white, T_6 with black hairs medially and with white or light yellow ones laterally, T_7 with black hairs.

Genitalia: Lacinia long, high-boot shaped; squama earlap-shaped, medio-proximal area curved upwards U-shaped through the sagitta, this portion is longer as in *M. portchinsky* and apically spherical; spatha short; lateral surface of sagitta smooth and without any projecting part, distal part slightly curved out through squama (Figure 1).

Material examined: 5-VI-1996, Çerkeş (Çankırı), 2♀♀, 5♀♀, 7♂♂ (900 m); 9-VIII-1998, Kızılcahamam (Ankara), 2♀♀, 2♀♀, 3♂♂ (1900 m); 4-VIII-1999, Bozkır (Konya), 2♀♀, 3♀♀ (1000 m); 15-IX-2000, Ortabeli (Çankırı), 2♀♀, 2♀♀, 1♂ (1300 m).

General Distribution: USSR (Skorikow, 1928); Finland (Hänninen, 1962); England, Scotland, Wales (Alford, 1975); Bulgaria (Atanassov, 1975); Poland (Anasiewicz and Warakomska, 1977); Finland (Pekkarinen and Teräs, 1977); Denmark, Norway, Sweden, Finland, Soviet Union (Pekkarinen, 1979); Belgium, France, Ireland, Turkey, Caucasia, Iran, Corsica, Spain, Portugal, Poland, Germany, Holland, Switzerland, Czech Rep., Slovakia, Austria, Hungary, Romania, Greece, Yugoslavia (Rasmont, 1983); Yugoslavia (Stevanovic and Demajo, 1985); England (Williams, 1985); Holland (Blom, 1989); Ireland, England, Wales, Scotland, Shetland Islands, Norway, Denmark, Sweden, Finland, Russia (Pekkarinen and Teräs, 1993); Corsica (Rasmont and Adamski, 1995); Germany (Cölln and Schlüter, 1996); Poland (Pawlikowski, 1999).

Distribution in Turkey: Uludağ (Bursa) (Reinig, 1967); Bolu, Dorukhan, Semen Dağı, Isfendiyar Dağı, Ilgaz Dağı (Kastamonu), (Reinig, 1968); Canik Dağları, Rize, Trabzon (Reinig, 1971); Kobaklı, Ardıçbaşı

(Çanakale), Ardahan, Çayırbaşı, Yalnızçam Dağları (Ardahan) (Reinig, 1973); Ardahan, Erzurum (Özbek, 1983); Ağrı, Ardahan, Artvin, Bayburt, Bilecik, Bolu, Bursa, Çankırı, Erzincan, Erzurum, Giresun, Gümüşhane, Kars, Kastamonu, Ordu, Rize, Samsun, Sinop, Trabzon (Özbek, 2002).

Megabombus (Megabombus) portchinsky Rad., 1883

Female

Body of the queen 18-24 mm, worker 9-16 mm; head long, queen 4.83 ± 0.61 mm, worker 3.77 ± 0.33 mm; head with black hairs; basal of the labrum with large spots, labral hollow deep and narrow; the clypeal line reaches 1/3 of the clypeus, surface little but dense punctuated; malar area very long, queen 1.34 ± 0.28 mm, worker 0.72 ± 0.22 mm; collar and scutellum with yellow hairs, interalar band with black ones; T₁ with yellow hairs, T₂ with yellow ones at latero-proximal and with black hairs distally, T₃ with black hairs, T₄-T₆ with dirty-white or very light yellow hairs.

Male

12-17 mm; head long, 3.71 ± 0.25 mm; the length of F₁ and F₂ are nearly the same, both longer than F₃;

malar area very long, 1.18 ± 0.11 mm; head generally with black hairs, yellow and black ones mixed at vertex; collar and scutellum with yellow hairs, interalar band with black ones; T₁ with yellow hairs, T₂ with yellow at latero-proximal and black hairs distally, T₃ with black hairs, T₄-T₅ with white hairs, T₆ and T₇ with black hairs.

Genitalia: Lacinia long, high-boot-shaped; squama earlap-shaped, medio-proximal area curved upwards U-shaped through the sagitta, this portion is shorter as in *M. hortorum* and apically pointed; spatha short; lateral surface of sagitta smooth and without any projecting part, distal part lightly turned out through squama (Figure 2).

Material examined: 15-VII-1998, Çeltek (Sivas), 2♀♀, 3♂♂, 5♂♂ (1600 m); 5-IX-1999, Uzunseki (Sivas), 2♀♀, 2♂♂, 3♂♂ (1400 m). (First recorded from Sivas province).

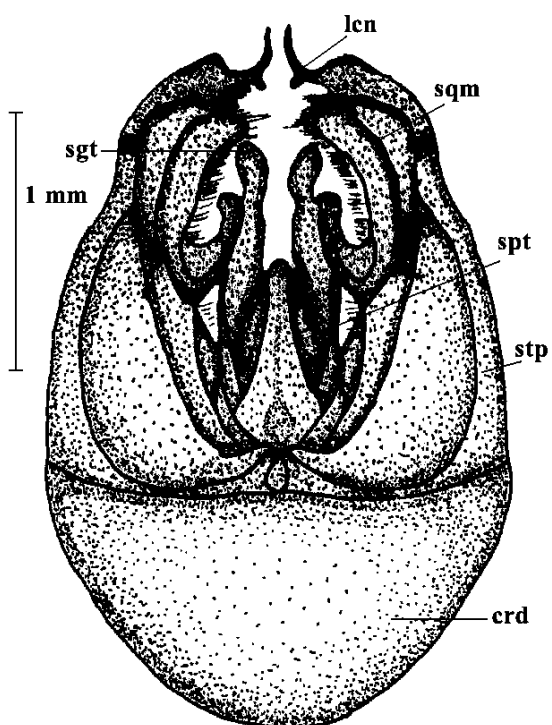


Figure 1. *Megabombus hortorum* male genitalia (dorsal view).

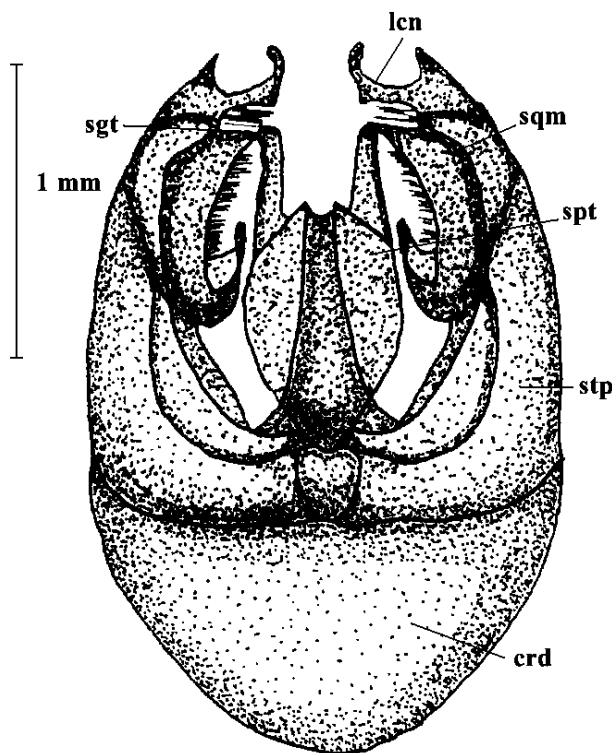


Figure 2. *Megabombus portchinsky* male genitalia (dorsal view).

General Distribution: Turkey, Caucasia, Iran (Rasmont, 1983).

Distribution in Turkey: Ardahan, Çayırbaşı (Reinig, 1973); Erzurum, Ağrı (Özbek, 1983); Ağrı, Ardahan, Bayburt, Erzurum (Özbek, 2002).

Subgenus *Thoracobombus* Dalla Torre, 1880

Syn. *Agrobombus* Vogt, 1911

***Megabombus (Thoracobombus) zonatus* (Smith, 1854)**

Material examined: 5-VI-1996, Çerkeş (Çankırı), 1♀ (900 m); 9-VII-1996, Beynam (Ankara), 3♀♀ (1100 m); 25-VI-1997, Kazımkarabekir (Karaman), 1♀, 2♀♀, 1♂ (1000 m); 24-VII-1997, Hacibektaş (Nevşehir), 2♀♀, 2♂♂ (1290 m); 24-VII-1997, Mahmatlar (Kayseri), 1♂ (1110 m); 25-VII-1997, Kesikköprü (Kırşehir), 2♀♀, 2♂♂ (600 m); 25-VIII-1998, Seyfe (Kırşehir), 1♀, 2♀♀, 2♂♂ (1100 m); 30-VIII-1998, Elmadağ (Ankara), 2♂♂ (1500 m); 7-VII-1999, Çiftlik (Niğde), 1♀, 2♀♀ (1400 m); 14-VII-1999, Eldivan (Çankırı), 2♀♀, 2♂♂ (1200 m); 4-VIII-1999, Bozkır (Konya), 4♂♂ (1000 m); 8-VII-1999, Tepesidelik (Aksaray), 1♀ (1200 m); 4-VIII-2000, Akbenli (Yozgat), 2♀♀ (1200 m).

General Distribution: Bulgaria (Atanassov, 1975); Romania, Hungary, Greece, Soviet Union, Iran, Caucasia (Rasmont, 1983).

Distribution in Turkey: Uludağ (Bursa) (Reinig, 1967); Kastamonu, Sultan Dağı (Konya), Baba Dağı (Zonguldak), Çankırı (Reinig, 1968); Van, Çorum, Akşehir, Afyon, Yozgat (Reinig, 1971); Mazıkıran, Derinkuyu, Develi (Kayseri) (Reinig, 1973); Isparta, Beyşehir, Konya, Ulukışla (Niğde) (Reinig, 1974); Erzurum, Sarıkamış, Hınıs, İspir, Oltu, Tortum, Tercan (Özbek, 1983); Ankara (Aytekin and Çağatay, 1999); Pozantı (Adana), Gölbaşı (Adıyaman), Hamur, Çumaçay, Doğubeyazıt (Ağrı), Aksaray, Turhal (Amasya), Çubuk, Beytepe, Haymana, Elmadağ, Polatlı, Şereflikoçhisar (Ankara), Antalya, Ardahan, Borçka (Artvin), Bayburt, Bilecik, Bitlis, Burdur, Bursa, Çankırı, Alaca (Çorum), Denizli, Harput, Kovancılar (Elazığ), Kemah, Iliç (Erzincan), Pasinler, Horasan, Köprüköy, Hınıs, Aşkale, Oltu, Olur, Tortum, Narman, Pazaryolu, İspir (Erzurum), Sivrihisar (Eskişehir), Gümüşhane, Iğdır, Hakkari, Hatay, Egridir, Keçiborlu, Gelendost (Isparta), İçel, Karaman, Sarıkamış, Digor, Kağızman (Kars), Kayseri, Kırıkkale, Akşehir, Ilgın, Güneysınır (Konya), Malatya, Zelve, Ürgüp (Nevşehir), Niğde, Sivas, Tokat, Tunceli, Van, Yozgat (Özbek, 2000).

***Megabombus (Thoracobombus) mlokosievitzii* Rad., 1877**

Female

Body of the queen 16-21 mm, worker 10-13 mm; head moderately long, queen 4.58 ± 0.43 mm, worker 3.52 ± 0.33 mm; head with mixed black and white hairs, white ones shorter; labral hollow deep and narrow; surface of the clypeus hardly visible and rare punctuated; malar area long, queen 0.95 ± 0.12 mm, worker 0.73 ± 0.13 mm; collar and scutellum with white hairs, interalar band with black ones; in queens T_1 - T_2 with reddish brown hairs, T_3 with black hairs, T_4 - T_6 with reddish brown hairs; the color dispersion of the worker's body hairs is nearly the same as that in queens but sometimes with rare and white hairs on T_1 - T_4 , with reddish brown ones on T_5 - T_6 .

Male

11-15 mm; head moderately long, 3.56 ± 0.27 mm; F_1 slightly longer than F_2 , both shorter than F_3 ; malar area long, 0.84 ± 0.15 mm; head with mixed black and white hairs, white ones shorter; collar and scutellum with white hairs, interalar band with black ones; T_1 - T_2 with reddish brown hairs medially and white laterally, T_3 with black, T_4 - T_7 with tile-red hairs.

Genitalia: Lacinia with three projections, first one short and apically pointed, second with quadranglar end, third one short and pointed; squama with a spin-like process medio-proximally curved upwards through the sagitta; spatha long; lateral surface of sagitta smooth and without any projecting part, distal part lightly turned out through squama like a small hook (Figure 3).

Material examined: 5-VI-1996, Çerkeş (Çankırı), 1♀♀, 2♂♂ (900 m); 8-VII-1998, Ayaş (Ankara), 2♀♀, 2♀♀, 1♂ (1058 m); 9-VII-1998, Ayaş (Ankara), 3♂♂ (820 m); 15-VIII-1998, Ayaş (Ankara), 1♀ (1032 m); 14-VII-1999, Çerkeş (Çankırı), 1♀ (900 m); 14-VII-1999, Eldivan (Çankırı), 1♀ (1200 m).

General Distribution: Turkey, Caucasia (Rasmont, 1983).

Distribution in Turkey: Bursa (Reinig, 1968); Yalnızçam Dağları (Ardahan), Kuruçay (Reinig, 1973); Ardahan, Erzurum (Özbek, 1983); Amasya, Ardahan, Artvin, Bayburt, Bolu, Bursa, Çankırı, Erzincan, Erzurum, Gümüşhane, Kars, Samsun, Sinop, Tokat, Trabzon (Özbek, 2000).

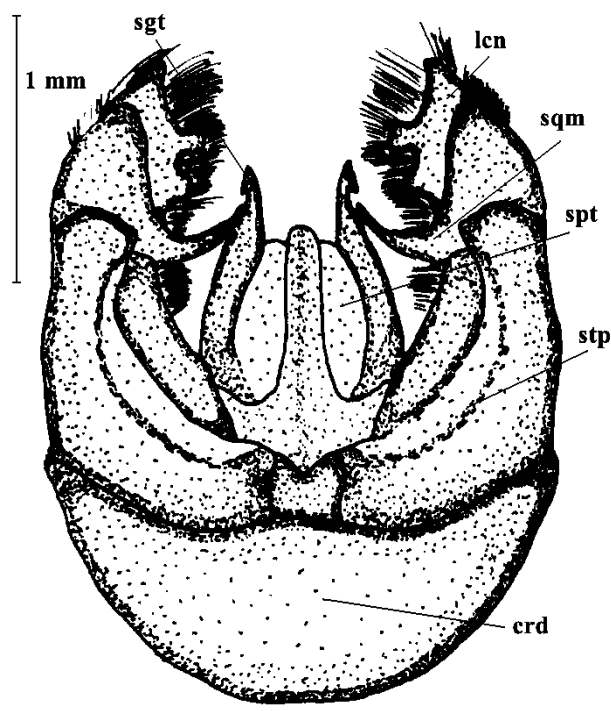


Figure 3. *Megabombus mlokosievitzii* male genitalia (dorsal view).

Megabombus (*Thoracobombus*) *humilis* Illiger, 1806

Syn. *Bombus solstitialis* Jurine, 1807, *Bombus helferanus* Seidl, 1837, *Bombus variabilis* Schmiedeknecht, 1878

Male

12-15 mm; head moderately long, 3.91 ± 0.25 mm; F_1 slightly shorter than F_3 , F_2 is nearly half of F_1 ; malar area long, 0.84 ± 0.09 mm; head with mixed black and light yellow hairs, black ones rare; in some specimens collar and scutellum with yellow hairs, interalar band with black ones while in other all thorax with camel or fully black hairs; if collar and scutellum with yellow hairs then T_1 - T_5 also with yellow hairs, T_6 - T_7 with black ones; if all the thoracic hairs are camel then T_1 with yellow or reddish brown hairs, T_2 - T_4 with black hairs at distal end with yellow ones at proximal end, T_5 - T_6 with reddish brown or yellow hairs at distal end with black ones at proximal end, T_7 with red hairs; if all the thorax with black hairs then T_1 - T_3 also with black hairs, T_4 - T_6 with yellow ones and T_7 with orange hairs.

Genitalia: Lacinia basally broad, distally narrower, apical part pointed; squama with two process projecting through the sagitta, the one at medio-distal part pointed

at apex, the other one is triangular; spatha short, proximally narrower, apically blunt; distal surface of sagitta smooth and globular, curved through the squama (Figure 4).

Material examined: 8-VII-1998, Ayaş (Ankara), 4♀, 5♂, 4♂♂ (1058 m); 15-VII-1998, Şarkışla (Sivas), 1♂ (1100 m); 9-VIII-1998, Kızılcahamam (Ankara), 2♀, 2♀, 6♂♂ (1900 m); 7-VII-1999, Çiftlik (Niğde), 2♀, 2♀, 2♂♂ (1400 m); 14-VII-1999, Çerkeş (Çankırı), 4♂♂ (900 m); 5-IX-1999, Uzunseki (Sivas), 2♀, 3♀ (1400 m); 19-IX-2000, Gülşehir (Nevşehir), 1♀, 2♀, 3♂♂ (800 m).

General Distribution: England, Scotland, Ireland (Alford, 1975); Finland (Pekkarinen and Teräs, 1977); Belgium, Holland, Germany, Poland, Switzerland, France, Turkey, Caucasia (Rasmont, 1983); North Korea (Ito, 1985b); Holland (Blom, 1989); England, Wales, Scotland, Ireland, Denmark, Norway, Sweden, Finland, Russia (Pekkarinen and Teräs, 1993); Germany (Cölln and Schlüter, 1996); Poland (Pawlikowski, 1996).

Distribution in Turkey: Uludağ (Bursa) (Reinig, 1967); İsfendiyar Dağları, İlgaz Dağı (Kastamonu),

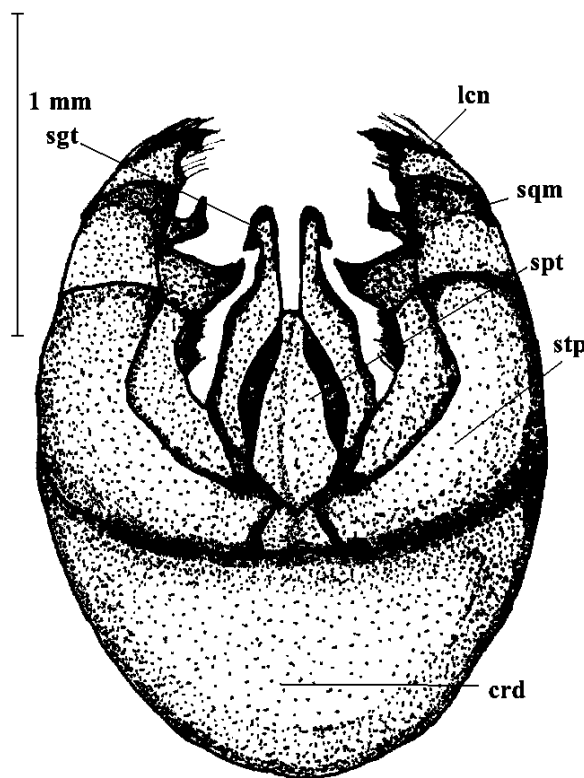


Figure 4. *Megabombus humilis* male genitalia (dorsal view).

Çankırı (Reinig, 1968); Bursa, Eleşkirt (Reinig, 1971); Yalnızçam Dağları (Ardahan) (Reinig, 1973); Erzurum, Muş, Tortum, Oltu, İspir, Ardahan (Özbek, 1983); Ankara (Aytekin and Çağatay, 1999); Ağrı, Aksaray, Ankara, Ardahan, Artvin, Bayburt, Bingöl, Elazığ, Erzincan, Erzurum, Kars, Muş, Nevşehir, Niğde, Sivas, Yozgat, Tunceli (Özbek, 2000).

Subgenus *Rhodobombus* Dalla Torre, 1880

Syn. *Pomobombus* Vogt, 1911, *Fervidobombus* Skorikov, 1922

***Megabombus (Rhodobombus) mesomelas* (Gerstaecker, 1869)**

Syn. *Bombus elegans* Seidl, 1837

Female

Body of the queen 16-21 mm, worker 11-14 mm; head long, queen 4.93 ± 0.41 mm, worker 3.53 ± 0.30 mm; head with black hairs; labral hollow moderately deep and narrow; surface of the clypeus little and rare punctuated, clearly convex and bright; malar area long, queen 1.03 ± 0.30 mm, worker 0.72 ± 0.13 mm; collar and scutellum with white hairs, interalar band with black ones; T_1 with white hairs, T_2 - T_5 with light yellow ones, T_6 with black hairs.

Material examined: 9-VII-1996, Beynam (Ankara), 6♀, 10♀, 11♂ (1100 m); 11-VII-1997, Beynam (Ankara), 2♀, 3♂ (1200 m); 29-VIII-1998, Elmadağ (Ankara), 3♀, 4♂ (1300 m).

General Distribution: Balkans, Turkey, Caucasia, Iran (Rasmont, 1983); Poland (Pawlikowski, 1996).

Distribution in Turkey: Rize, Kop, Eleşkirt, Van, Trabzon, Yozgat (Reinig, 1971); Yalnızçam Dağları (Ardahan) (Reinig, 1973); Bolkar Dağları (Reinig, 1974); Erzurum, Pasinler, Tercan, Palandöken (Özbek, 1983); Ankara (Aytekin and Çağatay, 1999); Ağrı, Amasya, Ardahan, Artvin, Bayburt, Bingöl, Erzincan, Erzurum, Iğdır, Gümüşhane, Kars, Niğde, Rize, Sivas, Tunceli, Van (Özbek, 2002).

***Megabombus (Rhodobombus) armeniacus* (Rad., 1877)**

Syn. *Bombus scythes* Skorikov, 1925

Male

13-16 mm; head moderately long, 3.87 ± 0.18 mm; F_1 and F_3 nearly the same, F_2 is nearly half of F_1 ; malar area long, 0.88 ± 0.08 mm; head with black hairs; collar and scutellum with yellow hairs, interalar band with black ones; T_1 - T_7 with yellow hairs, rarely in some specimens, T_7 with black ones.

Genitalia: Lacinia basally broad, distally narrower, apical part triangular, dorsal part curved upwards; squama with two projecting parts, distal part process a sharp triangle through sagitta while the other pointed at apex and longer; spatha short, distal end rounded; sagitta slightly curved through squama, proximal part pointed (Figure 5).

Material examined: 5-VI-1996, Çerkeş (Çankırı), 3♂ (900 m); 9-VII-1996, Beynam (Ankara), 1♀ (1100 m); 25-VI-1997, Kılbasan (Karaman), 3♂ (1010 m); 6-VI-1999, Develi (Kayseri), 2♀ (1000 m); 6-VII-1999, Bor (Niğde), 1♀, 1♀, 2♂ (900 m); 7-VII-1999, Melendez (Niğde), 2♂ (1600 m); 14-VII-1999, Çerkeş (Çankırı), 2♀, 1♂ (900 m); 4-VIII-1999, Bozkır (Konya), 2♀, 4♂ (1000 m); 5-IX-1999, Uzunseki (Sivas), 2♀, 3♂ (1400 m)

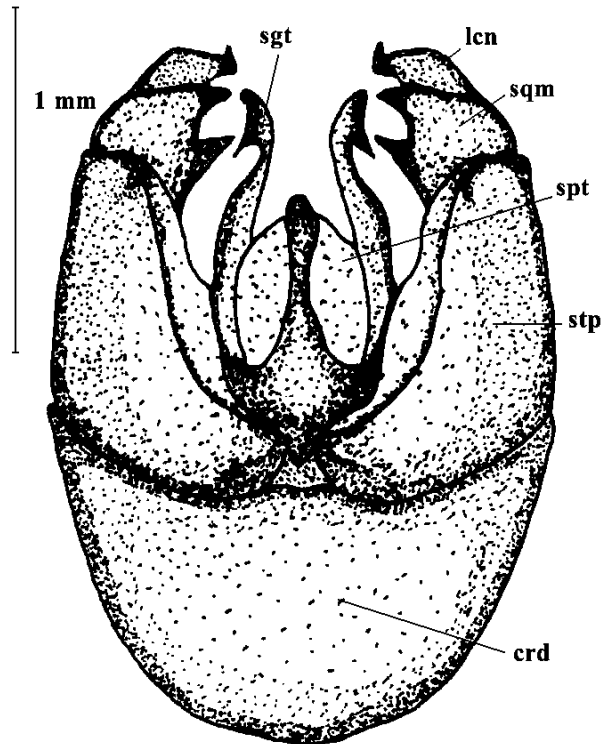


Figure 5. *Megabombus armeniacus* male genitalia (dorsal view).

m); 11-IX-2000, Beytepe (Ankara), 2♂♂ (900 m); 15-IX-2000, Kızılcahamam (Ankara), 1♀, 4♂♂ (1400 m); 17-IX-2000, Sulakyurt (Kırıkkale), 2♀♀, 1♂ (750 m); 20-IX-2000, Felahiye (Kayseri), 3♀♀, 3♂♂ (1200 m).

General Distribution: Bulgaria (Atanassov, 1975); Yugoslavia, Greece, Romania, Turkey, Caucasia, Iran, USSR (Rasmont, 1983); Poland (Pawlikowski, 1996).

Distribution in Turkey: Sultan Dağı (Konya) (Reinig, 1967); Çankırı, Baba Dağı (Zonguldak) (Reinig, 1968); Rize, Kop, Hamur, Van, Hattuşaş (Yozgat), Afyon (Reinig, 1971); Ürgüp (Nevşehir), Develi (Kayseri) (Reinig, 1973); Konya, Maden, Ulukışla (Niğde) (Reinig, 1974); Erzurum, Pasinler, Tercan, Palandöken, Olur, Tortum (Özbek, 1983); Ankara (Aytekin and Çağatay, 1999); Adana, Afyon, Ağrı, Aksaray, Ankara, Antalya, Ardahan, Artvin, Bayburt, Bingöl, Bitlis, Burdur, Çankırı, Çorum, Elazığ, Erzincan, Erzurum, Eskişehir, Gümüşhane, Iğdır, Isparta, İçel, Kahramanmaraş, Karaman, Kars, Kayseri, Konya, Malatya, Nevşehir, Niğde, Samsun, Sivas, Tokat, Tunceli, Van, Yozgat (Özbek, 2002).

Morphometric analysis

Phenograms of samples from eight species were constructed using the Mahalanobis distances among centroids of groups in a discriminant function by UPGMA, using 39 morphometric characters' averages. The clusters were divided into two groups according to sex, males (Figure 6) and females (Figure 7).

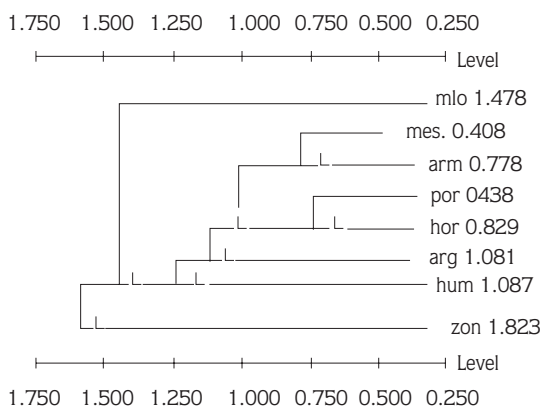


Figure 6. UPGMA phenogram of species from three subgenera based on Mahalanobis distances among centroids of groups in discriminant function analysis (males).

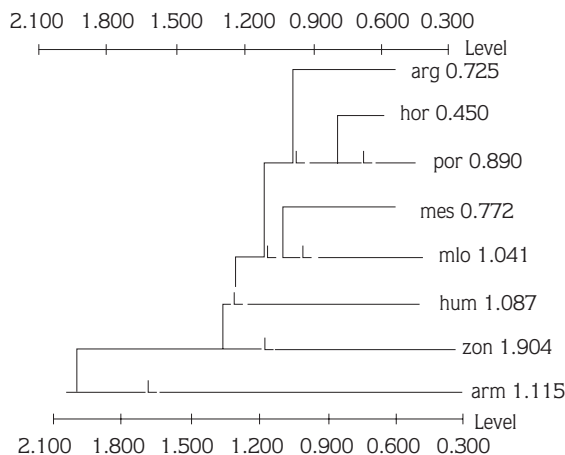


Figure 7. UPGMA phenogram of species from three subgenera based on Mahalanobis distances among centroids of groups in discriminant function analysis (females).

Discussion

The genus *Megabombus* is distinguished from other genera by the presence of a pointed exterior distal corner of the mid basitarsus and a well-developed sulcus obliquus in females. The males have a curved squama and a very long and oblique flagellum. The subgenus *Megabombus* species can be distinguished from each other by their coat colors. In *M. argillaceus*, females have a clypeal line that reaches 1/2 of the clypeus and in queens there are abdominal terga with black hairs. In *M. portchinsky* and *M. hortorum* this line reaches 1/3 of the clypeus and queens have yellow, white and black hairs in the abdominal terga. *M. portchinsky* differs from *M. hortorum* by a tangent passing the supra-orbital line to the lateral ocellus; in the latter this line cuts the ocellus in the middle. Males have a very similar morphology and genitalia. These data are generally consistent with those given by previous authors (Özbek, 1983; Prys-Jones and Corbet, 1987; Pawlikowski, 1999). Morphometric analysis of the females and males showed similar clusters and it seems that *M. portchinsky* and *M. hortorum* are more closely related to each other than to *M. argillaceus*. This is in agreement with the morphology data.

For *M. humilis* different authors have described different coat colors. In Özbek (1983), the collar and scutellum have yellow hairs, while T₁-T₅ have yellow ones and T₆ with black ones. Özbek recognised these specimens as *M. humilis insipidus* Rad. Pawlikowski

(1999) described the same species with very different coat colors, especially in females. Rasmont and Flagothier (1996) examined them as four different subspecies from Turkey with very different coat colors again. In Central Anatolia three of them were found in nearby areas. Most probably this species occurs as two subspecies in Turkey: *M. humilis insipidus* and *M. humilis aurantiacus*. DNA and geometric morphometric analyses are urgently needed to understand the systematics of this species. Especially in males, *M. mlokosievitzii* did not cluster with *M. humilis* and *M. zonatus*, the high intraspecific variability of *M. humilis* and the low specimen number of *M. mlokosievitzii* possibly affected the data. The interesting distribution pattern of *M. humilis* is another factor (Özbek, 2000).

References

- Alford, D.V. 1975. Bumblebees, Davis-Poynter. London. p. 352.
- Anasiewicz, A. and Warakomska, Z. 1977. Pollen Food of the Bumblebees (*Bombus* Latr., Hymenoptera) and Their Association with the Plant Species in the Lublin Region. *Ekologia Polska*. 25: 309-322.
- Atanassov, N. 1975. Artenzusammenstzung und Verbreitung der *Bombus* Latr. und *Psithyrus* Lep. (Hymenoptera) in den Rhodopen. *Academia Bulgare des Sciences, La Faune des Rhodopes, Materiaux*, Sofia. 145-160.
- Aytekin, A.M. and Çağatay, N. 1999. Systematic Studies on the Family Apidae (Hymenoptera) in Ankara Province Part I: Bombinae, Tr. *J. of Zoology*. 23: 231-241.
- Aytekin, A.M. and Çağatay, N. 2002. A Phenetic Approach to the Subgenera of Bumblebees (Apidae: Hymenoptera). *Mellifera*. 2: 60-64.
- Blom, J. Van Der. 1989. De Hommels van Nederland, Cip-Gegevens Koninklijke Bibliotheek. Den Haag. Holland, p. 45.
- Cölln, K. and Schlüter, R. 1996. Zur Kenntnis der Hummeln und Schmarotzerhummeln von Köln (Hymenoptera, Aculeata: *Bombus* et *Psithyrus*). *Decheniana-Beihefte*. 35: 305-312.
- Danforth, B.N. 1989. The Evolution of Hymenopteran Wings: The Importance of Size. *J. Zool., Lond.* 218: 247-276.
- Engel, M.S. 2001. A Monograph of the Baltic Amber Bees and Evolution of the Apoidea (Hymenoptera), *Bulletin of the American Museum of Natural History*. Number 259, New York. p.192.
- Hänninen, P. 1962. Bumblebee Species on Red Clover in Central Finland, Publications of the Finnish State Agricultural Research Board. No: 197. p.19.
- Harder, L.D. 1982. Measurement and Estimation of Functional Proboscis Length in Bumblebees (Hymenoptera: Apidae). *Canadian Journal of Zoology*. 60: 1073-1079.
- Detailed morphometrical analysis is needed for the subgenera *Thoracobombus* to show the naturality of this group, which seems to be partly unnatural (Aytekin and Çağatay, 2002). The same thing can also be stated for *Rhodobombus*. Therefore, more morphometrical data and especially studies on biochemical taxonomy are necessary.

Acknowledgments

The authors wish to thank to Prof. Dr. Aykut KENCE and Prof. Dr. Pierre RASMONT for their great help. This study was part of the requirements for a PhD degree submitted to Hacettepe University on 22-03-2002.

- Ito, M. 1985a. Supraspecific Classification of Bumblebees Based on Characters of Male Genitalia, *Zoological Section, The Institute of Low Temperature Science Publ. Hokkaido University, Japan*. p. 143.
- Ito, M. 1985b. Additional Notes on the Bumblebee Fauna of North Korea (Hymenoptera, Apidae). *Folia Entomologica Hungarica*. XLVL-1: 5-22.
- Ito, M. 1987. Geographic Variation of an East Asian Bumblebee *Bombus diversus* in Some Morphometric Characters (Hymenoptera, Apidae). *Kontyu*, 55: 188-201.
- Mayr, E. and Ashlock, P.D. 1991. Principles of Systematic Zoology, Second Ed., McGraw-Hill, Inc., New York. p. 475.
- Medler, J.T. 1962. Morphometric Studies on Bumble Bees. *Annals of the Entomological Society of America*. 55: 212-218.
- Özbek, H. 1983. Doğu Anadolu'nun Bazı Yörelerindeki Bombinae (Hymenoptera: Apoidea, Bombidae) Türleri Üzerinde Taksonomik ve Bazı Biyolojik Çalışmalar, Atatürk Üniversitesi Yayınları No: 621. Atatürk Üniversitesi Basımevi-Erzurum. p. 70.
- Özbek, H. 2000. On the Bumblebee Fauna of Turkey: III. The subgenus *Thoracobombus* D.T. (Hymenoptera, Apidae, Bombinae). *Journal of the Entomological Research Society*. 2: 43-61.
- Özbek, H. 2002. On the Bumblebee Fauna of Turkey: IV. The Subgenera *Megabombus*, *Eversmannibombus*, *Laesobombus*, *Rhodobombus* and *Subterraneobombus* (Hymenoptera, Apidae, Bombini). *Zoology in the Middle East*. 25: 79-98.
- Pawlikowski, T. 1996. Keys for the Identification of Polish Insects, Bees. Apidae. Subfamily: Apinae. Turpress. *Polskie Towarzystwo Entomologiczne Nr. 148 Serii*. p. 56.
- Pawlikowski, T. 1999. A Field Guide to Identification of Bumblebees (Hymenoptera: Apidae: Bombini) in Poland, *Wydawnictwo Uniwersytetu Mikolaja Kopernika, Torun*. p. 30.

- Pekkarinen, A. 1979. Morphometric, Colour and Enzyme Variation in Bumblebees (Hymenoptera, Apidae, *Bombus*) in Fennoscandia and Denmark. *Acta Zoologica Fennica*. 158: 1-60.
- Pekkarinen, A. and Teräs, I. 1977. Suomen Kimalaisista Ja Loiskimalaisista. *Luonnon Tutkija*. 81: 1-24.
- Pekkarinen, A. and Teräs, I. 1993. Zoogeography of *Bombus* and *Psithyrus* in Northwestern Europe (Hymenoptera, Apidae). *Ann. Zool. Fennici*. 30: 187-208.
- Plowright, R.C. and Stephen W.P. 1973. A Numerical Taxonomic Analysis of the Evolutionary Relationships of *Bombus* and *Psithyrus* (Apidae: Hymenoptera). *Canadian Entomologist*. 105: 733-743.
- Prys-Jones, O.E. and Corbet, S.A. 1987. *Bumblebees*, Cambridge Univ. Press, Cambridge. p. 86.
- Rasmont, P. 1983. Catalogue Commenté des Bourdons de la Region Ouest-Paléarctique, Notes Fauniques de Gembloux. No. 7. Belgium. p. 71.
- Rasmont, P. and Adamski, A. 1995. Les Bourdons de la Corse (Hymenoptera, Apoidea, Bombinae). *Notes Fauniques de Gembloux*. 31: 3-87.
- Rasmont, P. and Flagothier, D. 1996. Biogéographie et Choix Floraux des Bourdons (Hymenoptera, Apidae) de la Turquie, NATO-OTAN TU Pollination Project Report. Belgium. p. 68.
- Reinig, W.F. 1967. Zur Kenntnis der Hummelfaunen einiger Gebirge West-Kleinasiens (Hymenoptera, Apidae). Sonderabdruck aus dem Nachrichtenblatt der Bayerischen Entomologen. 16. Jahrgang, Nr. 9/10: 81-91.
- Reinig, W.F. 1968. Über die Hummeln und Schmarotzerhummeln Nordwest-Anatoliens (Hymenoptera, Apidae). *Nachrichtenblatt der Bayerischen Entomologen*. 17. Jahrgang, Nr. 6: 101-112.
- Reinig, W.F. 1971. Zur Faunistik und Zoogeographie des Vorderen Orients 3. Beitrag zur Kenntnis der Hummeln und Schmarotzerhummeln Anatoliens (Hymenoptera, Apidae). *Veröffentlichungen der Zoologischen Staatssammlung München*. 15: 139-165.
- Reinig, W.F. 1973. Faunistische und Zoogeographische Studien in Kleinasien 4. Beitrag zur Kenntnis der Anatolischen Hummeln (*Bombus* Latr., 1802) und Schmarotzerhummeln (*Psithyrus* Lapeletier., 1832; Hymenoptera, Apidae). Sonderabdruck aus den Mitteilungen der Müncher Entomologischen Gesellschaft (e. V.). 63. Jahrgang: 111-133.
- Reinig, W.F. 1974. Faunistische und Zoogeographische Studien in Kleinasien 5. Auf Hummelfang im Taurus (*Bombus* Latr., 1802 et *Psithyrus* Lep., 1832; Hymenoptera, Apidae). Sonderabdruck aus dem Nachrichtenblatt der Bayerischen Entomologen. 23. Jahrgang, Nr. 4: 67-80.
- Rohlf, F.J. 1992. Ntsys-pc, Numerical Taxonomy and Multivariate Analysis System. Exeter Software, New York. p. 198.
- Skorikow, A. 1928. Die Hummelfauna Turkestans und Ihre Beziehungen zur Zentralasiatischen Fauna (Hymenoptera, Bombidae). *Abhandlungen Der Pamir-Expedition*. VIII: 175-247.
- Stevanovic, A.M. and Demajo, M.A. 1985. Grada Zu Faunu Bumbara (Bombinae, Apoidea, Hym.) Jugoslavije. *Glasnik Prirodnjackog Muzeja U Beogradu*. B. 40: 183-190.
- Williams, P.H. 1985. A Preliminary Cladistic Investigation of Relationships among the Bumblebees (Hymenoptera: Apidae). *Systematic Entomology*. 10: 239-255.