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Distribution of Carpenter-Moths (Lepidoptera, Cossidae) in the Palaearctic Deserts

R. V. Yakovlev[a] and V. V. Dubatolov[b]

[a]*Altai State University, Barnaul, 656049 Russia*
e-mail: cossus_cossus@mail.ru
[b]*Institute of Animal Systematics and Ecology, Siberian Branch, Russian Academy of Sciences, Novosibirsk, 630091 Russia*
e-mail: wdubat@mail.ru

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Abstract—Specific features of the carpenter-moths (Cossidae) distribution in the Palaearctic deserts are considered. The Palaearctic frontier was delimited to the Arabian Peninsula (the eastern and northern parts of Arabia are attributed to the Palaearctic Region; Yemen, southwestern Saudi Arabia, and southernmost Iran belong to the Afrotropical Region). Cossidae are highly endemic to arid areas. Some Palaearctic carpenter-moth genera penetrate to Africa southward of the Sahara Desert (an important characteristic distinguishing them from most of the other Lepidoptera). The local faunas of the Palaearctic deserts are united into 4 groups: the Sahara–Arabian–Southern-Iranian, Central-Asian–Kazakhstanian, Western-Gobian, and Eastern-Gobian. In the Eastern Gobi Desert, the fauna is the most specific; it should be considered as a separate zoogeographical subregion.

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Cossidae (Lepidoptera) is a widely distributed family comprising 151 genera with 971 species (van Neukerken et al., 2011), among which 267 species occur in the Palaearctic Region (Yakovlev, 2011c). Many cossid taxa are specific inhabitants of the arid regions of the Palaearctic. Usually deserts are good zoogeographical barriers preventing from mixing the faunas of different zoogeographical regions. Nevertheless a number of animals have adapted to the desert climate, and their distribution significantly differs from that of the more abundant meso- and hygrophilous groups because of their association with arid barriers. In the present study, we attempted to estimate a change in the cossid distribution along the Sahara-Gobi desert belt and to determine the levels of similarity of their local faunas and of their specific and generic endemism in arid regions.

We have analyzed the data on the distribution of carpenter-moths over the desert areas of the Palaearctic Region and mapped the range of each species based on examination of material of the largest world collections (about 12000 specimens from the areas under study were examined). Lists of the local faunas of Cossidae of the Palaearctic deserts (Table 1) are compiled according to the species and to the number of species in each genus for each site.

The following areas were considered as the sites:

(1) the western part of the Sahara Desert (Morocco, northern Mauritania, the Western Sahara);

(2) the central part of the Sahara Desert (Algeria, Libya, Tunisia);

(3) the eastern part of the Sahara Desert (Egypt);

(4) the Arabian Desert;

(5) the deserts of southern Iran;

(6) the Kara Kum Desert;

(7) the Kyzyl Kum Desert;

(8) the deserts of Eastern Kazakhstan (Sary-Ishikotrau, Tau Kum, the sands of the Ili River valley);

(9) the deserts of Southern and Central Kazakhstan (Betpak Dala, Moyun Kum);

(10) the deserts of the Great Lakes valley;

(11) the Eastern Gobi and Ordos deserts;

(12) the Dzungar Gobi with the Baruunkhurai Depression and the Trans-Altai and Zakhuin-Gobi deserts.

The local faunas were compared later using Jaccard's coefficient (Jaccard, 1902) by means of

Table 1. Distribution of carpenter-moths species (Cossidae) in the Palaearctic deserts

Species	Regions											
	1	2	3	4	5	6	7	8	9	10	11	12
Holcocerus gloriosus (Erschoff, 1874)	–	–	–	+	+	+	+	–	+	–	–	–
H. zarudnyi Grum-Grshimailo, 1902	–	–	–	+	+	–	–	–	–	–	–	–
H. holosericeus Staudinger, 1884	+	+	+	+	+	+	+	+	+	–	–	+
H. nobilis Staudinger, 1884	–	–	–	–	–	+	+	+	+	–	–	–
H. reticuliferus Daniel, 1949	–	–	–	–	–	–	+	–	–	–	–	–
H. tancrei Püngeler, 1898	–	–	–	–	–	+	+	–	–	–	–	–
Deserticossus arenicolus (Staudinger, 1879)	–	–	–	–	+	+	+	+	+	–	–	–
D. murinus (Rothschild, 1912)	–	–	–	–	–	–	–	+	+	–	–	–
D. consobrinus (Püngeler, 1898)	–	–	–	–	–	–	–	+	+	+	–	–
D. decoratus Yakovlev, 2006	–	–	–	–	–	–	–	+	–	–	–	–
D. danilewskyi Yakovlev, 2006	–	–	–	–	–	–	–	–	+	–	–	–
D. pulverulentus (Püngeler, 1898)	–	–	–	–	–	+	+	+	+	–	–	–
D. campicola (Eversmann, 1854)	–	–	–	–	–	–	+	–	+	–	–	–
D. praeclarus (Püngeler, 1898)	–	–	–	–	–	+	–	–	–	–	–	–
D. mongoliana (Daniel, 1969)	–	–	–	–	–	–	–	–	–	+	+	+
D. artemisiae (Chou et Hua, 1986)	–	–	–	–	–	–	–	–	–	–	+	–
D. pullus (Hua, Chou, Fang et Chen, 1990)	–	–	–	–	–	–	–	–	–	–	–	+
D. beketi (Yakovlev, 2004)	–	–	–	–	–	–	–	–	–	–	–	+
Cryptoholcocerus mongolicus (Erschoff, 1872)	–	–	–	–	–	–	–	+	–	–	–	–
Barchaniella mus (Grum-Grshimailo, 1902)	–	–	–	–	+	–	–	–	–	–	–	–
B. inspersa (Christoph, 1887)	–	–	–	–	–	+	+	+	+	+	–	+
B. sacara (Grum-Grshimailo, 1902)	–	–	–	–	–	+	+	–	+	–	–	–
Pljuschiella gracilis (Christoph, 1887)	–	–	–	–	–	+	+	–	–	–	–	–
Vartiania zaratustra Yakovlev, 2004	–	–	–	+	+	–	–	–	–	–	–	–
V. muscula (Rothschild, 1912)	–	–	–	–	–	–	+	–	–	–	–	–
Eremocossus vaulogeri (Staudinger, 1887)	+	+	+	+	+	–	–	–	–	–	–	–
E. foedus (Swinhoe, 1884)	–	–	–	–	+	–	–	–	–	–	–	–
E. asema (Püngeler, 1899)	–	–	–	–	–	+	–	–	–	–	–	–
Cossulus zoroastres (Grum-Grshimailo, 1902)	–	–	–	–	+	–	–	–	–	–	–	–
C. intractatus (Staudinger, 1887)	–	–	–	–	–	–	+	–	–	–	–	–
C. turkomanicus (Christoph, 1893)	–	–	–	–	–	+	–	–	–	–	–	–
C. mucosus (Christoph, 1884)	–	–	–	–	–	–	–	+	–	–	–	–
*C. sheljuzhkoi (*Zukowsky, 1936)	–	–	–	–	–	–	–	–	+	–	–	–
Isoceras bipunctatus (Staudinger, 1887)	–	–	–	–	+	–	–	–	–	–	–	–
I. kruegeri Turati, 1924	–	+	–	–	–	–	–	–	–	–	–	–
Paropta paradoxa (Herrich-Schäffer, [1851])	–	–	+	+	–	–	–	–	–	–	–	–
Stygioides aethiops (Staudinger, 1887)	–	–	–	–	–	–	+	–	–	–	–	–
S. psyche (Grum-Grshimailo, 1893)	–	–	–	–	–	–	+	–	–	–	–	–
Dieida ahngeri (Grum-Grshimailo, 1902)	–	–	–	–	–	+	–	–	–	–	–	–
D. judith Yakovlev, 2009	–	–	–	+	–	–	–	–	–	–	–	–
Semagystia agilis (Christoph, 1884)	–	–	–	–	–	+	+	–	–	–	–	–

Table 1 (Contd.)

Species	Regions											
	1	2	3	4	5	6	7	8	9	10	11	12
S. bucharana (Bang-Haas, 1910)	–	–	–	–	–	–	+	+	–	–	–	–
S. clathrata (Christoph, 1884)	–	–	–	–	–	+	–	–	–	–	–	–
Dyspessa kabylaria A. Bang-Haas, 1906	–	+	+	+	–	–	–	–	–	–	–	–
D. affinis Rothschild, 1912	–	–	–	–	–	–	+	–	–	–	–	–
D. albosignata Rothschild, 1912	–	–	–	–	–	+	–	–	–	–	–	–
D. salicicola (Eversmann, 1848)	–	–	–	–	–	+	–	+	–	–	–	–
D. tristis A. Bang-Haas, 1906	–	–	–	–	–	–	–	+	+	–	–	–
D. marikowskyi Yakovlev, 2007	–	–	–	–	–	–	–	+	–	–	–	–
D. thianshanica Daniel, 1964	–	–	–	–	–	–	–	+	–	–	–	–
D. karatavica Yakovlev, 2007	–	–	–	–	–	–	–	–	+	–	–	–
D. algeriensis (Rambur, 1858)	–	+	–	–	–	–	–	–	–	–	–	–
D. fuscula (Staudinger, 1879)	–	+	–	–	–	–	–	–	–	–	–	–
D. walteri Yakovlev, 2011	–	+	–	–	–	–	–	–	–	–	–	–
D. rothschildi Yakovlev, 2011	–	+	–	–	–	–	–	–	–	–	–	–
D. marhoccana Rothschild, 1917	+	–	–	–	–	–	–	–	–	–	–	–
D. cyrenaica Turati, 1916	–	+	+	–	–	–	–	–	–	–	–	–
D. turbinans Turati, 1926	–	+	–	–	–	–	–	–	–	–	–	–
D. fantolii Krüger, 1934	–	+	–	–	–	–	–	–	–	–	–	–
D. syrtica Krüger, 1932	–	+	–	–	–	–	–	–	–	–	–	–
D. delrei Turati, 1936	–	+	–	–	–	–	–	–	–	–	–	–
Afroarabiella tahamae (Wiltshire, 1949)	–	–	–	+	–	–	–	–	–	–	–	–
Camellocossus abyssinica (Hampson, 1910)	–	–	–	+	–	–	–	–	–	–	–	–
C. henley (Warren et Rothschild, 1905)	–	+	+	–	–	–	–	–	–	–	–	–
Mahommedella rungsi (Daniel et Witt, 1974)	+	–	–	–	–	–	–	–	–	–	–	–
Semitocossus johannes (Staudinger, 1899)	–	–	–	+	–	–	–	–	–	–	–	–
Afrikanetz makumazan Yakovlev, 2009	–	–	–	+	–	–	–	–	–	–	–	–
Wiltshirocossus aries (Püngeler, 1902)	+	+	+	+	–	–	–	–	–	–	–	–
Alcterogystia l-nigrum (Bethune-Baker, 1894)	–	–	–	+	–	–	–	–	–	–	–	–
A. frater (Warnecke, 1929)	–	–	–	+	–	–	–	–	–	–	–	–
Mormogystia reibelli (Oberthür, 1876)	+	+	+	+	–	–	–	–	–	–	–	–
Brachygystia mauritanica (Lucas, 1907)	+	+	–	–	–	–	–	–	–	–	–	–
Kotchevnik modestus (Staudinger, 1887)	–	–	–	–	–	–	+	+	+	–	–	–
K. tapinus (Püngeler, 1898)	–	–	–	–	–	+	–	–	–	–	–	–
K. choui (Fang et Chen, 1989)	–	–	–	–	–	–	–	–	–	–	–	+
Gobibatyr colossus (Staudinger, 1887)	–	–	–	–	–	–	–	+	+	–	–	+
G. ustyuzhanini Yakovlev, 2004	–	–	–	–	–	–	–	–	–	+	–	+
Parahypopta caestrum (Hübner, 1804)	–	–	–	–	–	–	–	–	+	–	–	–
Eogystia kaszabi Daniel, 1965	–	–	–	–	–	–	–	+	–	–	–	–
E. hippophaecola (Hua, Chou, Fang et Chen, 1990)	–	–	–	–	–	–	–	–	–	–	+	–
Chingizid kosachevi Yakovlev, 2012	–	–	–	–	–	–	–	–	–	+	–	–
C. transaltaica (Daniel, 1970)	–	–	–	–	–	–	–	–	–	–	–	+

Table 1 (Contd.)

Species	Regions											
	1	2	3	4	5	6	7	8	9	10	11	12
C. gobiana (Daniel, 1970)	–	–	–	–	–	–	–	–	–	–	+	–
Cossus kerzhneri Yakovlev, 2011	–	–	–	–	–	–	–	–	–	–	+	–
Kerzhnerocossus sambainu Yakovlev, 2011	–	–	–	–	–	–	–	–	–	–	+	–
Stygia hades Le Cerf, 1924	+	–	–	–	–	–	–	–	–	–	–	–
Neostygia postaurantiaca Wiltshire, 1980	–	–	–	+	–	–	–	–	–	–	–	–
Phragmataecia castaneae (Hübner, 1790)	+	+	+	–	–	+	–	+	+	–	–	–
P. albida Erschoff, 1874	–	–	–	–	–	+	+	+	+	–	–	–
P. roborowskyi Alphéraky, 1897	–	–	–	–	–	–	–	+	–	–	–	–
P. anikini Yakovlev, 2011	–	–	–	–	–	–	–	–	–	–	–	+
Cecriphallus nubila (Staudinger, 1895)	–	–	–	–	–	+	+	+	–	–	–	+
C. helenae (Le Cerf, 1924)	+	+	–	–	–	–	–	–	–	–	–	–
Aethalopteryx wiltshirei Yakovlev, 2009	–	–	–	+	–	–	–	–	–	–	–	–
Phragmacossia territa (Staudinger, 1879)	–	–	–	–	+	+	–	–	–	–	–	–
Azygophleps scalaris (Fabricius, 1775)	–	–	–	–	+	–	–	–	–	–	–	–
A. larseni Yakovlev et Saldaitis, 2011	–	–	–	+	+	–	–	–	–	–	–	–
A. sheikh Yakovlev et Saldaitis, 2011	–	–	–	+	–	–	–	–	–	–	–	–
Meharia incurvariella Chrétien, 1915	–	–	–	–	+	–	–	–	–	–	–	–
M. semilactea (Warren et Rothschild, 1905)	–	–	–	+	–	–	–	–	–	–	–	–
M. phylbyi Bradley, 1952	–	–	–	+	–	–	–	–	–	–	–	–
M. acuta Wiltshire, 1982	–	–	–	+	–	–	–	–	–	–	–	–

Notes: Regions: (1) western part of Sahara (Morocco, northern Mauritania, Western Sahara); (2) central part of Sahara (Algeria, Libya, Tunisia); (3) eastern part of Sahara (Egypt); (4) Arabian Desert; (5) deserts of southern Iran; (6) Kara Kum Desert; (7) Kyzyl Kum Desert; (8) deserts of Eastern Kazakhstan (Sary-Ishikotrau, Tau Kum, sands of the Ili River valley); (9) deserts of Southern and Central Kazakhstan (Betpak Dala, Moyun Kum); (10) deserts of the Great Lakes valley; (11) Eastern Gobi and Ordos; (12) Dzungar Gobi with the Baruunkhurai Depression, Trans-Altai and Zakhuin-Gobi deserts; "+" means that the species has been recorded from the region; "–" means that the species has not been recorded from the region.

BIODIV software. Unfortunately, having no reliable data on the distribution of Cossidae in the deserts of the Tarim and Turfan depressions, Takla Makane, and the Tar Desert (mostly because of the total absence of collection material and literature data), we excluded these areas from analysis.

History of the Research of Cossidae of the Arid Areas of the Palaearctic Region

The carpenter-moth fauna of the Palaearctic deserts was specially investigated, mainly in the 20th century.

Detailed data on Cossidae of North Africa were published by French, Italian, and English experts (Tirati, 1922, 1924, 1926, 1927, 1934, 1936; Krüger, 1934, 1939; Wiltshire, 1949; Herbulot and Viette, 1952). Data on the cossid fauna of the western part of the Sahara Desert were published by Lucas (1907, 1907a, 1910) and Rungs (1979), with some later supplements (Yakovlev and Saldaitis, 2008; Yakovlev, 2008a, 2011c).

Wiltshire with coauthors gave representative data on the distribution of Cossidae on the Arabian Peninsula (Wiltshire, 1980, 1990; Legrain and Wiltshire, 1998). Later, the data on the fauna of Arabia were significantly supplemented owing to examination of new material (Hacker, 1999; Hacker et al., 1999, 2001; Yakovlev, 2006a, 2007a, 2008a, 2009b, 2009d, 2010; Borth et al., 2011).

The carpenter-moth fauna of the deserts of Middle Asia and Kazakhstan was manly studied in recent years (Falkovitsh, 1986; Krivokhatsky, 1995; Yakovlev, 2004a, 2006a, 2006b, 2008b, 2009a, 2009c, 2009e, 2011a).

Table 2. The ratio of the Palaearctic and the Afrotropical elements in the fauna of the Arabian Peninsula

Region	Zoogeographical groups		
	Palaearctic species	Afrotropical species	Eremic (desert species distributed from Sahara to Arabia or southern Iran)
Central and northern Arabia. 13 species	*Paropta paradoxa, Holcocerus gloriosus, H. holosericeus, Eremocossus vaulogeri, Dyspessa kabylaria* 5 species (38.5%)	*Afroarabiella tahamae* 1 species (7.7%)	*Wiltshirocossus aries, Alcterogystia l-nigra, A. frater, Mormogystia reibelli, Azygophleps larseni, A. sheikh, Meharia semilactea* 7 species (53.8%)
Southeastern Arabia (Oman). 10 species.	*Holcocerus holosericeus, Eremocossus vaulogeri* 2 species (20%)	Not found	*Vartiania zaratustra, Mormogystia reibelli, Azygophleps larseni, A. sheikh, Meharia semilactea, M. phylbyi, M. acuta, Neostygia postaurantiaca* 8 species (80%)
Southwestern Arabia (Yemen and the southwestern part of Saudi Arabia). 15 species	*Holcocerus gloriosus, Eremocossus vaulogeri* 2 species (13.3%)	*Camellocossus abyssinica, Afroarabiella tahamae, Afrikanetz makumazan, Aethalopteryx wiltshirei* 4 species (26.7%)	*Holcocerus zarudnyi, Alcterogystia l-nigra, A. frater, Mormogystia reibelli, Azygophleps larseni, A. sheikh, Meharia semilactea, M. phylbyi, M. acuta* 9 species (60%)

Data on the Cossidae of the arid areas of Mongolia were presented in sufficient detail by Daniel (1965, 1967, 1969, 1970) and by the first author of the present paper (Yakovlev, 2004, 2006a, 2007b, 2011b). The carpenter-moths of the deserts of southern Iran were rather fully studied (Yakovlev, 2004, 2006a, 2008c). The known host plants of carpenter-moths of the arid Palaearctic areas were considered in a number of publications (Schoorl, 1990; Yakovlev, 2012).

The Faunal Composition of the Carpenter-moths of the Palaearctic Deserts

102 carpenter-moth species belonging to 38 genera of 4 subfamilies are known for the deserts of the Palaearctic, which constitutes 38.2% of the total number of the species recorded in the zoogeographical region.

As mentioned above, there are quite a few desert endemics among carpenter-moths: 4 endemics to the Eastern Gobi Desert, 5 to the Dzungar Gobi Desert, 1 to the Great Lakes valley, 2 to the southern areas of the Trans-Altai and Zakhuin Gobi deserts, 6 to the Kyzyl Kum Desert, 2 to the Kara Kum Desert, and 4, to Mesopotamia. Two endemic genera of Cossidae occur in the deserts of Mongolia. In the northern part of Sahara, the number of endemics is also high—12; 6 endemic species and 2 endemic genera (*Brachigystia* Schoorl, 1990 and *Mahommedella* Yakovlev, 2011) are recorded for the arid foothills of the Atlas Range.

The Border between the Palaearctic and Afrotropical Zoogeographical Provinces

The borders between the Palaearctic and Afrotropical regions have long been discussed. The investigations of the lepidopterans of Sahara are far from being completed because of difficulties of working in at least two large North African countries: Libya and Mauritania. However, the data on Algeria help to fill the gaps. The material from the Ahaggar Mountains in the south of Algeria (Herbulot and Viette, 1952) and also our consultations with Dr. W. Speidel testify to the fact that the northern part of the Ahaggar Mts. has a Palaearctic "appearance," and their southern part is richer in Afrotropical elements. The material from Sahel is also not complete because of inaccessibility of the territories. Chad, Niger, and Mali have not been visited by entomologists for a rather long time because of a high risk.

Taking into account the above deficiency of information on the Cossidae distribution in North Africa,

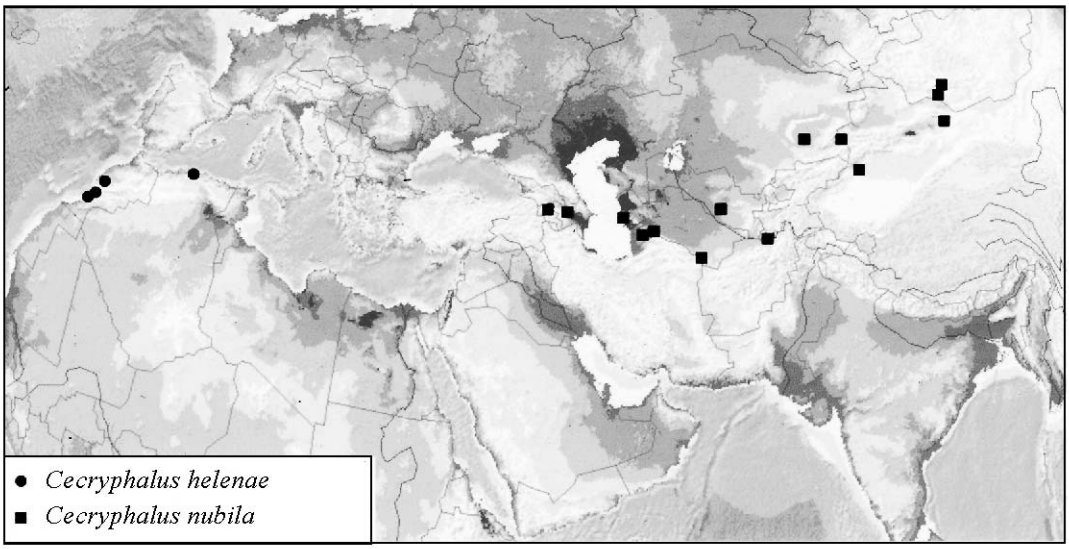

Fig. 1. Distribution of representatives of the genus *Cecriphallus* Schoorl, 1990.

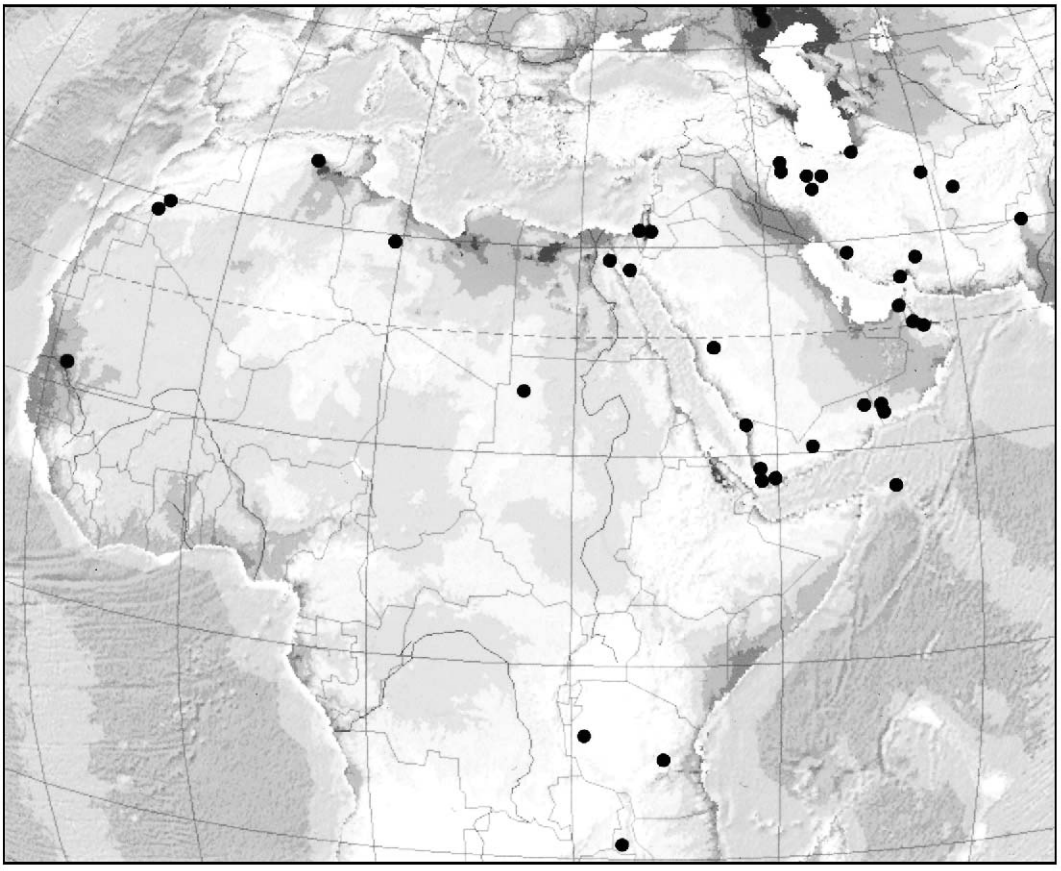

Fig. 2. Distribution of representatives of the genus *Meharia* Crétien, 1915.

we suggest that that the border should be drawn along the Tropic of Cancer, which will not contradict the data of Larsen (1991), Kryzhanovskij (2003), and Dubatolov (2007).

Most authors consider Arabia a transitive zone between the Palaearctic, Oriental, and Afrotropical regions. Larsen (1984) and Dubatolov (2007), based on the data on the distribution of diurnal lepidopterans

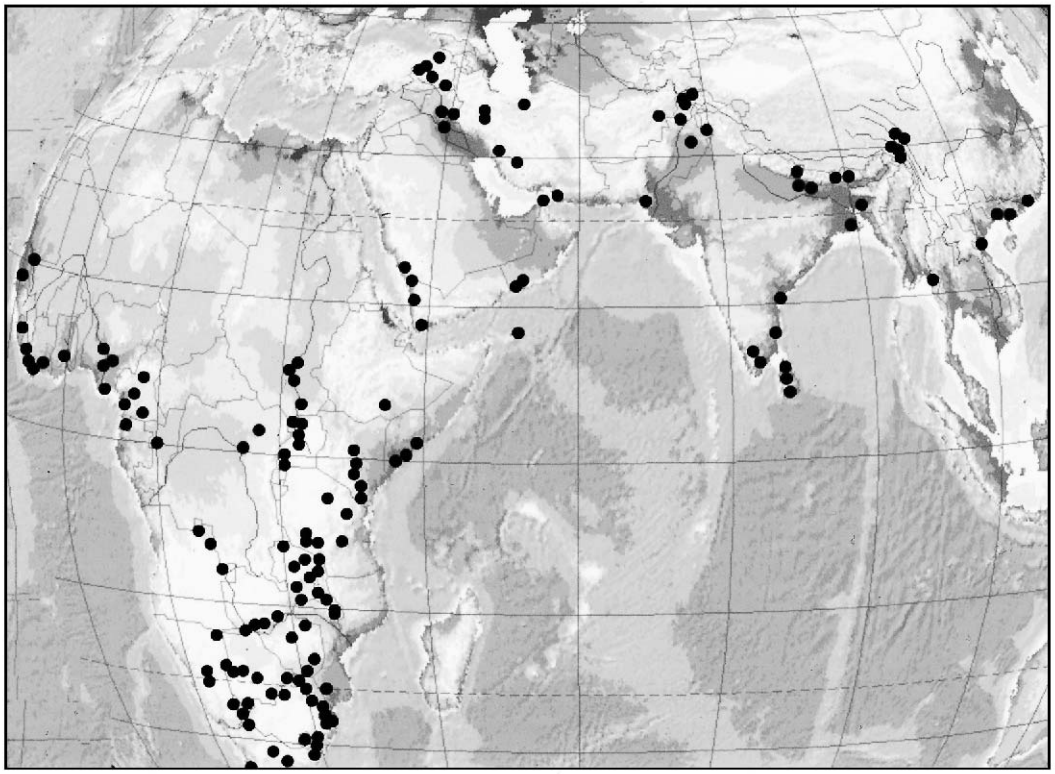

Fig. 3. Distribution of representatives of the genus *Azygophleps* Hampson, 1892.

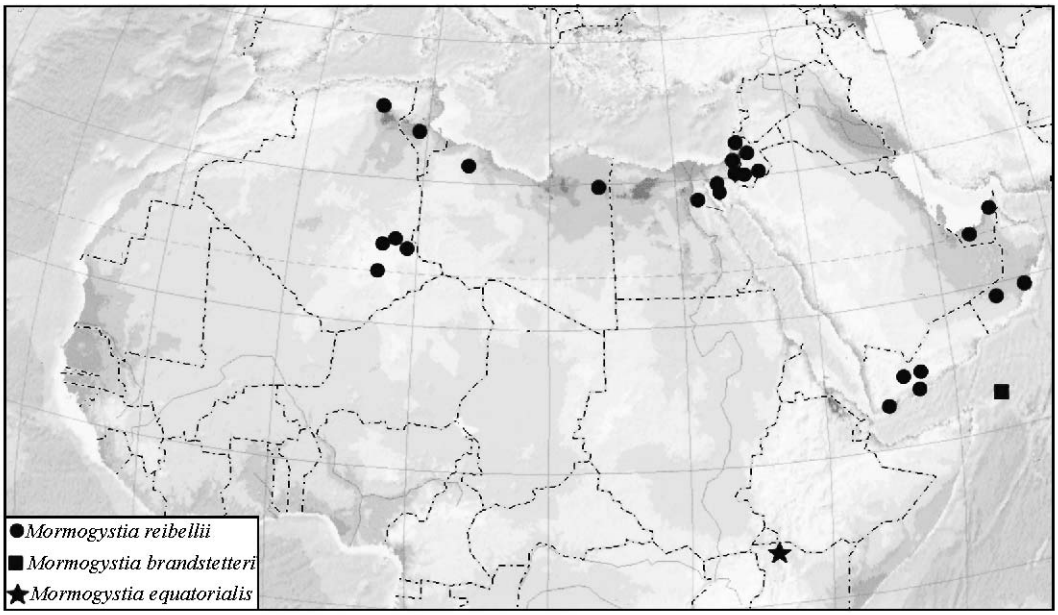

Fig. 4. Distribution of representatives of the genus *Mormogystia* Schoorl, 1990.

(Papilionoidea) and tiger moths of the subfamily Arctiinae, show that the northern and central parts of the peninsula belong to the Palaearctic, and the southern and western coasts, to the Afrotropical Region.

Having the representative material from various areas of Arabia at our disposal, we can confirm the above facts for Cossidae as well (Table 2).

Thus, the core of the fauna is represented by the so-called eremic group which is peculiar to Sahara, Ara-

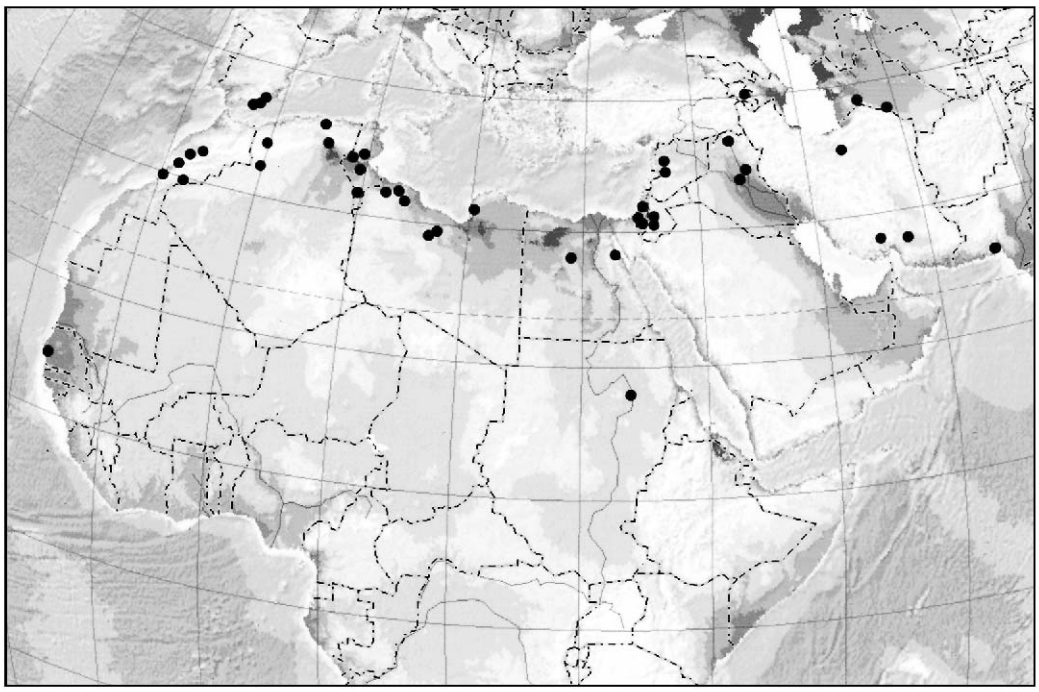

Fig. 5. Distribution of representatives of the genus *Eremocossus* Hampson, 1892.

bia, and the Near East. Eremic (desert) species are conventionally distinguished in zoogeographical studies of the lepidopterans of Arabia (Larsen, 1984, 1991; Wiltshire, 1986; Kravchenko et al., 2008; Lehman, 2010). In all the regions of Arabia, representatives of this group constitute from 53.8% (in Central and Northern Arabia) to 80% (in Oman and on Socotra). In the central and northern parts of the Arabian Peninsula, the fraction of the Palaearctic elements is 38.5%, and that of the Afrotropical species is 7.7%. In Oman, the Afrotropical elements have not been found, and the fraction of the Palaearctic species constitutes only 20%. In Yemen, the fraction of the Afrotropical species is 26.7%, and that of the Palaearctic species 13.3%. On Socotra, the Afrotropical species constitute 20%, and 80% are eremic species. Thus, the fraction of the Afrotropical elements is much higher in southern Arabia. Representatives of the following four Afrotropical genera have been found there: *Aethalopteryx* Schoorl, 1990, *Afroarabiella* Yakovlev, 2008), *Camellocossus* Yakovlev, 2011, and *Afrikanetz* Yakovlev, 2009. The eremic group in the family Cossidae is presented by 15 species belonging to 8 genera of 3 subfamilies.

The data on the distribution of Cossidae over the territory of Arabia testify that Yemen and the southwestern part of Saudi Arabia, belong to the Afrotropical Region, whereas the east and the north of Arabia belong to the Palaearctic Region.

The Peculiarities of the Distribution of the Desert Genera of Cossidae

We interpret desert genera as those mostly comprising obligate inhabitants of arid biotopes. The majority of desert genera of carpenter-moths are more or less widely distributed over the arid and subarid areas of the Palaearctic Region. *Holcocerus* Staudinger, 1884 is distributed from Morocco to Gobi (Bayan-Hongor). *Deserticossus* Yakovlev, 2006 occurs from Sinai to eastern China, and this genus also includes mesophilous species, for example, *D. tsingtauana* Bang-Haas. The genera *Cryptoholcocerus* Yakovlev, 2006 and *Kotchevnik* Yakovlev, 2004 are widespread in the deserts and mountains of Middle Asia and in some adjacent territories (Betpak Dala, Northern Iran, Northern Pakistan). Species of the genus *Barchaniella* Yakovlev, 2006 are distributed from the deserts of southern Iran to the Trans-Altai Gobi Desert. *Gobibatyr* Yakovlev, 2004 has a narrower distribution: *G. colossus* occurs in the deserts of the eastern part of Middle Asia, and *G. ustyuzhanini* in the Dzungar and Trans-Altai Gobi deserts. The monotypical genus *Pljuschiella* Yakovlev, 2006 was recorded only from the Kyzyl Kum and Kara Kum deserts. The listed genera have a Turanian origin.

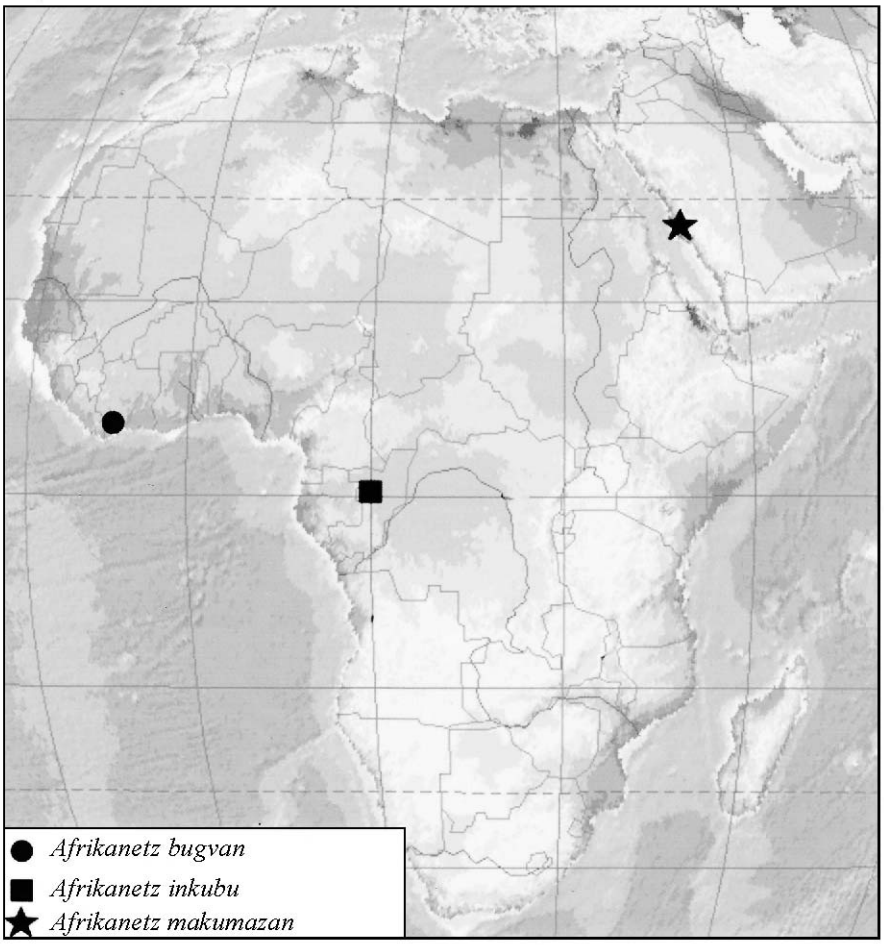

Fig. 6. Distribution of representatives of the genus *Afrikanetz* Yakovlev, 2009.

Two carpenter-moth genera *Chingizid* Yakovlev, 2011 and *Kerzhnerocossus* Yakovlev, 2011 are endemics to the deserts of Mongolia, and 3 out of 4 species of these genera occur only in the Eastern Gobi Desert.

A peculiar distribution is inherent in the genus *Cecriphallus* Schoorl, 1990. The type species of the genus, *C. nubila*, occurs from the Kara Kum to Trans-Altai Gobi deserts, and the second species of the genus, *C. helenae*, inhabits the western areas of Sahara (Fig. 1).

The ranges of the genera *Alcterogystia* Schoorl, 1990, *Neostygia* Wiltshire, 1982, *Semitocossus* Yakovlev, 2007, and *Wiltshirocossus* Yakovlev, 2007 do not extend beyond the limits of Morocco and western Mauritania (in the west) to the Near East (in the east), i.e., they are typical eremic genera. A narrower (only in the western areas of Sahara) distribution is characteristic of the genera *Brachygystia* Schoorl, 1990 and *Mahommedella* Yakovlev, 2011.

Sahara is an impenetrable zoogeographical barrier for the overwhelming majority of the Palaearctic genera and species of insects (Larsen, 1991; Kryzhanovskij, 2003; Dubatolov, 2007;). However, another pattern is exhibited by some desert genera of carpenter-moths. The widest distribution range is demonstrated by representatives of the genus *Meharia* Chrétien, 1915 (Fig. 2). They occur from the southern Volga River Area through the Near East and Sahara to Kenya and Malawi. Everywhere representatives of *Meharia* inhabit extremely arid biotopes. Representatives of *Azygophleps* Hampson, 1892 have a pan-palaeotropical distribution with the east of the range in eastern Hindustan and Bangladesh (Fig. 3). Representatives of the genus *Mormogystia* Schoorl, 1990 are widespread in the Near East, on the Arabian Peninsula, and in Sahara; *M. brandstetteri* is endemic to Socotra Island, and *M equatorialis* occurs much southwards, in the arid localities along the coast of Lake Turkana (Rudolf) in Northern Kenya (Fig. 4). *Eremocossus* Hampson, 1892 occurs in southern

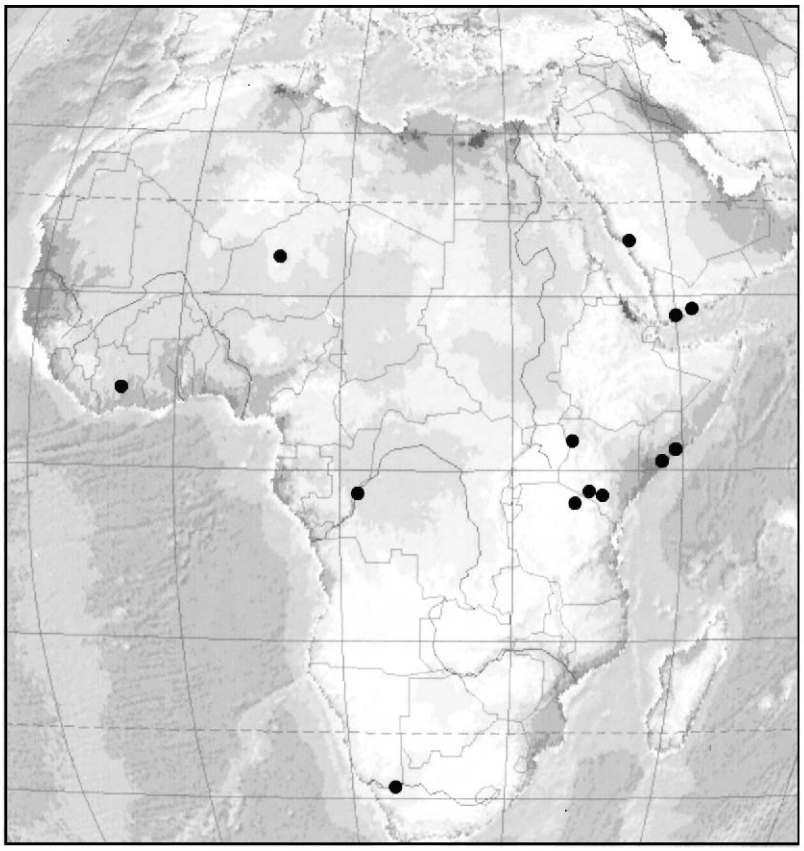

Fig. 7. Distribution of representatives of the genus *Afroarabiella* Yakovlev, 2008.

Armenia, the Kara Kum Desert; it is widespread in the Northern Sahara Desert and in Arabia (Fig. 5). One of the species of this genus (*E. nubica*) was recorded from the western Sahel. Similar distribution is observed in representatives of *Camellocossus* Yakovlev, 2011: its species are widespread in Sahara and Sahel.

Some African genera penetrate far northward into Arabia. These are *Afrikanetz* Yakovlev, 2009 reaching Congo in the south (Fig. 6) and *Afroarabiella* Yakovlev, 2008 (Fig. 7) and *Aethalopteryx* Schoorl, 1990 (Fig. 8) distributed even more widely over Africa (as far as the northern areas of the Republic of South Africa: the Limpopo and Orange river valleys, the Kalahari Desert).

Analysis of Heterogeneity of the Distribution of Carpenter-moths in the Arid Areas of the Palaearctic Region

Analysis of the distribution of Cossidae species over 12 local desert Palaearctic faunas, performed with KLAFA method, has shown that these faunas are combined into 4 groups: Sahara–Arabian–South-Iranian, Middle-Asian–Kazakhstanian, Western-Gobian, and Eastern-Gobian. They are accepted as types of the fauna. These groups are combined into a common scheme (graph) using the method of correlation pleiads, which allows us to disregard any weak relationships between classes and to consider only significant ones (Terent'ev, 1959). In this case, 20% of similarity (Fig. 9) is accepted as a threshold of significance of the relationships. When such relationships are absent, the greatest postthreshold relationships are used. The supertypes of the fauna were distinguished as aggregations on a graph, when the relations exceed 20% of the factor of similarity of separate faunas. A brief characteristic of the distinguished types of the faunas is given below.

The Sahara–Arabian–South-Iranian group is primarily characterized by a great number of endemic (eremic) elements and a great number of representatives of the Afrotropical genera. The Middle-Asian–Kazakhstanian group of the faunas includes a high portion of endemic species of the Palaearctic genera: *Dyspessa* Hbn., *Deserticossus* Yak., *Holcocerus* Stgr., etc. The West-Gobian fauna is considerably isolated from both the Middle-Asian–Kazakhstanian and the Eastern-Gobian faunas. The fauna of the Western

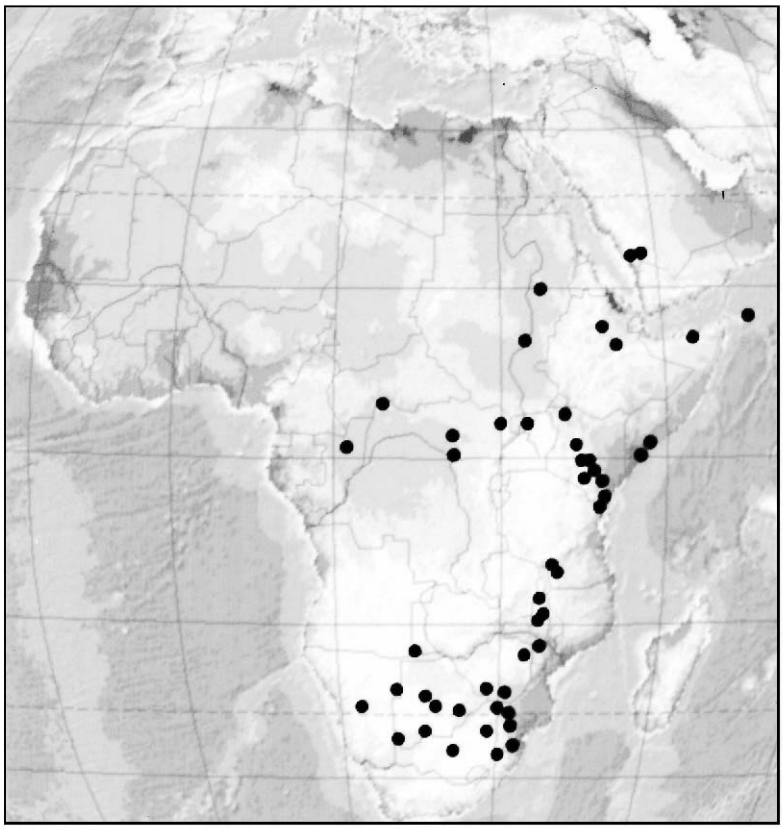

Fig. 8. Distribution of representatives of the genus *Aethalopteryx* Schoorl, 1990.

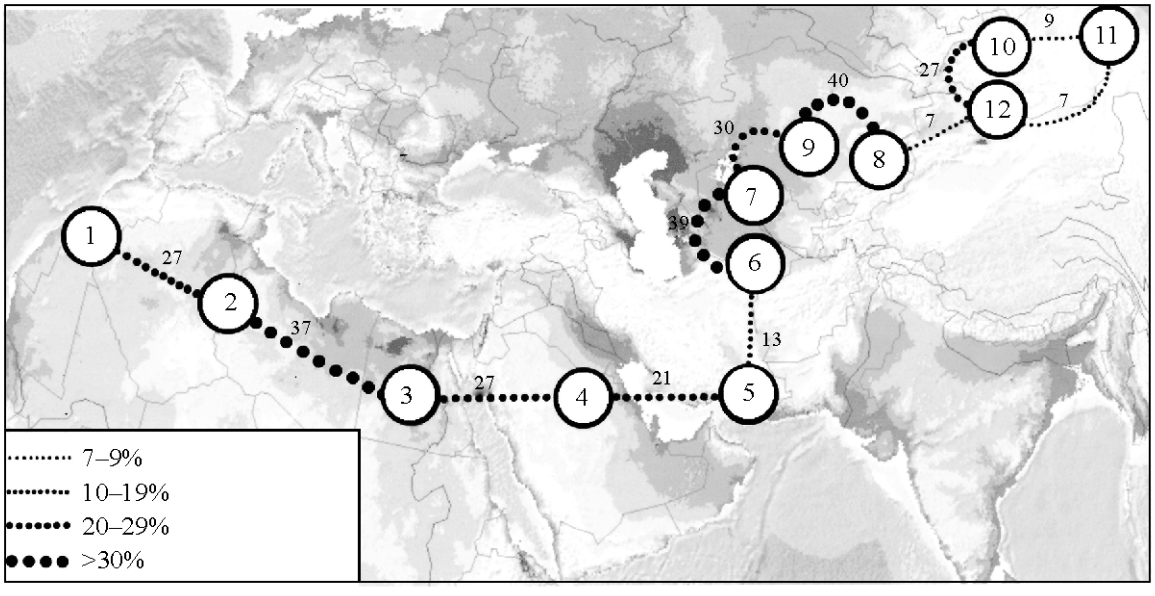

Fig. 9. Graph of heterogeneity of the carpenter-moth fauna of the deserts of the Palaearctic Region (species-level). Regions: (1) western part of Sahara (Morocco, northern Mauritania, Western Sahara); (2) central part of Sahara (Algeria, Libya, Tunisia); (3) eastern part of Sahara (Egypt); (4) Arabian Desert; (5) deserts of southern Iran; (6) Kara Kum Desert; (7) Kyzyl Kum Desert; (8) deserts of Eastern Kazakhstan (Sary-Ishikotrau, Tau Kum, sands of the Ili River valley); (9) deserts of Southern and Central Kazakhstan (Betpak Dala, Moyun Kum); (10) deserts of the Great Lakes valley; (11) Eastern Gobi and Ordos; (12) Dzungar Gobi with the Baruunkhurai Depression and Trans-Altai and Zakhuin-Gobi deserts.

Gobi still retains characters of the Middle-Asian–Kazakhstanian cluster (first of all, at the level of the genera *Deserticossus* Yak., *Cecryphallus* Schoorl, *Dyspessa* Hbn., *Gobibatyr* Yak., etc.), whereas in the fauna of the Eastern Gobi Desert, endemic elements dominate (*Cossus kerzhneri* Yak., *Chingizid gobiana* Dan., *Ch. transaltaica* Dan., *Kerzhnerocossus sambainu* Yak.).

As seen from the structural graph (Fig. 9), the fauna of the Eastern Gobi Desert is most strongly isolated (7% of similarity to the fauna of the Dzungar, Trans-Altai Gobi, and Zakhuin-Gobi deserts, and 9% of similarity to the fauna of the Great Lakes valley). Such significant differences allow us to consider the cossid fauna of the eastern part of the Gobi Desert in the rank of a separate supertype. Analysis of the distribution of the genera of Cossidae over the Palaearctic deserts has also showed a pronounced specificity of the fauna of the Eastern Gobi Desert.

CONCLUSIONS

(1) The family Cossidae includes a great number of desert endemics (42 species, which constitutes 41.2% of the total number of the species recorded from the deserts).

(2) The east and the north of Arabia belong to the Palaearctic Region, and Yemen, the southwestern part of Saudi Arabia, and the southernmost part of Iran (Makran Coast) belong to the Afrotropical Region.

(3) The Sahara Desert is not an insuperable barrier for six carpenter-moth genera (*Meharia* Chrét., *Azygophleps* Hmps., *Mormogystia* Schoorl, *Aethalopteryx* Schoorl, *Afrikanetz* Yak., and *Eremocossus* Hmps.).

(4) Based on the results of analysis of the Cossidae distribution, the Eastern Gobi Desert should be distinguished as a separate zoogeographical subregion.

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