Acta Soc. Zool. Bohem. **74**: 185–353, 2010
ISSN 1211-376X

Bats (Mammalia: Chiroptera) of the Eastern Mediterranean and Middle East. Part 8. Bats of Jordan: fauna, ecology, echolocation, ectoparasites

Petr Benda[1,2], Radek K. Lučan[2], Ján Obuch[3], Antonín Reiter[4], Michal Andreas[5], Peter Bačkor[6], Thierry Bohnenstengel[7], Ehab Khalil Eid[8], Martin Ševčík[9], Peter Vallo[10] & Zuhair Sami Amr[11]

Received 12 December 2010; *accepted 23 December 2010*
Published 30 December 2010

[1] Department of Zoology, National Museum (Natural History), Václavské nám. 68, CZ–115 79 Praha 1, Czech Republic; petr.benda@nm.cz
[2] Department of Zoology, Faculty of Science, Charles University in Prague, Viničná 7, CZ–128 44 Praha 2, Czech Republic
[3] Botanical Garden, Comenius University, SK–038 15 Blatnica, Slovakia
[4] South Moravian Museum, Přemyslovců 8, CZ–669 45 Znojmo, Czech Republic
[5] The Silva Tarouca Research Institute for Landscape and Ornamental Gardening, Květnové nám. 391, CZ–252 43 Průhonice, Czech Republic
[6] Department of Biology and Ecology, Faculty of Science, Matej Bel University, SK–974 01 Banská Bystrica, Slovakia
[7] Centre Suisse de Cartographie de la Faune (CSCF), Passage Max-Meuron 6, CH–2000 Neuchâtel, Switzerland
[8] The Royal Society for the Conservation of Nature, Research and Survey Section, P.O. Box 1215, Jubaiha 11941, Jordan
[9] Department of Zoology and Anthropology, Faculty of Natural Sciences, Constantine the Philosopher University, Nábrežie mládeže 91, SK–949 74 Nitra, Slovakia
[10] Institute of Vertebrate Biology, Academy of Sciences of the Czech Republic, Květná 8, CZ–603 65 Brno, Czech Republic
[11] Department of Biology, Jordan University of Science and Technology, Irbid, Jordan

Abstract. A complete list of bat records available from Jordan was compiled from literature and from new records, based on field studies and examination of museum specimens. The record review is complemented by distribution maps, summaries of distributional status of the particular species, files of field observations, and data on feeding ecology. Basic descriptive echolocation parameters for 17 species (782 calls from 134 call sequences analysed) are given and discussed. Arthropod ectoparasites were collected from 14 bat species. In some species sheets, notes concerning variation of the Levantine populations are added. From the territory of the modern Hashemite Kingdom of Jordan, 289 records of 26 bat species belonging to nine families are known; viz. *Rousettus aegyptiacus* (Geoffroy, 1810) (21 record sites), *Rhinopoma microphyllum* (Brünnich, 1782) (4), *R. cystops* Thomas, 1903 (21), *Taphozous perforatus* Geoffroy, 1818 (7), *T. nudiventris* Cretzschmar, 1830 (6), *Nycteris thebaica* (Geoffroy, 1803) (3), *Rhinolophus ferrumequinum* (Schreber, 1774) (12), *R. clivosus* Cretzschmar, 1828 (10), *R. hipposideros* (Borkhausen, 1797) (4–5), *R. euryale* Blasius, 1853 (5), *R. mehelyi* Matschie, 1901 (1), *R. blasii* Peters, 1866 (14), *Asellia tridens* (Geoffroy, 1813) (3), *Myotis blythii* (Tomes, 1857) (2), *M. nattereri* (Kuhl, 1817) (10), *M. emarginatus* (Geoffroy, 1806) (5), *M. capaccinii* (Bonaparte, 1837) (1), *Eptesicus bottae* (Peters, 1869) (21), *Hypsugo ariel* (Thomas, 1904) (12), *Pipistrellus pipistrellus* (Schreber, 1774) (10–11), *P. kuhlii* (Kuhl, 1817) (33), *Otonycteris hemprichii* Peters, 1859 (22), *Barbastella leucomelas* (Cretzschmar, 1830) (6), *Plecotus christii* Gray, 1838 (19), *Miniopterus pallidus* Thomas, 1905 (3), and *Tadarida teniotis* (Rafinesque, 1814) (33). *Myotis blythii*, *Pipistrellus pipistrellus*, and *Barbastella leucomelas* are here reported from Jordan for the first time. Simple zoogeographical analysis of the bat fauna of Jordan revealed four main groups of particular faunal elements as well as community types. The fauna is composed of (1) the Mediterranean, (2) southern desert, (3) Rift desert, and (4) widespread

elements, while the bat communities are represented by (1) Mediterranean arboreal, (2) southern desert, (3) Rift, and (4) transient (combined) types. Seventeen species of bat ectoparasites belonging to seven families were recorded from Jordan; the following eleven species are here reported for the first time from the country: *Argas vespertilionis* (Latreille, 1802) (collected from *Rousettus aegyptiacus*, *Pipistrellus pipistrellus* and *P. kuhlii*), *A. confusus* Hoogstraal, 1955 (from *Rhinopoma cystops*), *Spinturnix psi* Kolenati, 1856 (from *Miniopterus pallidus*), *S. myoti* (Kolenati, 1856) (from *Myotis blythii*), *Steatonyssus periblepharus* Kolenati, 1858 (from *Pipistrellus pipistrellus* and *P. kuhlii*), *Parasteanonyssus hoogstraali* Keegan, 1956 (from *Tadarida teniotis*), *Cacodmus vicinus* Horvath, 1932 (from *Pipistrellus pipistrellus* and *P. kuhlii*), *Penicillidia conspicua* Speiser, 1901 (from *Miniopterus pallidus*), *P. dufourii* Westwood, 1835 (from *Myotis blythii*), *Nycteribia schmidlii* Schiner, 1853 (from *Miniopterus pallidus*), and *Basilia daganiae* Theodor et Moscona, 1954 (from *Pipistrellus pipistrellus*).

Key words. Distribution, ecology, echolocation, ectoparasites, Chiroptera, Middle East, Jordan, Arabia, Palaearctic Region.

CONTENTS

INTRODUCTION

The territory of the present Hashemite Kingdom of Jordan (89,556 km^2, see Fig. 1) lies in the easternmost part of the Mediterranean Basin or southern part of the Levant in its broader sense, on the crossroads of cultural and environmental influences between the West and the Orient, between Afrotropics and Palaearctic, and/or between the fertile Mediterranean and arid Arabia. Moreover, this region in its widest sense is important for most of human inhabitants of the western Palaearctic since it represents a cultural cradle, being a large part of the Holy Land. However, the attraction of Jordan for zoologists remained for a long time far behind the attraction for archaeologists and/or art historians, although the territory of Jordan is situated at the transition of two main biomes of the southwestern Palaearctic, the Mediterranean arboreal and the Saharo-Sindian eremial (Blondel et al. 2010). The former one reaches here its southernmost fringe, while in the latter one, Jordan lies on the northern margin.

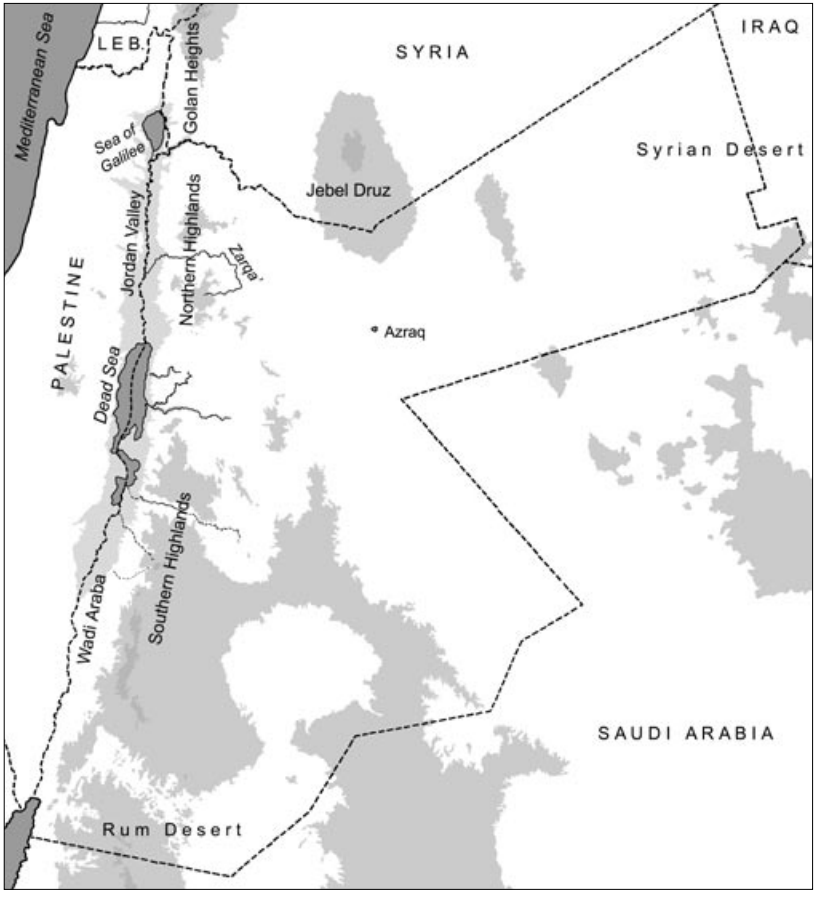


Fig. 1. General map of Jordan; main geographical features (pale shaded – area below sea level, medium shaded – area above 900 m a. s. l., dark shaded – area above 1500 m a. s. l.). LEB. = Lebanon.

Table 1. Composition of the bat fauna of Jordan and the number of records of particular species according to subsequent reviews. Numbers of cases with inaccurate species identification are given in parentheses

	Harrison 1964	Atallah 1977	Harrison & Bates 1991	Qumsiyeh et al. 1998	present review
Rousettus aegyptiacus	–	–	3	6	21
Rhinopoma microphyllum	–	–	1	2	4
Rhinopoma cystops	1	1	1	3	21
Taphozous perforatus	–	–	–	1	7
Taphozous nudiventris	–	–	–	–	6
Nycteris thebaica	–	–	–	–	3
Rhinolophus ferrumequinum	2	2	6	7	12
Rhinolophus clivosus	–	–	1	3	10
Rhinolophus hipposideros	–	–	1	2	5
Rhinolophus euryale	–	1	1(2)	2	5
Rhinolophus mehelyi	–	–	–	1	1
Rhinolophus blasii	–	–	3	6	14
Asellia tridens	–	–	–	1	3
Myotis blythii	–	–	–	–	2
Myotis nattereri	–	–	1	1	10
Myotis emarginatus	–	–	1	1	5
Myotis capaccinii	–	–	1	1	1
Eptesicus bottae	–	–	1	2	21
Hypsugo ariel	–	–	–	2	12
Pipistrellus pipistrellus	–	–	–	(1)	10
Pipistrellus kuhlii	–	2	2	5	33
Otonycteris hemprichii	–	1	2	3	22
Barbastella leucomelas	–	–	–	–	6
Plecotus christii	–	–	–	3	19
Miniopterus pallidus	1	1	2	2	3
Tadarida teniotis	–	1	2	6	33
total (no. species)	3	7	16	21–22	26
total (no. records)	4	9	30	60–61	289
records per species	1.3	1.3	1.9	2.8–2.9	11.1

Although there are many papers, mainly from the last fifteen years, providing data on the distribution and biology of mammals of Jordan (see the reviews by Amr 2000 and Amr et al. 2004), these contributions gave records of bats only exceptionally. The number of published records of bats from Jordan is not large, however, there are many papers available concerning the individual data on bats. Perhaps the earliest published records of bats from Jordan were those by Harrison (1959a). David L. Harrison visited Jordan in 1953 and recorded three bat species there, *Rhinopoma hardwickei* [= *R. cystops*] and *Miniopterus schreibersii* [=? *M. pallidus*] from Jerash and *Rhinolophus ferrumequinum* from Jerash and Sueleh [= Swaileh at ʿAmman]. In 1963–1964 and in 1966, two international expeditions were organised to explore the potential for establishment of a Desert National Park and an International Biological Station in the Azraq region of eastern Jordan. Results of these expeditions were summarised by J. M. Boyd; the late Sana Atallah joined the scientific team in 1966. Besides other mammals, he recorded several individuals of *Pipistrellus kuhlii* from the Azraq area, pregnant females of *Otonycteris hemprichii* from near Azraq ed Druz [= Al Azraq Al Shimali] and *Tadarida teniotis* from Faidhat edh Dhahikiya (Atallah 1966, 1967). Kock (1969) and Kock & Nader (1979) mentioned an old record of *Rousettus aegyptiacus* from the Zerka [= Zarqa'] Valley. Atallah (1977) summarised records from Jordan,

including some new of *Rhinopoma hardwickei* [= *R. cystops*], *Rhinolophus ferrumequinum*, and *R. euryale* from Jerash.

The first serious attemp to study bat fauna of Jordan was carried out by Qumsiyeh (1980). He recorded three species of bats for the first time in Jordan (*Rhinolophus blasii*, *R. hipposideros*, and *Myotis nattereri*) and provided additional records for two others (*Rousettus aegyptiacus*, *Tadarida teniotis*). The first Jordanian *Rhinolophus clivosus* was collected in Petra [= Al Batra] by P. Boye during the German Ornithological Research Trip in 1983 (Boye 1983). Qumsiyeh et al. (1986) made new findings of and conducted karyological studies on the bats of Jordan; they also brought the first records of two species, *Myotis capaccinii*, and *M. emarginatus*. Amr et al. (1987) described a colony of *Rousettus aegyptiacus* found in a cave in the Yarmuk Valley. Amr & Disi (1988) published the mammals collection deposited in the Natural History Museum of the University of Jordan. They listed six bat species (*Rousettus aegyptiacus*, *Rhinolophus ferrumequinum*, *R. blasii*, *Myotis nattereri*, *M. capaccinii*, and *M. emarginatus*), most of them were collected by M. B. Qumsiyeh and Z. S. Amr. Bates & Harrison (1989) recorded *Eptesicus bottae* and *Otonycteris hemprichii* at the Lawrence's Pool in the Wadi Rum, *E. bottae* for the first time from Jordan.

Reviewing the whole mammal fauna of Arabia including Jordan, Harrison & Bates (1991) included new Jordanian records of *Rhinolophus euryale* from the Dibbin Forest, *R. ferrumequinum* from Tabaqat Fahl, and *Miniopterus schreibersii* [= *M. pallidus*] from Magharat Al Wardani [= 'Al Wardeh Cave' mine] in the Ajlun region. Qumsiyeh et al. (1992) reported the first record of *Taphozous perforatus* from Jordan, and also findings of ten other bat species. In his monumental work, Qumsiyeh (1996) included many bat records from Jordan based on examination of the material from the deposition of Z. S. Amr, which were later published by Qumsiyeh et al. (1998). The latter paper also includes all specimens at the deposition of the Jordan University of Science and Technology collected during 1991–1997 and represents the last published work aimed particularly at the field research of bat fauna of Jordan. It summarised some 60 records of 21 species from the country (Table 1). Darweesh et al. (1997) added *Taphozous nudiventris* to the bat fauna of Jordan. Benda & Sádlová (1999) reported on a small collection of mammals from Jordan, including three bat species from Tabaqat Fahl (*Rousettus aegyptiacus*, *Rhinopoma hardwickei* [= *R. cystops*], and *R. microphyllum*). Disi & Hatough-Bouran (1999) listed eight bat species from Petra [= Al Batra], however, they gave actual records only for *Rhinolophus clivosus*, *Asellia tridens*, *Pipistrellus bodenheimeri* [= *Hypsugo ariel*], and *Plecotus austriacus* [= *P. christii*]. Al-Omari et al. (2000) recorded *Nycteris thebaica* for the first time in Jordan along with records of some other bat species. Some important records of bats from Jordan were mentioned among comparative material within the karyological and taxonomic studies and revisions of the Mediterranean bats (Felten et al. 1977, Nader & Kock 1983a, Qumsiyeh 1985, Qumsiyeh & Baker 1985, Benda et al. 2004a, 2006, 2008, 2009, Hulva et al. 2007a, Karatas et al. 2008, Benda & Gvoždík 2010). Amr (2000) presented all previous and recent localities for the bats of Jordan in his book on the mammals of Jordan. Another review of the mammals of Jordan, including summaries of the bats was published by Amr et al. (2004).

Bat ectoparasites were studied only occasionally in Jordan. The first note on an arthropod ectoparasite from a bat of Jordan was mentioned by Kock & Nader (1979); they reported a bat fly *Eucampsipoda aegyptia* from *Roussetus aegyptiacus*. Saliba et al. (1990) mentioned findings of two tick species from bats in Jordan, *Argas* sp. ex *vespertilionis* group from *Myotis nattereri* and *Ornithodoros salahi* from *Myotis* sp. More numerous data on bat parasites from Jordan were published by Amr & Qumsiyeh (1993). They presented four bat fly species (Nycteribiidae and Streblidae) from three hosts: *Brachytarsina flavipennis* and *Stylidia biarticulata* [= *Phthiridium biarticulatum*] from *Rhinolophus blasii*; *Stylidia integra* [= *Phthiridium integrum*] from *R. hipposideros*; and *Basilia nana* from *Myotis nattereri*.

A comprehensive review of the diversity and conservation status of bats in Jordan was published by Amr et al. (2006). In the paper, they discussed zoogeographical affinities, threats and human impact on current populations. They also addressed recommendations for implementing conservation measures and future bat research approaches in Jordan.

The Research and Survey Section of the Royal Society for the Conservation of Nature (RSCN), ʿAmman, has conducted many faunal and floral surveys in the proposed or existing nature reserves in Jordan since 1994. Bats also received some attention and were studied in several reserves under the RSCN responsibility. In 2008–2010, a group of Jordanian and European authors carried out a detailed survey of bats in the RSCN reserves as well as in other areas of Jordan, in attempt to collect as comprehensive field data as possible on the fauna composition, zoogeography, ecology, echolocation and bat ectoparasites from Jordan. All records and findings from these baseline surveys are incorporated in this study, presenting a synthesis of all records along with other available data on bats from the territory of Jordan.

Biogeography of Jordan

Jordan is influenced by four major biogeographic regions; vegetation, soil texture, altitude and annual rainfall are among the major factors that shaped these biogeographic regions. Al-Eisawi (1985) and Disi & Amr (1998) agreed on the delineation of these four regions based on vegetation cover as well as animal distribution in Jordan (see also Amr 2000: 10).

(1) **Mediterranean Region**. The region comprises the mountain ranges extending from near Irbid in the north to Ras El Naqab in the south. Its forested parts are represented by abundance of *Juniperus phoenicea*, *Pistacia atlantica*, *Quercus coccifera*, and *Retama raetam*. Open areas are characterised by high cover of *Sarcopoterium spinosum*. The altitude varies between 700 and 1500 m a. s. l., with the average annual preciptations of 300 mm. The soil consists of several types, *terra rosa*, sandy and sandy-loamy due to erosion of the Nubian sandstone that dominates most of the area, and calcareous. (2) **Irano-Turanian Region**. The region is represented by a narrow strip that surrounds the Mediterranean region except from the north, extending to the northeast, joining the Syrian Desert. The vegetation is dominated by *Anabasis articulata*, *Artemisia herba-alba*, *Astragalus spinosum*, *Retama raetam*, *Urginea maritima*, *Ziziphus lotus*, *Zygophyllum dumosum*, and scattered *Juniperus phoenicea* and *Pistacia atlantica* trees. The altitude ranges from 400 to 700 m a. s. l., with the average annual rainfall of 50–100 mm. The soil layer is very thin or absent in some instances and surface rockiness is very high. (3) **Sudanian Penetration Region**. The region extends from the south near Aqaba along the Wadi Araba reaching Dayr ʿAlla in the Jordan Valley, then continues to southeastern Jordan including the Rum Desert and the granite mountains eastwards. The acacia sub-tropical vegetation is present in areas from the sea level to 400 m a. s. l., with the annual precipitation of less than 50 mm. Trees of both *Acacia raddiana* and *A. tortilis* are common at varying densities. Other trees such as *Tamarix* spp. and *Ziziphus spina-christi* are also common. Shrubs including *Anabasis articulata*, *Gymnocarpos decander*, *Haloxylon persicum*, *Zygophyllum dumosum*, and *Lycium* sp. are abundant. The soil is mostly sandy with rocky areas. Wadis are filled with alluvial materials washed from the calcareous sandstones. (4) **Saharo-Arabian Region**. This is the largest biogeographic region of Jordan and covers over 70% of the total area of the country. It is situated in the east, bordering the Irano-Turanian region from the west and the Sudanian Penetration region from the southwest. The sand dune desert vegetation dominated by *Haloxylon persicum*, *Hammada scoparia*, and *Ochradenus baccatus*. Open areas and wadi beds are characterised by *Achillea fragrantissima*, *Artemisia herba-alba*, and *Astragalus* sp. Few scattered *Acacia tortilis* are also found. The soil is mostly covered by gravel, sandy hammada, saline and sandy. The altitude ranges from 100 m b. s. l. to 200 m a. s. l., with rainfall not exceeding 50 mm annually.

MATERIAL AND METHODS

Records

The lists of records (arranged in alphabetical and/or chronological orders) include, for each item, the following information: name of the locality (each record is primarily listed by a name of the nearest settlement or notable physical feature) [in brackets, number of locality is given as indicated in the map], and/or description of record site, date, number of recorded bats with indication of their sex, age and physiological condition (for details see Abbreviations below), and a reference to museum specimen/s.

Geographical terms used (in alphabetical order)

Arabia – most of the Asian areas inhabited by Arabs; the territory south of Turkey and south and west of Iran, incl. Palestine, Hatay and the Sinai;

Asia Minor – Asian part of Turkey;

Central Asia – the former Russian or Soviet Central Asia or Western Turkestan; nowadays, the area of Turkmenistan, Uzbekistan, Kirghizstan, Tajikistan, and southern Kazakhstan;

Holy Land – Palestine, western part of Jordan and southernmost part of Lebanon; a subunit of the Levant (see also Qumsiyeh 1996);

Jordan Valley – part of the Rift Valley from the Sea of Galilee (Lake Kinneret) to the Dead Sea, creating a border between Jordan and Palestine;

Levant – a subunit of the Middle East; comprising Jordan, Palestine, Lebanon, Syria, and mostly also Cyprus (i.e. the Levant in the broader sense);

Mesopotamia – lowland territories of middle and lower parts of the Euphrates and Tigris Rivers in southeastern Turkey, eastern Syria, Iraq, and southwestern Iran;

Middle East – region covering the countries of Arabia, Cyprus, Anatolia, and Iran;

Palestine – historical territory in the Levant south of Lebanon and west of the Rift Valley (Jordan Valley, Dead Sea and the Arava Valley), and east of the Sinai, at present covered by the State of Israel and the Palestinian Territories or Palestine Autonomy. This historical geographical term is used rather than the political term Israel, which covered various territories within the southwestern Levant in various periods of its existence;

Rift Valley (or Great Rift Valley) – longitudinal depression, approximately 6,000 km in length, which runs from Hatay in the Middle East via the Red Sea to Mozambique in East Africa, varying in width from thirty to one hundred kilometres, and in depth from a few hundred to several thousand metres; here this term is used only for its part from the Hula Valley to the Gulf of Aqaba, i.e., the whole western border of Jordan;

Syria – the territory of the present Syrian Arab Republic according to the international law, including the Golan Heights;

Wadi Araba [= Arava Valley] – part of the Rift Valley from the Dead Sea to the Gulf of Aqaba, creating a border between Jordan and Palestine.

Morphological analysis

For morphological comparisons, we used museum specimens which were examined as described in previous studies (see Benda et al. 2004c, 2006). Specimens were measured in a standard way with the use of mechanical or optical callipers. Horizontal dental dimensions were taken on cingulum margins. Bacula were extracted in 4% solution of NaOH and coloured with alizarin red. The examined museum material is mentioned in the respective species chapters, the list of comparative material is given in Appendix II. For the evaluated external and cranial measurements see Abbreviations. Statistical analyses were performed using the Statistica 6.0 software. Other methodological details or aspects are described in the respective chapters giving the statistics.

Genetic analysis

For the genetic part of the study applied on *Pipistrellus pipistrellus* specimens, we used the analysis of mitochondrial DNA. Genetic material was obtained from pectoral muscles or wing punches preserved in alcohol. Partial sequences of the mitochondrial gene for cytochrome *b* (402 bp) were obtained according to the protocol described by Benda & Vallo (2009). For comparisons, sequences from previous studies stored in GenBank were used (Benda et al. 2003, 2004b, Hulva et al. 2004, 2007b). Genetic distances and phylogenetic reconstructions were obtained using the PAUP 4.0b10 software.

Diet compostion analysis

We collected a set of faecal pellets during our field studies for further examination. Content of digestive tracts was analysed from museum specimens. Pellets were disassembled in a Petri dish filled with water under a binocular microscope. Particular pieces of prey were identified to the order or family level and the percentage volume of prey categories was estimated for each pellet. The total volume of each diet item in a sample was counted as a mean value per sample. Digestive tracts were dissected in a Petri dish filled with water and the percentage volume of particular prey categories was estimated for each tract. The number of analysed pellets or digestive tracts regarding particular species is mentioned in the corresponding chapter and in the legends of the respective figures.

Sound recordings and analysis

Acoustic recordings were made using a portable ultrasound detector D-240x (Pettersson Elektronik AB) set on time-expansion mode connected either to Sony WM-GX 550 stereo cassette recorder (in 2004), minidisc recorder MD MZ-RH1 (in 2008 and 2009), or Edirol R-09HR recorder (in 2010). All the analysed bat calls were recorded in free flight under natural conditions.

The recordings were analysed with the BatSound Pro software (Pettersson Elektronik AB). A sampling frequency of 44,100 samples/sec, with 16 bits/sample and expansion factor of 10 were used (36 call sequences). Alternatively, we used a sampling frequency of 48,000 samples/sec. A 512 pt. FFT with Hamming window was used for the analyses. The obtained frequency and time resolution for spectrograms and power spectra were 1120 Hz (0.23 ms) and 975 Hz (0.27 ms), respectively. Oscilograms, power spectra and spectrograms were evaluated. For each echolocation call, the following parameters were measured: pulse duration (PDUR), start frequency (SF), end frequency (EF, both SF and EF at –30 dB below the peak power spectral intensity), frequency of maximum energy (FMAXE) and inter-pulse interval (IPI, the time between two consecutive calls). In most cases, we used only high quality recordings for analyses. Only the search phase calls were measured.

In total, we analysed 134 call sequences (782 calls) of 17 bat species. Most figures of spectrograms of echolocation sequences within the text serve as an illustration of real field conditions, and, hence, they show a real time of particular recording on the time axes.

Ectoparasites

Ectoparasites were collected directly from the bats and preserved in alcohol. With an exception of fleas, the parasite individuals were simply examined under microscope, fleas (Ischnopsyllidae) were dissected according to O'Mahony (Rosický 1957). Mites (Macronyssidae and Spinturnicidae) were mounted in the 'Liquid de Swan' to permanent microscopic slides (cf. Whitaker 1988). The parasites were determined with the help of identification keys (Jobling 1934, Hoogstraal 1953, 1956, Theodor 1954, 1967, 1975, Theodor & Moscona 1954, Hopkins & Rothschild 1956, Rudnick 1960, Dusbábek 1962, Filippova 1966, Usinger 1966, Radovsky 1967, Skuratowicz 1967, Micherdzinski 1980, Hůrka 1982). In the insect parasites (Cimicidae, Nycteribiidae, Streblidae, Ischnopsyllidae), we identified sex and stage of the life cycle (ma – adult male, fa – adult female); in ticks (Argasidae) sex and stage (larva, nymph, and adult – see insects); and in mites (Macronyssidae) sex and stage (protonymph, deutonymph, and adult – see insects). The lists of ectoparasite records (arranged in taxonomical, alphabetical and/or chronological orders) include, for each item, the following information: name of the family, name of the parasite, the recorded specimen, name of the locality, and date of collection; according to these data the record is detectable in the Records paragraph, where other circumstances of the record are available.

ABBREVIATIONS

Collection acronyms

AUB = American University Beirut, Lebanon; BMNH = Natural History Museum, London, United Kingdom; CUP = Department of Zoology, Charles University, Prague, Czech Republic; IVB = Institute of Vertebrate Biology, Academy of Sciences of the Czech Republic, Brno, Czech Republic; IZB = Institute of Zoology, Slovak Academy of Sciences, Bratislava, Slovakia; MSNG = Civil Natural History Museum Giacomo Doria, Genoa, Italy; MZUF = Natural History Museum, Florence, Zoology Section "La Specola", Italy; NMP = National Museum (Natural History), Prague, Czech Republic; RSCN = collection of the Royal Society for the Conservation of Nature, deposited partly at the Society head-office, Amman, and partly at the Administration of the Dhana Nature Reserve, Dhana, Jordan; JUST = Department of Biology, Jordan University of Science and Technology, Irbid, Jordan; SMF = Senckenberg Museum and Research Institute, Frankfurt am Mein, Germany; TAU = Tel Aviv University, Tel Aviv, Israel; UCPN = Department of Zoology and Anthropology, University of Constantine the Philosopher in Nitra, Slovakia; WIC = Willi Issel private collection, Augsburg, Germany; ZFMK = Zoological Institute and Museum Alexander Koenig, Bonn, Germany; ZIN = Zoological Institute, Russian Academy of Sciences, St. Petersburg, Russia.

Measurements

External dimensions. G = body weight; LC = head and body length; LCd = tail length; LAt = forearm length; LPl = thumb length (without claw); LA = auricle length; LTr = tragus length; LaFE = horseshoe width.

Cranial dimensions. LCr = greatest length of skull (incl. the praemaxilla in *Rhinolophus*); LOc = occipitocanine length of skull; LCb = condylobasal length of skull; LCc = condylocanine length of skull; LaZ = zygomatic width; LaI = width of interorbital constriction; LaP = width of postorbital constriction; LaInf = infraorbital width; LaN = neurocranium width; LaM = mastoidal width; AN = neurocranium height; LBT = largest horizontal length of tympanic bulla; CC = rostral width between canines (incl.); M^2M^2 = rostral width between second upper molars (incl.); M^3M^3 = rostral width between third upper molars (incl.); CM^2 = length of upper tooth-row between CM^2 (incl.); CM^3 = length of upper tooth-row between CM^3 (incl.); LMd = condylar length of mandible; ACo = height of coronoid process; CM_3 = length of lower tooth-row between CM_3 (incl.).

Other abbreviations
a = adult; A = alcoholic preparation; B = stuffed skin (balg); coll. = collected; det. = detected by a bat detector; f = female; G = pregnant; j = juvenile; m = male; M = mean; max., min. = dimension range margins; net. = netted; obs. = observed; rec. = a call recording collected; s = subadult; S = skull; SD = standard deviation, Sk = skeleton.

LIST OF SPECIES

Rousettus aegyptiacus (Geoffroy, 1810)

Records. **New data**: ʻA m m a n: Az Zara Springs [1] (Fig. 19), 22 October 2004: net. 1 fs; – An Nuzha, Wadi Al Wala [2], above a river (Fig. 103), 11 July 2010: net. 1 fs, obs. 1 ind.; – Iraq Al Amir [3], artificial caves (Fig. 3), 10 October 2008: obs. a colony of ca. 30–50 inds., net. 6 fa+j, 1 fa, 6 fs (coll. fa, NMP 92362 [S+A]), 10 May 2009: obs. a colony of ca. 50 inds. in a cave (obs. ca. 220 inds. during evening emergence), net. 5 ma, 3 fa, 3 faG, 14 faL (bearing 3 mj, 8 fj), 3 fs, coll. 1 ma (NMP 92411 [S+A]), 2 July 2010: obs. a colony of ca. 200 inds. in a cave, net. 6 ma, 1 ms, 5 mj, 5 faG, 4 faL, 5 fj, 13 October 2010: obs. a colony of ca. 140 inds., net. 1 ma, 9 fa; – Wadi Abu Khushabeh (Wadi Sgara) [4], April 1999: coll. 1 ind. (RSCN unnumbered [A], leg. K. A. Al Omari & M. A. Abu Baker), May 2007: obs. a colony of ca. 30 inds. – A q a b a: Aqaba [5], Ottoman fortress (Fig. 12), 16 May 2009: obs. several feeding places with abundant feeding rests. – B a l q a': Jufat Al Qafrayn [6], above a fishpond, 15 July 2010: net. 1 ms, 1 fa. – I r b i d: Al Hamma [7], cave, 2 April 2001: coll. 1 fj (JUST unnumbered [S+B]; leg. M. Abu Baker & L. Rifaj); – Al Mustaba [8], Az Zarqa' River valley, above a spring in valley slope, 11 October 2008: net. 1 fs; – Kufranja [9], Iraq Al Wahaj Cave, 25 October 2008: obs. a large colony, found rests of 20 inds. (2 skulls, 9 rostral fragments, 20 right and 18 left mandibles) in *Strix aluco* pellets, 26 May 2009: obs. a colony of at least 200 inds., net. 3 ma, 2 fa, 2 faG, 4 faL (bearing 1 mj, 1 fj), 1 fs (coll. 1 ma; NMP 92558 [S+A]), found rests of 6 inds. (3 rostral fragments, 5 right and 6 left mandibles) in *Strix aluco* pellets, 4 October 2010: obs. ca. 25 inds., found rests of 2 inds. (2 rostral fragments, 1 right and 2 left mandibles) in *Strix aluco* pellets; – Nahla [10], above a spring in the village (Fig. 64), 13 July 2010: net. 1 fa; – Tabaqat Fahl [11], a cave in the Roman nekropolis of Pella, 24 May 2009: obs. traces of a colony. – K a r a k: vicinity of Ar Raddass [12], south of Wadi Al Mawjib, 10 July 2005: obs. 3 inds. – M a f r a q: Al Qunayya [13], at the Zarqa' River, May 2006: obs. a small colony of ca. 10 inds. – T a f i l a: Dhana, Wadi Dhana [14], ca. 5 km NE of the Feynan Ecolodge, small sandstone cave (Figs. 5, 6), 14 May 2009: obs. a colony of ca. 40 inds., net. 2 ma, 1 faG, 9 faL, bearing 6 mj, 3 fj (coll. 1 ma, 7 fa, 3 mj, 3 fj; NMP 92430, 92431, 92433, 92434, 92436, 92438, 92442 [S+A], 92432, 92435, 92437, 92439–92441, 92443 [A]). – **Published data**: ʻA m m a n: Amman [15], cave in Al-Mahhatta [a small cave at Roman Amphiteatre in the ʻAmman centre], 3 dead specimens (Qumsiyeh 1980), 2 inds. (Qumsiyeh 1985); – Amman [16], commonly seen around street trees (Qumsiyeh 1980). – I r b i d: Irbid, El Hamma [7], unnamed cave on south bank of Yarmouk River, a colony of at least 3000 inds., coll. 3 m, 1 f (Qumsiyeh et al. 1986); Al-Hemma, 5 February 1980, 29 May 1983 and June 1987 (Amr & Disi 1988); El-Hemma, 7 May 1983: hundreds of inds., coll. 2 f (Amr et al. 1987); – Tabaqat Fahl [11], small cave [of the Roman nekropolis], 5 July 1997: obs. a colony of ca. 10 inds., coll. 1 ms (Benda & Sádlová 1999). – K a r a k: Ghur As-Safi [= Ghor As Safi] [17], May 1978 (Amr & Disi 1988); – vicinity of Ar Raddass [12], south of Wadi Al Mawjib, [31 March] 1999: net. [4 inds.] (Al-Omari et al. 2000); – Wadi Ibn Hamad [18], 19 May 1992: 1 ind. (Qumsiyeh 1996, Qumsiyeh et al. 1998), Wadi Ben Hammad, cave, thousands of inds. (Amr 2000). – T a f i l a: Wadi Faynan [near the main water course] [19], 1 January 1997: [net.] 1 [juv.] ind. (Qumsiyeh et al. 1998); – Wadi Fidan [20], 1978 (Amr & Disi 1988). – NW Jordan (undef.): Zerka-Fluß [= Zarqa' River], 1886: 1 f (Kock 1969, Kock & Nader 1979).

Distribution. *Rousettus aegyptiacus* is a rather common bat species in Jordan, 21 record sites are available from the country (Fig. 2). Although actually not rare, it was discovered relatively late, in the early 1980s only one colony was known in the northernmost region of the country, the Yarmuk Valley (Qumsiyeh et al. 1986, Amr et al. 1987, Amr & Disi 1988). An older record from the Zarqa' Valley was already available, however, it was originally interpreted as lying in Syria (Kock 1969) and this misinterpretation was corrected as late as by Kock & Nader (1979) (cf. Bergmans 1994, Benda et al. 2006).

The records of *R. aegyptiacus* are concentrated along the whole course of the Rift Valley in Jordan between the Yarmuk Valley in the north and Aqaba in the south (Fig. 2), covering three biogeographical regions of Jordan (see above). While the records in the areas adjacent to the Wadi Araba are quite limited, the records in the regions contacting valleys drained to the Dead Sea and Jordan Valley are markedly numerous. This pattern conforms to the distribution picture of the species in Palestine (Mendelssohn & Yom-Tov 1999).

Along the Zarqa' River the range of *R. aegyptiacus* stretches most extensively into the interior of the Levant, making up some 120 km of continuous occurrence from the sea coast across Palestine and western Jordan. (Moreover, Qumsiyeh et al. (1998) suggested that the fruit bat still continues to expand its range in Jordan.) In the area of northwestern Jordan and central and northern Palestine, the range of *R. aegyptiacus* is geographically the most extensive within the Levantine part of the species distribution range (Qumsiyeh 1996, Mendelssohn & Yom-Tov 1999). In other Levantine parts of the distribution area (from Lebanon to SW Turkey), the occurrence follows the Mediterranean Sea coast in a rather narrow belt of several tens of kilometres at the most (see Benda et al. 2006: 12).

The records of *R. aegyptiacus* in Jordan come from a rather broad range of altitudes from 370 m b. s. l. to 800 m a. s. l. (n=21); however, the mean altitude (227.5 m) shows a general preference of rather low sites. Similarly, the known sites of colony roosts of the fruit bat also come from lower altitudes between 120 m b. s. l. and 741 m a. s. l. (mean 288.3 m; n=7).

Very recently, undoubted traces of presence of the fruit bats have been found in Aqaba in southernmost Jordan; such a record is in accordance with the new evidence of the species in Eilat

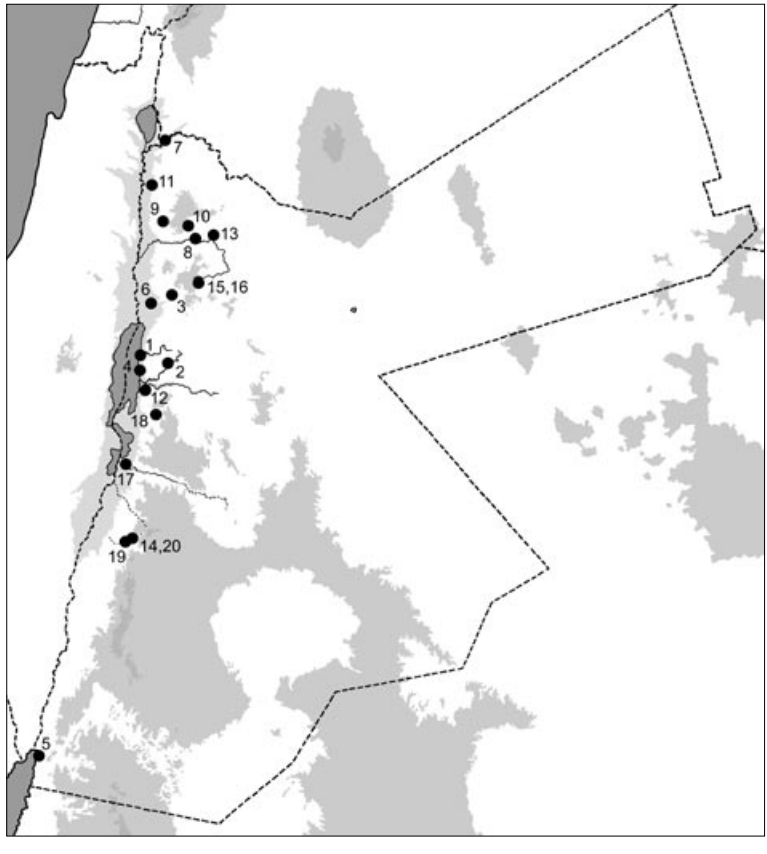


Fig. 2. Records of *Rousettus aegyptiacus* (Geoffroy, 1810) in Jordan.

on the Palestinian side of the Gulf of Aqaba (Mendelssohn & Yom-Tov 1999, Zelenova & Yosef 2003). As we already discussed (Benda et al. 2008: 7–8), the available evidence suggests very recent invasion of *R. aegyptiacus* into newly cultivated areas of southern parts of the Holy Land and into the Sinai. Until the mid 1990s, fruit bats were known to occur in the Holy Land north of the southern margin of the Dead Sea (Qumsiyeh 1985, Harrison & Bates 1991, Bergmans 1994), i.e. in the relatively humid areas of the region. Mendelssohn & Yom-Tov (1999) and Zelenova & Yosef (2003) first mentioned records of *R. aegyptiacus* from the Arava Valley of Palestine as southwards as Eilat and Benda et al. (2008) first documented this bat from the Sinai (ten record sites in four oases). These records connect the parts of the species distribution range being in evidence for a long time, i.e. the Mediterranean Levant and continental Egypt (cf. Bergmans 1994). In Jordan, this supposedly new 'desert' part of the species distribution range was documented as the first one, Amr & Disi (1988) reported a finding of a fruit bat from the Wadi Fidan made already in 1978.

Field notes. Roosts containing colonies of *Rousettus aegyptiacus* were found at several sites in Jordan. Probably the largest colony was found at Al Hamma in the Yarmuk Valley in northern Jordan on the border with Syria (Qumsiyeh et al. 1986, 1992, Amr et al. 1987). Qumsiyeh et al. (1992: 104) specified the finding: "The colony [...] numbered some 3,000 bats in a small well-lit cave (widely open) overlooking the Yarmouk River." Another large colony was recorded in the Wadi Ibn Hammat adjacent to the central part of the Jordanian side of the Rift Valley (Qumsiyeh et al. 1998, Amr 2000). The number of bats in the colony was not specified accurately, Amr (2000: 23) only noted: "thousands of bats were active in a cave". Two medium-sized colonies were found in the Northern Highlands. About 200 individuals were documented in the partially artificial underground system of Iraq Al Amir in the Wadi As Sir near ʿAmman (Figs. 3, 4), where the colony roosted in a high narrow fissure of a cave ceiling, some 5 m deep in the cave (however only about 50 bats were visible from the cave bottom). This colony was observed three times in three different periods of a year (May, July, October), each time a similar number of bats was counted (most accurate numbers were recorded during the evening emergence of the colony). In the Iraq Al Wahaj Cave at Kufranja in the Ajlun Mts., a large colony was observed twice (October 2008, May 2009), consisting of at least 200 individuals; in October 2010, only some 25 bats were observed there (and smouldering wood in the cave entrance). The bats were hidden in a dark inner room of the cave, about 50 m from its entrance (the beginning of the cave was used as a stock and shepherd shelter with traces of fire kindling). A small colony of ca. 40 individuals was found in a cavity between sandstone rocks in a side of the Wadi Dhana, ca. 5 km NE of the Feynan Ecolodge (Figs. 5, 6). This colony was roosting in an inaccessible site, several metres from the cavity entrance. Benda & Sádlová (1999) reported on a finding of a small colony in the rocky tomb of the nekropolis of Tabaqat Fahl; in 1997, a group of ca. 10 individuals was observed, while only traces of a disappeared colony were found there in 2009 (the colony left the roost certainly several years before the check).

Individuals of *R. aegyptiacus* were netted in two types of localities, at cave entrances (roosts of fruit bat colonies) and above water bodies. At the Iraq Al Amir caves (Fig. 3), bats were netted three times and fruit bats were recorded during all three sessions; 25 individuals were netted on 10 May, 26 bats on 2 July, and 13 individuals on 10 October. Fourteen individuals were netted at the entrance to the Iraq Al Wahaj Cave at Kufranja. A subadult female was netted above a spring in the southern slope of the Az Zarqa' River valley near Al Mustaba. Another subadult female was netted above a stream at the thermal Az Zara Springs, above the bank of the Dead Sea (Fig. 19). A subadult male was netted and an additional foraging individual observed above a river in the Wadi Al Wala leading to the Dead Sea Basin (Fig. 103). A subadult male and an adult female were

Fig. 3. Iraq Al Amir in the Wadi AS Sir, ʿAmman region (photo by P. Benda). At this complex combining artificial and natural caves, six bat species were recorded; *Rousettus aegyptiacus* and *Rhinopoma cystops* roost there, *Rhinolophus blasii* and *Myotis nattereri* were netted at the entrance to the central part of the cave system (visible above the white building on the right side of the picture), and calls of foraging *Pipistrellus kuhlii* and *Tadarida teniotis* were detected there. While colonies of *Rhinopoma cystops* were scattered throughout the cave system, the colony of *Rousettus aegyptiacus* roosted in the only cave at the left edge of the medium level of the system (visible above the left palm tree on the left side of the picture).

Fig. 4. A group of *Rousettus aegyptiacus* (Geoffroy, 1810) roosting in a cave of the underground complex of Iraq Al Amir (photo by A. Reiter).

Fig. 5. A view through the Wadi Dhana (Southern Highlands), from the Dhana village to the Wadi Araba (photo by A. Reiter). The Wadi Dhana connects the upper (Mediterranean) and lower (desert) parts of the Dhana Reserve. In the Wadi Dhana, the southernmost roost of a maternity colony of *Rousettus aegyptiacus* in Jordan was discovered (in the rocks of the right slope of the wadi, on the right side of the picture; see also Fig. 6); in that area, *Rhinopoma cystops* and *Tadarida teniotis* were also recorded. In the gardens of the Dhana Village, *Myotis nattereri*, *Eptesicus bottae*, *Hypsugo ariel*, *Pipistrellus pipistrellus*, *Barbastella leucomelas*, *Plecotus christii*, and *Tadarida teniotis* were recorded (mostly their echolocation calls).

Fig. 6. Entrance to a small pseudokarstic cave (round opening in the centre of the picture) in the right slope of the Wadi Dhana, serving as a roost of *Rousettus aegyptiacus* maternity colony (photo by A. Reiter).

netted above a fishpond at Jufat Al Qafrayn in the Jordan Valley. An adult female was netted above a small pool at a spring in the village of Nahla (Fig. 64), near Jerash in the Northern Highlands.

R. aegyptiacus was recorded to share its roosts with many other bat species. In the caves at Iraq Al Amir, a colony of *Rhinopoma cystops* was found (in addition, *Rhinolophus blasii* and *Myotis nattereri* were netted and *Pipistrellus kuhlii* detected). In tombs and caves at Tabaqat Fahl four other species were recorded, all of them are expected to roost there, *Rhinopoma cystops*, *R. microphyllum* and *Rhinolophus ferrumequinum* (possibly also *Rhinolophus blasii* and *Myotis capaccinii*; cf. Qumsiyeh et al. 1986). During the netting session at the entrance of the Iraq Al Wahaj Cave, *Rhinolophus euryale*, *R. blasii*, *Myotis blythii*, *M. nattereri*, and *M. emarginatus* were also netted, these species most probably left the same roost in the cave. Near the shelter of the colony of *R. aegyptiacus* in the sandstone cavity in the Wadi Dhana, four individuals of *Rhinopoma cystops* were netted – their roost could be expected in the nearby rocky fissures and overhangs (*Tadarida teniotis* was also detected at this place). A colony of *Rhinopoma cystops* was found in the Ottoman fortress of Aqaba (Fig. 12), where a traditional feeding place of fruit bats was evidenced and common temporal roosting could be expected.

At many places, individuals of *R. aegyptiacus* were evidenced to forage together with other bats. In the Wadi Al Wala, fruit bats were netted along with *Pipistrellus pipistrellus* and *Tadarida teniotis*, and *Rhinopoma cystops* and *Eptesicus bottae* were detected. At the Az Zara Springs, *Taphozous perforatus* was netted and *Tadarida teniotis* detected (on another occasion we detected *Taphozous nudiventris* and *Rhinopoma cystops*). In Nahla, *Pipistrellus kuhlii* was netted and *Pipistrellus pipistrellus* detected. *Pipistrellus kuhlii* was also netted together with fruit bats at Jufat Al Qafrayn, where also *Rhinopoma microphyllum*, *R. cystops*, *Taphozous perforatus*, *T. nudiventris*, and *Eptesicus bottae* were detected. *Pipistrellus kuhlii* was also detected at Al Mustaba above the Az Zarqa' River valley, where a *R. aegyptiacus* individual was netted.

Only fragmentary data are available from Jordan concerning the reproduction of *R. aegyptiacus*. Qumsiyeh et al. (1998: 278) noted: "In northern Jordan [= most probably at Al Hamma], we obtained juveniles in February". We recorded presence of juvenile fruit bats in all sites with the colonies visited. From the colony in the Iraq Al Wahaj Cave in the Mediterranean Jordan, nine females were examined on 26 May 2009; eight of them were adult, two of them were pregnant in an advanced stage of gravidity, and four were lactating, two of them carried a nonvolant juvenile (male and female). From the colony in the sandstone cavity in the Wadi Dhana in the desert Jordan, 12 volant fruit bats were examined on 14 May 2009; ten bats were adult females, one of them was a pregnant female (containing one foetus of the crown-rump length 22.8 mm), the rest was composed of lactating females, each carrying a nonvolant juvenile (six males, three females). The juveniles showed forearm lengths on average 67.5% (58.3–62.9 mm, mean 60.7 mm) of the mothers' forearm lengths (86.4–95.0 mm, mean 89.9 mm). Juveniles were observed during all three visits of the colony in Iraq Al Amir. On 10 October 2008, 13 females were netted, seven of them were lactating, of them six carried nonvolant juveniles. On 10 May 2009, 23 females were netted, three were pregnant and 14 lactating, eleven of them carried a nonvolant juvenile (three males, eight females). On 2 July 2010, out of 16 full grown fruit bats netted, five were pregnant females and four lactating females, along with these bats also ten volant juveniles were netted.

These records conform to the opinion concerning seasonal bimodality of reproduction in *R. aegyptiacus*, as already suggested by observations of its East African (Mutere 1968, Anciaux de Faveaux 1978) and Middle Eastern populations (Spitzenberger 1979, Mendelssohn & Yom-Tov 1999, Benda et al. 2008, Benda et al. in press). In the Levant, one parturition term might occur in spring (April/May) and the other one at the summer/autumn break, supposedly in September.

R. aegyptiacus was reported to represent a part of the diet of owls in several countries of the Middle East (Bonhote 1909, Dor 1947, Spitzenberger 1979, Qumsiyeh 1985, Benda & Horáček

Table 2. Basic biometric data on the examined samples of *Rousettus aegyptiacus* (Geoffroy, 1810), *Rhinopoma microphyllum* (Brünnich, 1782), *R. cystops* Thomas, 1903, and *Taphozous perforatus* Geoffroy, 1818. For abbreviations see pp. 192, 193

	Rousettus aegyptiacus					*Rhinopoma microphyllum*	*Rhinopoma cystops*					*Taphozous perforatus*	
	n	**M**	min	max	SD	NMP 47965	n	M	min	max	SD	RSCN –	NMP 92094
LC	11	**139.5**	131	153	7.118	88	31	**63.8**	56	72	3.127	–	–
LCd	11	**18.3**	15	25	2.687	68	30	**67.2**	61	77	4.415	–	–
LAt	15	**91.59**	86.4	96.5	2.825	68.6	36	**56.64**	51.5	60.5	1.975	63.7	64.0
LAu	15	**21.37**	19.4	23.3	1.061	22.5	31	**20.93**	19.2	22.8	0.880	–	–
LTr	–	–	–	–	–	7.3	31	**7.29**	5.3	8.5	0.705	–	–
LCr	10	**42.44**	40.24	44.82	1.481	21.07	27	**17.93**	17.31	18.78	0.363	–	–
LOc	–	–	–	–	–	20.75	26	**17.44**	16.92	18.08	0.344	20.68	20.67
LCb/Cc	10	**40.80**	38.67	42.84	1.427	19.16	28	**15.81**	15.32	16.48	0.300	19.41	19.33
LaZ	10	**25.85**	24.89	26.87	0.719	12.79	26	**10.26**	9.74	10.85	0.244	11.68	11.76
LaI	10	**8.30**	7.83	9.17	0.379	2.75	27	**2.47**	2.22	2.63	0.105	5.62	5.48
LaPO	9	**7.87**	7.44	8.71	0.358	–	–	–	–	–	–	3.97	4.29
LaInf	10	**9.69**	9.27	10.02	0.291	5.29	27	**4.68**	4.31	5.05	0.201	5.44	5.27
LaN	10	**16.95**	16.41	17.71	0.448	9.05	27	**7.50**	7.16	7.77	0.186	9.36	9.45
LaM	10	**15.61**	14.82	16.62	0.610	10.59	27	**9.05**	8.57	9.41	0.215	10.48	10.71
ANc	10	**13.18**	12.45	14.57	0.652	8.13	27	**5.62**	5.18	5.98	0.195	7.19	7.42
LBT	10	**4.32**	4.08	4.51	0.140	5.26	27	**4.86**	4.52	5.19	0.151	3.82	3.66
CC	10	**8.46**	7.72	9.02	0.460	5.91	27	**4.34**	3.94	4.56	0.137	8.23	8.22
$M^{2/3}M^{2/3}$	10	**12.62**	12.11	13.12	0.380	9.68	27	**8.03**	7.61	8.33	0.184	8.71	8.73
$CM^{2/3}$	10	**16.09**	15.31	17.07	0.587	7.57	27	**6.05**	5.02	6.37	0.240	15.08	14.90
LMd	10	**32.70**	30.75	34.37	1.237	15.02	27	**12.16**	11.64	12.52	0.262	5.56	5.33
ACo	10	**15.38**	14.08	16.56	0.969	5.96	27	**4.64**	4.29	5.06	0.182	9.68	9.53
CM_3	10	**17.35**	14.98	18.85	1.077	8.20	27	**6.51**	6.32	6.69	0.116	4.45	4.70

1998, Obuch unpubl.). In Jordan, numerous rests of fruit bats were found in pellets of *Strix aluco* collected at three occasions in the Iraq Al Wahaj Cave at Kufranja, making an extraordinarily high proportion of the owl prey (9.0% of all prey items and 26.4% of the mammal items, see Table 17).

Morphology and variation. External and cranial dimensions of the Jordanian specimens of *Rousettus aegyptiacus* examined are shown in Table 2. For the material examined see Records.

The simple morphometric comparison of *R. aegyptiacus* specimens from the Middle East (Benda et al. 2008) more or less surprisingly showed close similarity in size of the Sinaitic samples to the samples from Yemen and Iran, i.e. to the small-sized subspecies *R. a. arabicus* Anderson 1902 (described from SW Yemen). On the other hand, the samples from Egypt and the Levant (Syria, Lebanon, Cyprus, Turkey) were biometrically homogeneous; these populations were traditionally considered to belong to the large-sized nominotypical subspecies, described from Lower Egypt (Anderson 1902, Eisentraut 1959, Harrison 1964, DeBlase 1980, Harrison & Bates 1991, Bergmans 1994, Koopman 1994, Kwiecinski & Griffits 1999, Ferguson 2002, Simmons 2005, etc.). A similar observation, i.e. small body size in comparison to the north-Levantine representatives, was reported from the southern Palestinian populations of *R. aegyptiacus* by Ferguson (2002) and Zelenova & Yosef (2003).

However, a simple genetic comparison of samples of *R. aegyptiacus* from various parts of the Middle East (both large- and small-sized bats) showed the Middle Eastern populations to create

Table 3. Comparison of biometric data on four *Rousettus aegyptiacus* (Geoffroy, 1810) population sample sets from the Levant. For abbreviations see pp. 192, 193

	n	**M**	min	max	SD	n	**M**	min	max	SD
			N Jordan					S Jordan		
LAt	6	**93.18**	90.7	96.5	2.19	9	**90.53**	86.4	95.0	2.792
LCr	3	**43.63**	41.92	44.82	1.52	7	**41.93**	40.24	43.49	1.230
LCb	3	**42.10**	40.64	42.84	1.26	7	**40.25**	38.67	41.89	1.150
LaZ	3	**26.13**	25.07	26.72	0.92	7	**25.72**	24.89	26.87	0.658
LaN	3	**17.11**	16.45	17.71	0.63	7	**16.88**	16.41	17.33	0.385
ANc	3	**12.85**	12.45	13.34	0.45	7	**13.32**	12.62	14.57	0.702
CM^2	3	**16.37**	15.68	16.76	0.60	7	**15.97**	15.31	17.07	0.585
LMd	3	**33.79**	32.68	34.37	0.96	7	**32.23**	30.75	33.52	1.070
CM_3	3	**17.95**	17.31	18.45	0.58	7	**17.10**	14.98	18.85	1.172
			Sinai					N Levant (TR, CY, SY, LB)		
LAt	14	**91.56**	87.0	95.4	2.358	16	**94.53**	90.0	98.1	2.321
LCr	13	**41.27**	38.91	43.66	1.329	19	**43.51**	40.68	45.19	1.130
LCb	13	**39.55**	37.53	41.47	1.173	18	**41.87**	39.24	43.57	1.129
LaZ	13	**24.95**	23.48	27.33	0.920	19	**26.88**	24.63	29.26	1.050
LaN	13	**16.47**	16.02	17.91	0.530	19	**17.31**	16.83	17.93	0.323
ANc	13	**12.53**	11.56	13.24	0.453	19	**13.17**	11.64	13.93	0.546
CM^2	13	**16.02**	14.91	16.99	0.583	19	**16.54**	15.15	17.62	0.642
LMd	13	**32.12**	30.08	33.82	1.048	19	**33.87**	31.98	35.32	0.955
CM_3	13	**17.29**	16.08	18.44	0.692	18	**18.20**	17.56	19.20	0.464

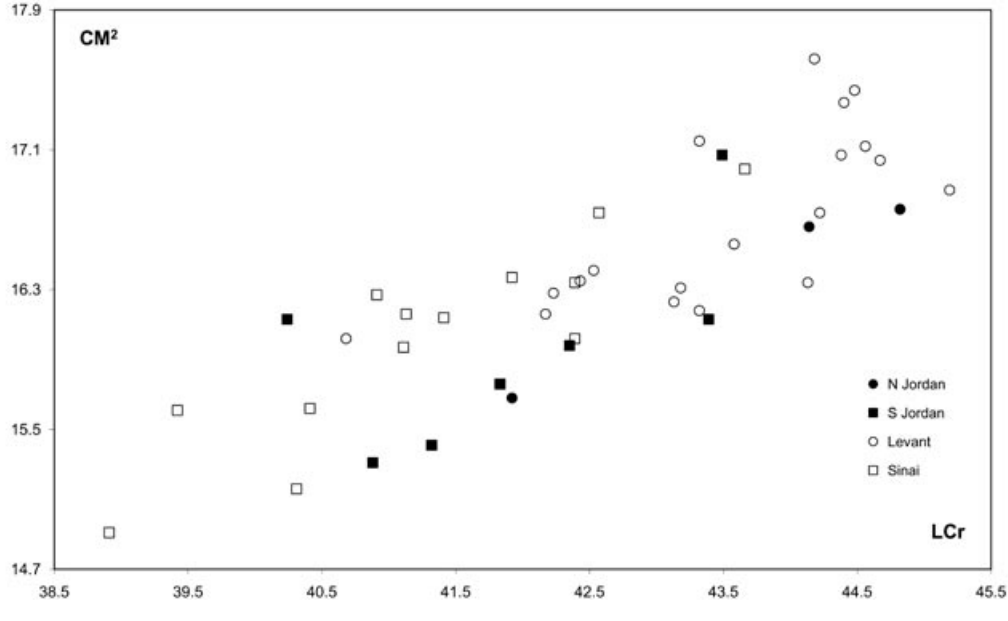


Fig. 7. Bivariate plot of the examined Jordanian and comparative samples of *Rousettus aegyptiacus* (Geoffroy, 1810): greatest length of skull (LCr) against the length of upper tooth-row (CM^2).

a homogeneous clade of haplotypes with a very shalow variation (genetic distances of 0.1–0.4%; Benda et al. 2007). As we already concluded (Benda et al. 2008: 10–14), such a result rather disproves the supposition of two phylogenetic units / subspecies within the *R. aegyptiacus* range in the Middle East (contra the opinions by the above mentioned authors). Regarding to the low genetic differences between the respective populations of the Middle East, the well pronounced differences among them in morphometric characters suggest that the rearrangements in body size could have occurred during just a few generations and are possibly of a considerable adaptive meaning. Populations from rather dry habitats tend towards smaller body dimensions than those from more humid conditions and such size changes seem to happen relatively fast (see Benda et al. 2008 for a detailed review).

In this respect, we compared the samples of *R. aegyptiacus* from Jordan – the area lying between the ranges of two morphotypes in the Levant and Sinai – with the large-sized Levantine specimens and the small-sized Sinaitic bats. The comparison confirmed two basic size morphotypes of the comparative population samples from the Levant and Sinai, as already mentioned (Benda et al. 2008), and these basic groups overlapped only partially in their dimension ranges (less than 50% in the largest skull measurements). The limited sample set (n=3) from northern (Mediterranean) Jordan (the ʿAmman region and Ajlun Mts.) fitted by its dimension ranges into the ranges of the Levantine large-sized form, while the samples (n=7) from southern Jordan (Dhana Reserve) were intermediate in their dimensions between the two groups of size-morphotypes (Fig. 7, Table 3).

The distribution of the size characters along the latitudinal gradient in the northern part of the Middle East suggest a rather continuous, cline shift in size among the respective regions. The large morphotype living in the Mediterranean habitats of the Levant gradually shifts into the Sinaitic desert small morphotype via the Rift valley of Jordan and presumably also Palestine (see Zelenova & Yosef 2003, Benda et al. 2008). Hence, the existence of such shift in size characters can hardly support the traditional conception of two broadly distributed forms, but rather indicates to a mosaic of local populations of different size types and transitions between them. Such a conclusion better conforms to the findings from the comparison of genetic markers (Benda et al. 2007). Anyway, based on the available information it is obvious, that the current taxonomic arrangement of the species in the Middle East should be revised.

Records of ectoparasites. **Original data**: A r g a s i d a e: *Argas vespertilionis*: 1 larva (IZB; det. J. Krištofík) from an ind., Iraq Al Amir, 2 July 2010; – *Ornithodoros salahi*: 4 ma, 3 nymphs (UCPN) collected under the colony at Iraq Al Amir, 10 May 2009. – N y c t e r i b i i d a e: *Eucampsipoda aegyptia*: 1 fa (UCPN) from 1 ms, An Nuzha, Wadi Al Wala, 11 July 2010; – 1 ma, 1 fa (UCPN) from 1 fa, Nahla, 13 July 2010; – 9 ma, 2 fa (UCPN) from 1 ms, 1 fa, Jufat Al Qafrayn, 15 July 2010; – 8 ma, 10 fa (UCPN) from 3 inds., Iraq Al Amir, 2 July 2010. – **Published data**: N y c t e r i b i i d a e: *Eucampsipoda aegyptia*: 1 ma, 3 fa from 1 f, Zerka [= Zarqa'] river, 1886 (Kock 1969, Kock & Nader 1979).

Comments on ectoparasites. *Rousettus aegyptiacus* was found to be a host of three arthropod ectoparasites in Jordan, *Eucampsipoda aegyptia* (Macquart, 1851), *Argas vespertilionis* (Latreille, 1802), and *Ornithodoros salahi* (Hoogstraal, 1953). The bat fly *E. aegyptia* is an exclusive parasite of *R. aegyptiacus*, it was reported from all main parts of the host distribution range, including its Middle Eastern portion – besides Jordan the records are available from Turkey, Lebanon, Palestine, and Saudi Arabia (Theodor & Moscona 1954, Şadoğlu 1956, Lewis & Harrison 1962, Theodor 1967, Kock & Nader 1979, Wolton et al. 1982, Aktaş & Hasbenli 1994, Hasbenli 1997). The tick *Argas vespertilionis* was previously found to parasitise *R. aegyptiacus* in Sudan (Hoogstraal 1956), the newly reported record from Jordan is the first evidence of this species from the country (it was also found on *Pipistrellus pipistrellus* and *P. kuhlii*). The finding of *Ornithodoros* (*Reticulinasus*) *salahi* from faeces on the bottom of the cave containing a colony of *R. aegyptiacus* suggests possible parasitation of this bat by this tick species. The parasitation of fruit bats by *Ornithodoros*

salahi was evidenced in Egypt (Hoogstraal 1953) and Palestine (Theodor & Costa 1960, 1967). In Jordan, this parasite was previously collected from *Myotis* sp. (Saliba et al. 1990).

Theodor & Moscona (1954) reported two Nycteribiidae species to be found on *R. aegyptiacus* in Palestine, viz. *Nycteribia pedicularia* Latreille, 1805 and *N. schmidlii* Schiner, 1853. Their occurrence is thus well probable in the Jordanian populations of the Egyptian fruit bats.

Rhinopoma microphyllum (Brünnich, 1782)

Record. **New data**: B a l q a': Jufat Al Qafrayn [1], above a fishpond, 15 July 2010: det. several foraging inds. [6 echolocation recordings]. – I r b i d: ʿArjan [2], above a creek below the village, 12 July 2010: obs. & det. several foraging inds. [1 echolocation recording]. – **Published data**: I r b i d: Al Majdal [3], 8 August 1994: 2 f (Qumsiyeh 1996, Qumsiyeh et al. 1998); – Jordan Valley, Tabqat Fahl [4], 1 m, 2 f (Qumsiyeh et al. 1986, cf. Qumsiyeh & Baker 1985); Tabaqat Fahl, small cave [of the Roman nekropolis], 4 July 1997: net. 1 faG (Benda & Sádlová 1999, cf. Benda et al. 2004a, 2006, 2009, Hulva et al. 2007a). – M a' a n: Petra [= Al Batra] (Amr 2000, based on the vague mention by Disi & Hatough-Bouran 1999).

Distribution. *Rhinopoma microphyllum* is a rare bat species in Jordan, only four record sites are known, lying in the northwestern part of the country (Fig. 8). The Jordanian records come from the two areas, the Ajlun Mts. and the Jordan Valley, and represent the easternmost Levantine spot of occurrence of the species (Harrison 1963, Harrison & Bates 1991, Benda et al. 2006). The region of records belongs to the relatively more humid areas of Jordan, the concentration of records in this region thus could seem rather surprising. However, a species very similar to *R. microphyllum* in its physiological adaptations to arid habitats and in its habitat preferences, its congener *Rhinopoma cystops*, was found in very similar habitats – in three cases even in the same sites/roosts (see Fig. 9). The occurrence of *R. microphyllum* in the Ajlun Mts. seems to be a result of spreading from the Jordan Valley, a region of its relatively common occurrence on the Palestinian side (see Mendelssohn & Yom-Tov 1999: 69). The Rift Valley represents an axis of the distribution range of *R. microphyllum* in the Levant, from southern Lebanon to the Gulf of Aqaba (Harrison & Bates 1991, Mendelssohn & Yom-Tov 1999). Anyway, because of the apparent rarity of the species in its whole range, or at least in its western part (Schlitter & Qumsiyeh 1996), the distribution of *R. microphyllum* in Jordan cannot be considered as appropriately known.

Regarding the distribution pattern in Palestine (Mendelssohn & Yom-Tov 1999), *R. microphyllum* may be also found in more arid southern regions of Jordan, adjacent to the Wadi Araba. Although a vague mention from Al Batra (Petra) is available from the report by Disi & Hatough-Bouran (1999), we consider this mention rather doubtful, as the autors did not give any information concerning the record (on the other hand, Amr 2000 and Amr et al. 2004 did accept this report).

The limited records of *R. microphyllum* in Jordan come from a medium-wide range of altitudes from 235 m b. s. l. to 575 m a. s. l. (n=4), their mean altitude (211.5 m) suggests a possible preference of localities situated in lower to medium altitudes.

Field notes. The only known roost of *Rhinopoma microphyllum* from Jordan was reported by Qumsiyeh et al. (1998) from the vicinity of Al Majdal in the southern part of the Ajlun Mts. A colony was present in a cave, in which about 500 individuals of both *Rhinopoma* species roosted. Benda & Sádlová (1999) mentioned netting of an adult female at a small cave (most probably a destroyed tomb) of the Pella nekropolis at Tabaqat Fahl in the Jordan Valley. During this netting session, individuals of *Rhinopoma cystops* were also netted; in the surrounding tombs/caves of the nekropolis also *Rousettus aegyptiacus* and *Rhinolophus ferrumequinum*, probably also *Rhinolophus blasii* and *Myotis capaccinii* were recorded (cf. Qumsiyeh et al. 1986, Harrison & Bates 1991). Calls of several foraging individuals of *R. microphyllum* were recorded in ʿArjan, in the valley of the creek below the village, and at a fishpond at Jufat Al Qafrayn in the Jordan Valley.

At the former occasion, *Pipistrellus pipistrellus* was also netted and *Rhinolophus ferrumequinum* and *Pipistrellus kuhlii* detected, while at the latter session, *Rousettus aegyptiacus* and *Pipistrellus kuhlii* were netted and calls of *Rhinopoma cystops*, *Taphozous perforatus*, *T. nudiventris*, and *Eptesicus bottae* detected.

Concerning the record from Tabaqat Fahl made on 4 July 1997, Benda & Sádlová (1999: 30) mentioned: "Collected individual was a pregnant female, with one embryo, 26.5 mm long (i.e., just pre-partum)." Parturitions in Jordan thus probably occur at the beginning of July, a similar term was already suggested by Mendelssohn &Yom-Tov (1999) from Palestine. Schlitter & Qumsiyeh (1996) reported the period of births from June to August, which also is in accordance with our finding (although the authors regarded the whole species range from West Africa to Indochina).

Although bats of the genus *Rhinopoma* were found in the diet of owls in Palestine (Dor 1947), and individuals of *R. microphyllum* from owl pellets were collected at two sites in Iran (Obuch unpubl.), the species was not evidenced in the analysed samples of owl pellets from Jordan.

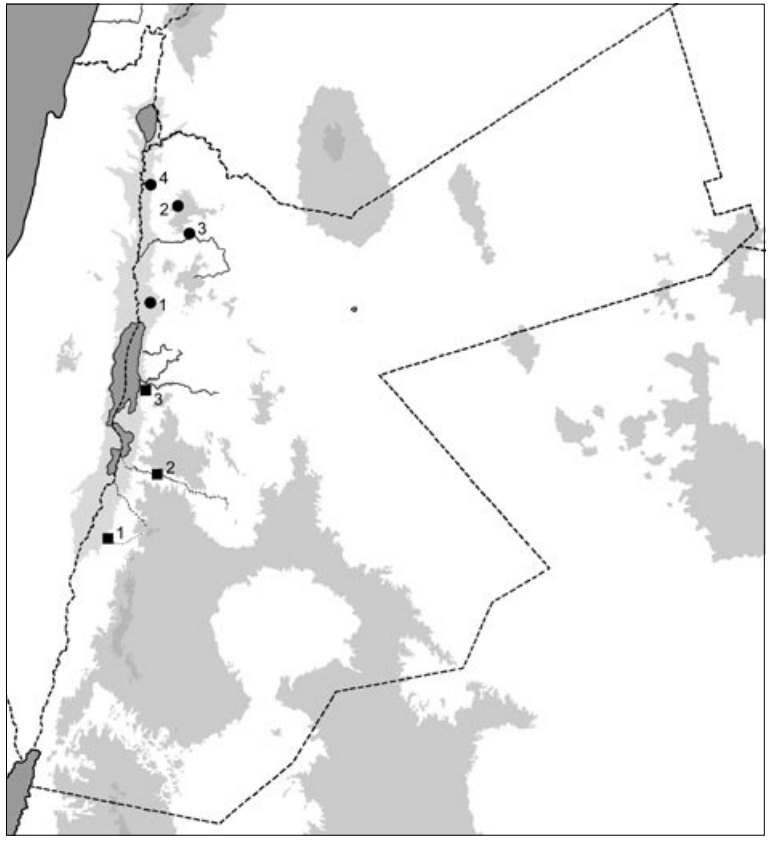


Fig. 8. Records of *Rhinopoma microphyllum* (Brünnich, 1782) (circles) and *Nycteris thebaica* (Geoffroy, 1803) (squares) in Jordan.

Table 4. Descriptive parameters of echolocation calls of 17 bat species from Jordan. In *Barbastella leucomelas*, type A2 calls are type A calls which do not alternate with type B calls. Explanations: n – number of individual calls analysed (in parentheses number of call sequences from which calls were obtained); SF – start frequency; FMAXE – frequency with maximum energy (peak frequency); EF – end frequency; PDUR – pulse duration; IPI – inter-pulse interval; upper lines – mean ±SD, lower lines – range.

species	n	SF	EF	FMAXE	PDUR	IPI
Rhinopoma microphyllum	9 (2)	29.6±0.3 28.9−30.0	25.7±0.6 25.2−26.7	28.0±0.7 27.0−29.0	11.7±0.8 10.5−13.0	202.3±46.8 110.0−267.0
Rhinopoma cystops	59 (11)	36.4±1.5 33.2−39.6	32.5±1.4 29.5−35.8	34.3±1.2 32.0−37.1	8.0±1.6 4.5−12.0	116.0−29.9 60.0−210.0
Taphozous perforatus	20 (5)	31.4±1.5 29.6−34.4	27.6±0.6 26.6−28.8	29.2±0.6 28.5−30.0	12.4±4.2 5.8−19.7	225.1±110.4 58.0−426.0
Taphozous nudiventris	17 (4)	26.1±1.0 24.4−27.6	22.2±0.6 20.3−22.9	24.5±0.5 23.6−25.3	15.4±2.6 11.0−19.5	363.9±115.1 188.0−571.0
Rhinolophus ferrumequinum	3 (1)			81.1±0.0		
Rhinolophus clivosus	10 (2)	73.1±1.9 71.5−77.0	73.8±2.3 70.0−77.0	84.4±0.4 83.5−85.0	48.0±4.8 43.0−59.0	39.6±12.9 27.0−59.0
Rhinolophus blasii	1 (1)			93.4		
Rhinolophus cf. *hipposideros*	39 (13)	88.4±3.7 80.0−95.9	85.5±2.2 82.0−90.3	101.8±0.3 101.0−102.3	51.8±4.6 42.0−61.0	31.5±5.5 23.0−45.0
Myots nattereri	45 (4)	83.2±25.4 55.0−123.0	18.6±2.9 14.0−27.2	43.0±6.5 26.0−51.8	4.3±1.2 2.1−6.4	76.3±22.5 36.0−135.0
Eptesicus bottae	146 (25)	53.6±9.3 37.9−83.0	30.4±1.5 27.0−33.7	34.3±1.8 29.6−39.5	5.5±1.3 2.7−9.4	123.6±39.7 52.0−241.0
Hypsugo ariel	129 (20)	58.1±4.1 47.7−75.0	43.0±2.1 30.0−47.4	46.4±1.3 43.4−49.0	4.1±0.8 2.4−7.2	81.9±18.9 45.0−193.0
Pipistrellus pipistrellus	70 (8)	69.3±14.8 53.1−110.0	48.4±0.9 46.8−50.5	51.2±2.0 48.2−57.9	5.7±1.5 2.8−8.0	81.7±22.2 49.0−169.0
Pipistrellus kuhlii	76 (11)	51.7±6.2 41.4−65.6	39.1±1.1 36.2−41.0	41.1±1.1 37.2−43.2	6.4±1.7 3.4−10	112.9±38.0 70.0−279.0
Otonycteris hemprichii	66 (9)	46.8±8.6 34.2−68.3	20.4±3.0 15.0−25.6	26.8±3.2 19.4−31.8	7.2±2.4 2.9−11.9	142.7±52.9 72.0−302.0
Barbastella leucomelas type A call	28 (3)	37.1±1.3 34.9−40.3	29.2±1.1 27.7−31.8	33.8±1.0 32.7−36.0	2.9±0.4 1.9−3.5	76.8±39.3 50.5−146.0
Barbastella leucomelas type A2 call						125.8±30.5 94.0−201.0
Barbastella leucomelas type B call	14(3)	44.1±0.5 43.0−45.0	34.3±2.9 29.8−38.5	42.7±1.3 40.0−44.2	13.0±4.2 6.9−17.6	52.6±6.4 43.0−65.0
Plecotus christii	42 (6)	44.2±2.8 34.5−49.0	25.0±1.0 22.6−26.7	30.5±1.7 28.6−34.2	2.3±0.5 1.4−3.5	57.6±18.9 18.0−89.0
Tadarida teniotis	7 (3)	15.7±3.8 12.4−22.6	9.8±0.4 9.4−10.5	11.7±0.4 11.1−12.6	16.3±2.2 13.1−19.3	571.8±254.6 163.0−800.0

MORPHOLOGY. External and cranial dimensions of the Jordanian specimen of *Rhinopoma microphyllum* examined are shown in Table 2 (cf. Benda & Sádlová 1999, Benda et al. 2006).

ECHOLOCATION. In total, we obtained seven recordings of the *Rhinopoma microphyllum* calls from two localities. Basic echolocation parameters are given in Table 4. There is little information on

echolocation parameters of this species and in all cases it is limited to simple reports concerning the range and frequency with maximum energy (Shalmon et al. 1993, Mendelssohn & Yom-Tov 1999, Dietz 2005). In this respect, our findings fully conform to the published data.

Rhinopoma cystops Thomas, 1903

Record. **New data**: ʻA m m a n: An Nuzha, Wadi Al Wala [1], above a river (Fig. 103), 11 July 2010: det. & rec. 2 foraging inds. [1 echolocation recording]; – Ash Shunah Al Janubiyya, Wadi Shu'ayb ca. 7 km NE [2], wadi wall cave, 22 May 2009: obs. a colony of ca. 20 inds., coll. 2 fs (NMP 92502 [S+A], 92503 [A]); – Az Zara Springs [3] (Fig. 19), 22 October 2004: det. & rec. numerous foraging inds. [4 echolocation recordings], 11 May 2009: det. & rec. calls of several inds.; – Iraq Al Amir [4], artificial caves (Fig. 3), 10 October 2008: small colony (obs. 3 inds.), net. 1 ma (NMP 92363 [S+A]), 2 July 2010: obs. a colony of ca. 55 inds. in a cave, net. 8 ma, 15 ms, 1 fa, det. numerous foraging inds., rec. 10 calls [7 echolocation recordings]. – A q a b a: Aqaba [5], Ottoman fortress (Fig. 12), 16 May 2009: obs. a colony of ca. 130–150 inds., coll. 2 fa, 1 fs (NMP 92463–92465 [S+A]). – B a l q a': Bethania [6], Baptism Site, 22 August 2000: coll. 1 fa (JUST unnumbered [S+B]; leg. M. Abu Baker), Baptism Site, Orthodox church, 11 May 2009: obs. 1 ind. roosting on the outside church wall; – Jufat Al Qafrayn [7], above a fishpond, 15 July 2010: det. & rec. 2 inds. [2 echolocation recordings]. – I r b i d: Al Majdal [8], 1995: coll. 2 m, 1 fs (JUST unnumbered [A]; collector unlisted); – Tabaqat Fahl [9], small cave in the Roman nekropolis of Pella, 25 October 2008: obs. 1 ind.; – Umm Qais [10], Mgharet Issa Cave, 7 July 2010: obs. a small colony (leg. Z. A. Allah). – K a r a k: An Naqah [11], 26 May 1991: coll. 1 ms (JUST unnumbered [A]; leg. Z. Amr & R. Al Oran); – Ghor As Safi [12], Lot's Cave, 18 October 2008: obs. small colony of ca. 10 inds. (coll. 1 ma, 2 fs; NMP 92382, 92383 [S+A], 92381 [A]), 13 May 2009: obs. small colony of ca. 10 inds.; – Karak [13], Karak Castle, 24 April 2008: det. 2 inds.; – Wadi Ibn Hammat [14], at a river in rocky canyon, 23 October 2008: det. & rec. calls of 1 ind.; – Wadi Weida'a [15], fissures in a rocky wall in the wadi estuary, 12 May 2009: obs. two colonies of 10 and 20 inds., respectively, coll. 11 inds. (6 ma, 1 ms, 1 fa, 3 fs; NMP 92415–92420, 92422–92424 [S+A], 92421 [A]), det. & rec. calls of several foraging inds.; – Wadi Weida'a [16], a pool at water pumping station, 3 July 2010: det. numerous foraging inds. [1 echolocation recording]; – Wadi Weida'a [17], fissures in a rocky wall ca. 1 km NE of the wadi estuary, 13 May 2009: obs. a roosting group of 3 inds. – T a f i l a: Al Qurayqira, Khirbet Feynan [18], ca. 2 km W of the Feynan Ecolodge, mine, 5 July 2010: obs. 1 ind.; – Dhana, Wadi Dhana [19], ca. 5 km NE of Feynan Ecolodge, sandstone overhang (Fig. 5), 14 May 2009: net. 2 fa, 2 fs (coll. 3 f; NMP 92444, 92446 [S+A], 92445 [A]); – Wadi Al Hasa [20] (Fig. 23), above a river ca. 1 km E of Hammamat Borbatah, 5 July 2010: det. & rec. several inds. [6 echolocation recordings]. – **Published data** (all records were published under *R. hardwickii*): A q a b a: Wadi Fidan, a cave near Qaraiqira [18], June [= 29 May 1990]: some 30–40 inds. [net. 2 fa] (Qumsiyeh et al. 1992, Amr et al. 2004). – I r b i d: Al Majdal [8], near Dibbin Forest, a cave, 18 August 1994: about 500 inds., coll. 3 f (Qumsiyeh et al. 1998); – Jerash [21], Roman ruins, Temple of Artemis, 13 October 1953: 1 m (Harrison 1959a, 1964); Jerash, 17 inds. (Atallah 1977), 10 inds. (Qumsiyeh 1985); – Tabaqat Fahl [9], small cave [of the Roman nekropolis], 4 July 1997: net. 12 inds., coll. 9 fs (Benda & Sádlová 1999, cf. Benda et al. 2004a, 2006, 2009, Hulva et al. 2007a). – K a r a k: An-Naqah [11], 26 May 1991: 1 f (Qumsiyeh et al. 1998). – M a' a n: Petra [= Al Batra] (Amr 2000, most probably based on the vague mention by Disi & Hatough-Bouran 1999).

Distribution. *Rhinopoma cystops* was formerly considered a form within a species rank of its Indo-Persian congener, *R. hardwickii* Gray, 1831, however, its separate status seems to be well proved (Hulva et al. 2007a, Benda et al. 2009). *R. cystops* belongs to rather common species of bats in Jordan. Twenty-one record sites are available from the western portion of the country (Fig. 9), from the whole extent of the Rift Valley between the Yarmuk area to Aqaba, i.e. the localities cover three biogeographical regions of Jordan (see above). The oldest available record from the Roman ruins of Jerash (Harrison 1959a) also represents the easternmost record of the species within its Levantine distribution range (the easternmost records within the whole range come from SW Oman; Harrison & Bates 1991, own unpubl. data). All the Jordanian records were made in the Rift Valley or in valleys creating tributaries to the Rift. This distribution pattern is well in accordance with the distribution described from Palestine, where the more numerous records (some 25–30 sites) are concentrated to the Rift Valley but are also scattered in the adjacent elevated regions (Qumsiyeh 1996, Mendelssohn & Yom-Tov 1999). The Jordanian population of *R. cystops* belongs to those living most northward within the species range (sensu Hulva et al. 2007a), the northernmost localised record in Asia is known from the Qala'at Nimrud in the

northern Golan Heights (Benda et al. 2006), some 65 km north of Umm Qais, the northernmost record site in Jordan.

Similarly as in the previous species, we consider the mention of *R. cystops* from Al Batra (Petra) by Disi & Hatough-Bouran (1999) to be rather doubtful, as the autors did not give any details concerning the record unlike in some other reported species (on the other hand, Amr 2000 and Amr et al. 2004 did accept this record). However, the *R. cystops* occurrence in the ruins of Al Batra is well probable, as the species was commonly found in a series of surrounding sites (Fig. 9).

The records of *R. cysops* in Jordan come from a broad range of altitudes from 375 m b. s. l. to 995 m a. s. l. (n=21); however, the mean altitude (125.8 m) shows a clear preference of lower sites. Although only two thirds of the records represent findings of bats in their roosts (n=14), the altitudinal preferences of roost sites (range –375–580 m; mean 90.7 m) are very similar to the general preference of altitudes.

Field notes. In Jordan, *Rhinopoma cystops* was recorded very frequently in its roosts. Atallah (1977: 288) reported probably a finding of a dispersed colony in the ancient ruins of Jerash: "These

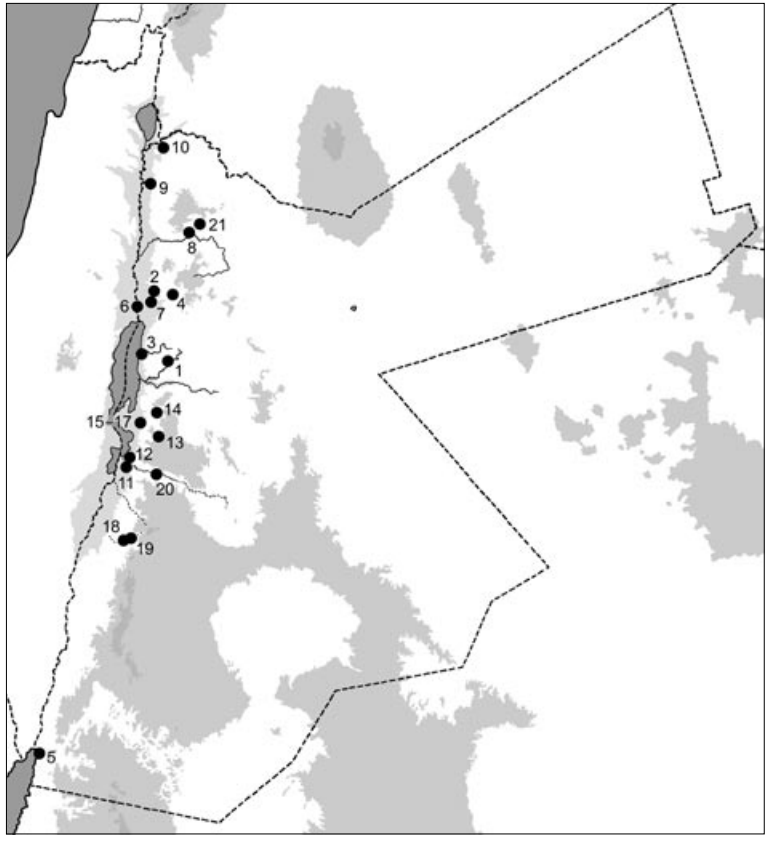


Fig. 9. Records of *Rhinopoma cystops* Thomas, 1903 in Jordan.

Fig. 10. An individual of *Rhinopoma cystops* Thomas, 1903 roosting in a cave of the underground complex of Iraq Al Amir (photo by A. Reiter).

bats are abundant among the ruins of Jerash with colonies of varying sizes, 25–200 individuals." Qumsiyeh et al. (1992: 105) described a record from a site adjacent to the Wadi Araba: "We collected two individuals from a cave near Quraiqira in Wadi Fidan. The cave had a wide opening (about 8 by 10 meters) and thus was well lit. Some 30–40 bats were observed inhabiting the cave. They were very active and retreated deep into a small crevice upon our approach." Qumsiyeh et al. (1998) reported on a finding of a mixed colony of some 500 *Rhinopoma* bats in a cave at Majdal in the Ajlun Mts. (see also under *R. microphyllum*). Benda & Sádlová (1999) mentioned a record of a colony of ca. 30 individuals of *R. cystops* in a small cave (most probably a destroyed tomb) of the Pella nekropolis at Tabaqat Fahl in the Jordan Valley. During a check of this ca. 15 m long cave in 2008, only one bat was recorded, and no bats were found there in 2009. In artificial caves of Iraq Al Amir in the Wadi As Sir at ʿAmman (Fig. 3), a colony of *R. cystops* was observed twice (Fig. 10); on 10 October 2008 a small number of bats was documented, at least three individuals were observed in one time and others heard in adjacent crevices, on 2 July 2010 a colony of ca. 55 individuals was found (on 10 May 2009, no *Rhinopoma* bats were observed there). In the Lot's Cave above Ghor As Safi (Fig. 11), a small colony of about 10 individuals of *R. cystops* was observed in two years (2008, 2009). The cave is an about 10 m long narrow cavity in an agglomerate rock (at the entrance to the cave, rests of monastery ruins are present). In fissures between blocks of rocks in the walls of entrance to the Wadi Weida'a, three groups (colonies) of 10, 20,

Fig. 11. Entrance to Lot's Cave in the Dead Sea Basin (photo by A. Reiter). In the cave, a small colony of *Rhinopoma cystops* was observed.

and 3 individuals were found in separate cavities. In the partly ruined Ottoman fortress of Aqaba (Fig. 12), a colony of about 130–150 individuals dispersed into several separated groups was found in dark rooms of the ground floor. Another colony of some 20 individuals was observed in a loamy vertical crevice in the wall of the canyon-like Wadi Shu'ayb, ca. 7 km NE of Ash Shunah Al Janubiyya in the Jordan Valley. In this valley, very close to the Baptism Site (Bethania) at the Jordan River, a roosting individual was observed on the outside wall of an Orthodox church (Fig. 13). A solitary individual of *R. cystops* was found in the Khirbet Feynan mine (ca. 150 m long gallery) near the Feynan Ecolodge at Al Qurayqira, in the Wadi Araba.

R. cystops was netted only in three sites, solely at the roosts. Twelve bats were netted at the entrance to the cave at Tabaqat Fahl where a colony roosted (see above) (Benda & Sádlová 1999). At entrances of artificial caves of Iraq Al Amir (Fig. 3), one individual of *R. cystops* was netted in 2008 and 24 bats in 2010. At a sandstone overhang in a slope of the Wadi Dhana (Fig. 5), some 5 km above the Feynan Ecolodge, four individuals were netted. Ultrasound calls of *R. cystops* were detected at more sites, mostly during netting sessions, i.e. by water streams or at pools in wadis. However, as *Rhinopoma* bats do not need to drink from water surface unlike other desert-dwelling bats, the detection of foraging calls is a more effective method to record these bats than netting. The calls of foraging individuals of *R. cystops* were recorded in the rocky canyon of the Wadi Ibn Hammat, along the canyon walls of the Wadi Al Hasa (Fig. 23), at the Az Zara Springs (Fig. 19), above a river in the Wadi Al Wala (Fig. 103), and also during a netting session at a fishpond at Jufat Al Qafrayn in the Jordan Valley.

Since *R. cystops* is known from Jordan from a number of sites of different habitats, it was recorded along with many other bat species at the localities. At least at three sites, other bats were

Fig. 12. Quad of the Ottoman fortress in Aqaba, Red Sea coast (photo by A. Reiter). In rooms of the ground floor of the fortress, a numerous colony of *Rhinopoma cystops* was discovered; in large corner rooms accessible from the quad, traces of feeding of *Rousettus aegyptiacus* were found.

Fig. 13. An individual of *Rhinopoma cystops* Thomas, 1903 roosting on the outside wall in the portal of an Orthodox church at the Baptism Site of Bethania (photo by A. Reiter).

found in the *R. cystops* roosts. Qumsiyeh et al. (1998) reported a finding of a mixed colony with *Rhinopoma microphyllum* at Majdal. In the Khirbet Feynan mine at Feynan Ecolodge, *R. cystops* roosted along with a colony of *Plecotus christii*. In the Iraq Al Amir caves, a colony of *Rousettus aegyptiacus* was also documented and foraging individuals of *Rhinolophus blasii*, *Myotis nattereri*, and *Pipistrellus kuhlii* were recorded nearby. At the system of caverns at Tabaqat Fahl, *Rousettus aegyptiacus*, *Rhinopoma microphyllum*, *Rhinolophus ferrumequinum*, *R. blasii*, and *Myotis capaccinii* were also recorded. In the abandoned Ottoman fortress of Aqaba, where a colony of *R. cystops* roosts, a feeding place of *Rousettus aegyptiacus* was documented. Common foraging was documented in more sites; in the Wadi Ibn Hammat along with *Taphozous perforatus* and *Hypsugo ariel*; at the Az Zara Springs with *Tadarida teniotis* (*Rousettus aegyptiacus* and *Taphozous nudiventris* were also documented at the site); in the Wadi Weida'a along with *Eptesicus bottae*, *Hypsugo ariel*, and *Tadarida teniotis*; in the Wadi Dhana with *Rousettus aegyptiacus* and *Tadarida teniotis*; in the Wadi Al Hasa with *Taphozous perforatus*, *T. nudiventris*, *Eptesicus bottae*, *Hypsugo ariel*, and *Tadarida teniotis*; in the Wadi Al Wala with *Rousettus aegyptiacus*, *Eptesicus bottae*, *Pipistrellus pipistrellus*, and *Tadarida teniotis*; and at a fishpond near Jufat Al Qafrayn with *Rousettus aegyptiacus*, *Rhinopoma microphyllum*, *Taphozous perforatus*, *T. nudiventris*, *Eptesicus bottae*, and *Pipistrellus kuhlii*.

Despite the numerous individuals of *R. cystops* recorded from Jordan, no direct signs of reproduction were observed. Although bats of the genus *Rhinopoma* were found in the diet of owls in Palestine and Iran (Dor 1947, Obuch unpubl.), *R. cystops* was not proved in the analysed samples of owl pellets from Jordan.

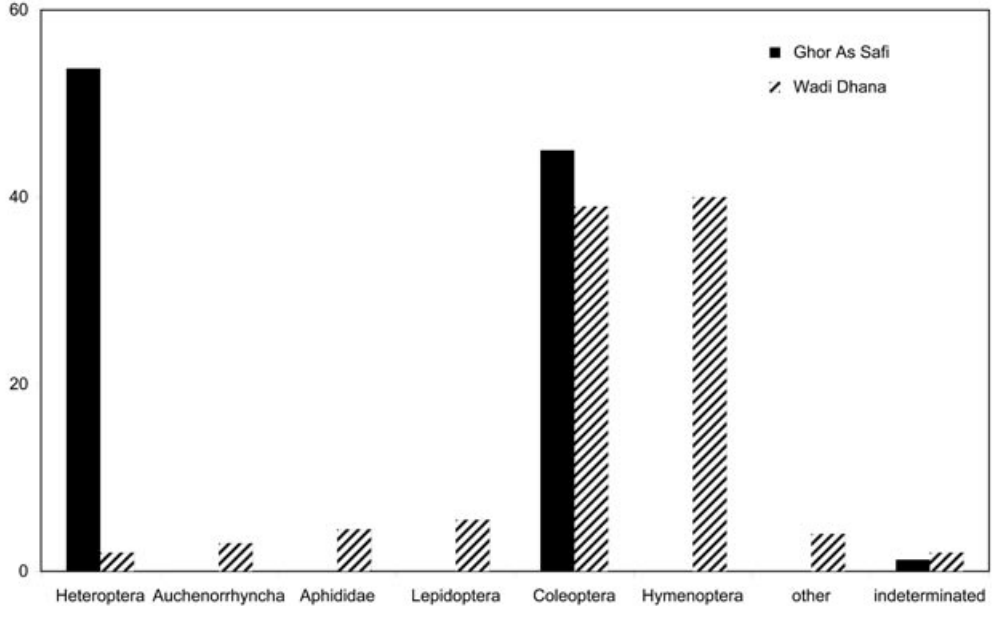


Fig. 14. Volume of particular prey categories in the diet of *Rhinopoma cystops* Thomas, 1903 from Jordan. Material: Wadi Dhana – 10 pellets analysed from two bats; Lot's Cave, Ghor As Safi – eight pellets analysed from three bats.

Morphology and variation. External and cranial dimensions of the Jordanian specimens of *Rhinopoma cystops* examined are shown in Table 2. For the material examined see Records.

Feeding ecology. *Rhinopoma cystops* belongs to the medium-sized representatives of the genus (along with *R. hardwickii* Gray, 1831 and *R. hadramauticum* Benda, 2009), it is a slightly built bat which captures food in a rapid swallow-like flight (Habersetzer 1981). The diet of this body size-group was studied in the deserts of Rajasthan, India (*R. hardwickii*; Advani 1982), and Palestine (*R. cystops*; Whitaker & Yom-Tov 2002). In Rajastan, Coleoptera, Orthoptera, Lepidoptera, Hymenoptera, and seasonally also Isoptera were recorded as the main prey categories (Advani 1982). Whitaker & Yom-Tov (2002) found mainly Coleoptera and Hymenoptera (particularly Formicoidea) in the *R. cystops* diet in northern Palestine.

From Jordan, we analysed 18 feacal pellets originating from two sites and six contents of digestive tracts from four sites. The analysed samples showed remarkable local variation (Fig. 14), the most important prey categories recorded in the faeces were Coleoptera, Heteroptera and Hymenoptera (mainly Formicoidea). These taxa also prevailed in the analysed digestive tract contents; viz. Heteroptera (0–100% of the volume of particular tract contents), Hymenoptera (0–100%), Coleoptera (0–80%), and Lepidoptera (0–10%). One stomach of a subadult individual from the Wadi Shu'ayb contained solely a bird feather (most probably accidentally swallowed).

The local variation in the diet composition suggests flexible foraging behaviour in the species and its ability to locate currently abundant swarming prey like ants or termites. The diet composition recorded in Jordan well corresponds with the findings by Whitaker & Yom-Tov (2002) from the neighbouring Palestine, while the results by Advani (1982) differ in a high proportion of consumed Orthoptera (13.3–26.2% of total dry mass).

Echolocation. In total, we obtained 21 recordings of *Rhinopoma cystops* calls from six sites (Figs. 15, 16). Basic echolocation parameters are given in Table 4. The values obtained from Jordan conformed to the data on echolocation of *R. cystops* from northern Egypt reported by Simmons et al. (1984). However, the Jordanian and Egyptian mean values of FMAXE were somewhat higher than those recorded in Palestine and the Sinai (Shalmon et al. 1993, Mendelssohn & Yom-Tov 1999, Benda et al. 2008).

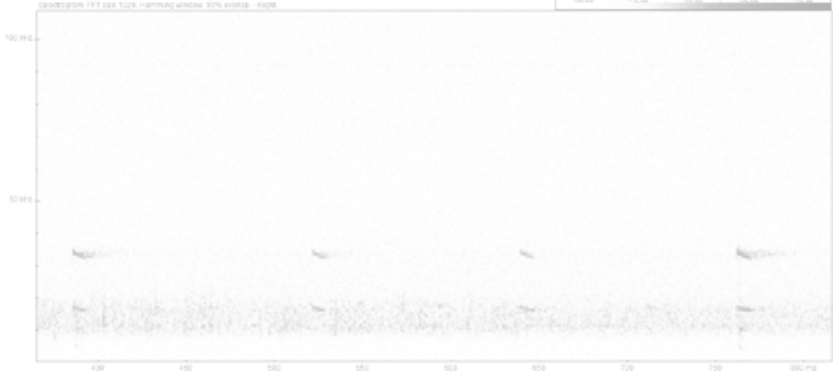


Fig. 15. Spectrogram of echolocation calls of *Rhinopoma cystops* Thomas, 1903; an individual foraging in the Wadi Weyda'a.

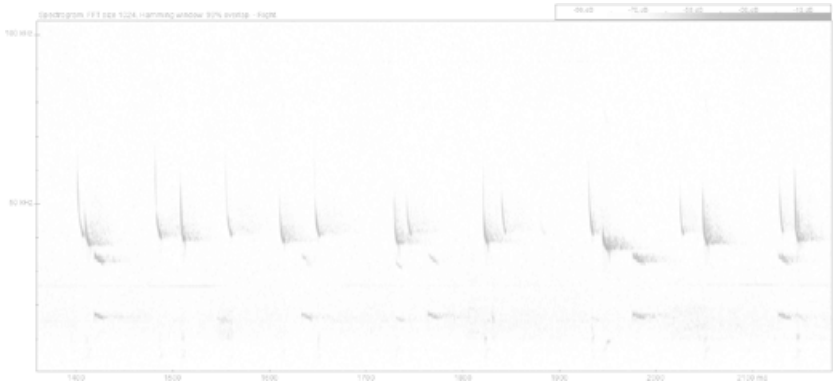


Fig. 16. Spectrogram of echolocation calls of *Rhinopoma cystops* Thomas, 1903 and *Pipistrellus kuhlii* (Kuhl, 1817); several individuals foraging above a fishpond at Jufat Al Qafrayn.

Records of ectoparasites. **Original data**: A r g a s i d a e: *Argas confusus*: 2 larvae (IZB; det. J. Krištofík) from 2 inds., Iraq Al Amir, 2 July 2010.

Comments on ectoparasites. Only one parasite species was found on *Rhinopoma cystops* in Jordan, the tick *Argas confusus* Hoogstraal, 1955. Its finding represents the first record of this parasite from Jordan. Occurrence of this tick has been known from Palestine (Theodor & Costa 1967), however, its range comprises mainly northeastern Africa (Hoogstraal 1955, 1956). Two other *Argas* species were reported from *R. cystops* from Egypt (Anciaux de Faveaux 1987): *Argas vespertilionis* (Latreille, 1802) and *A. transgariepinus* White, 1846, and four insect parasites from Palestine (Theodor & Moscona 1954, Theodor 1968): *Brachytarsina alluaudi* (Falcoz, 1923), *Ascodipteron rhinopomatos* Jobling, 1952, *Leptopsylla segnis* (Schonherr, 1811), and *Eucampsipoda aegyptia* (Macquart, 1851). All these species could be expected also in Jordan.

Taphozous perforatus Geoffroy, 1818

Records. **New data**: ʿA m m a n: Az Zara Springs [1] (Fig. 19), 22 October 2004: net. 1 m (NMP 92094 [S+A]), det. numerous calls of foraging inds. – B a l q a': Jufat Al Qafrayn [2], above a fishpond, 15 July 2010: det. several foraging inds. [2 echolocation recordings]. – K a r a k: Mujib Nature Reserve [3], April 1999: coll. 1 ma (RSCN unnumbered [S+A], leg. K. A. Al Omari & M. A. Abu Baker); – Wadi Ibn Hammat [4], at a river in rocky canyon, 23 October 2008: det. calls of 1 ind. [1 echolocation recording]; – Wadi Mujib [5], siq estuary (Fig. 18), 16 October 2008: det. numerous inds. [16 echolocation recordings]. – T a f i l a: Wadi Al Hasa [6] (Fig. 23), above a river ca. 1 km E of Hammamat Borbatah, 5 July 2010: det. & rec. 1 ind. – **Published data**: K a r a k: 2 km E of Ghor es-Safi [= Ghor As Safi] [7], [28 May 1990:] net. 1 m (Qumsiyeh et al. 1992).

Distribution. *Taphozous perforatus* belongs to rare bat species in Jordan, seven records sites are available. All records are associated with the middle part of the Rift Valley of Jordan, surrounding the Dead Sea (Fig. 17) and belonging to the Sudanian Penetration biogeographical region. Four records published from Palestine come from the northern portion of the Rift Valley and from the central Negev Desert (Mendelssohn & Yom-Tov 1999, Korine & Pinshow 2004); two records are known from the southern part of the Dead Sea basin and one record was made in Nakhal ʿAmmud at the Sea of Galilee. The latter is the northernmost locality of *T. perforatus* within its whole distribution range (cf. Harrison & Bates 1991, Bates & Harrison 1997). The Jordanian records

from Jufat Al Qafrayn and the Az Zara Springs thus represent the second and third northernmost sites of the *T. perforatus* range. The distance between Jufat Al Qafrayn and Nakhal ʿAmmud is some 115 km.

Since the occurrence of *T. perforatus* continues in Arabia southwards via the Sinai and the Hijaz range to Saudi Arabia and Yemen (Harrison & Bates 1991, Benda et al. 2008, Benda et al. in press), and in Africa southwards via the Nile Delta and Valley (Qumsiyeh 1985), this species may be also found in the southern part of the Rift Valley of the Levant, in areas adjacent to the Wadi Araba, both on the Jordanian and Palestinian sides. However, no records of *T. perforatus* are available from these regions, although roosting as well as foraging opportunities seem to be abundant there.

The few records of *T. perforatus* in Jordan come from a rather narrow range of altitudes between 385 m b. s. l. and 360 m a. s. l. (n=7); the mean altitude (–110.7 m) clearly shows a preference of very low sites. Such a trend is obvious also from the Palestinian sites of *T. perforatus* and shows a general pattern of occurrence within the Levantine range of distribution (comp. *Taphozous nudiventris*).

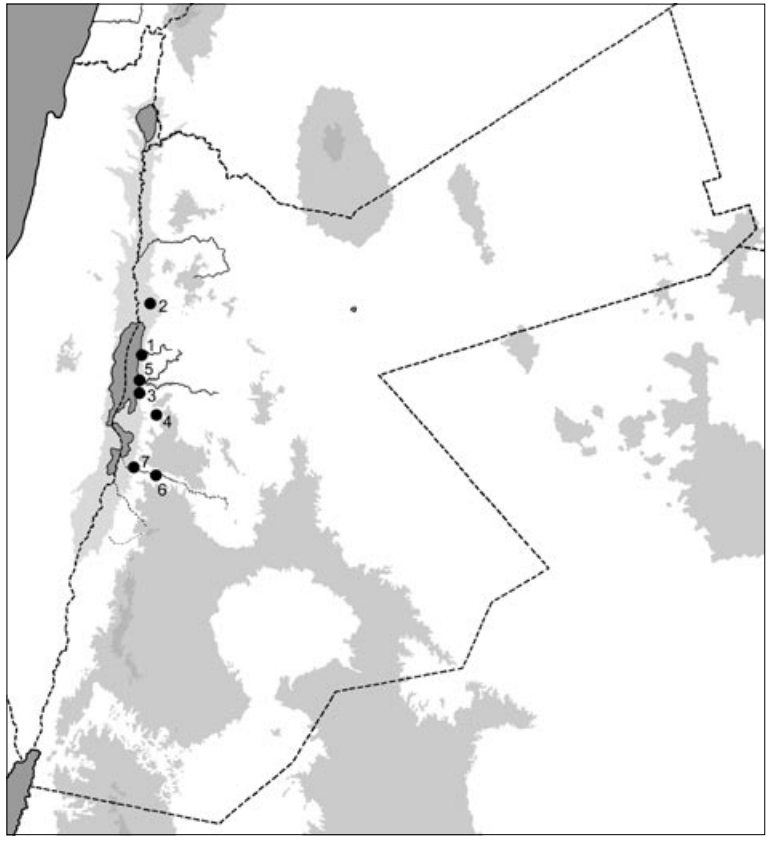


Fig. 17. Records of *Taphozous perforatus* Geoffroy, 1818 in Jordan.

Fig. 18. Siq estuary of the Wadi Mujib, Mujib Reserve, Dead Sea Basin (photo by A. Reiter). In this canyon numerous foraging individuals of *Taphozous perforatus* were detected and recorded, several passes of *Tadarida teniotis* were also registered.

Field notes. No roost of *Taphozous perforatus* was documented from Jordan. Records were obtained only by netting or by detection of ultrasound calls. Qumsiyeh et al. (1992) reported netting of a male at Ghor As Safi, in area adjacent to the Dead Sea Basin. Another individual was netted at the Az Zara Springs, also in the region of the Dead Sea. Foraging calls of *T. perforatus* were recorded in the Wadi Al Hasa (Fig. 23), in the broad part of the wadi above the resort of Hammamat Borbatah, at a fishpond near Jufat Al Qafrayn in the Jordan Valley, calls of numerous individuals were detected and recorded in the siq estuary of the Wadi Mujib (Fig. 18), and also in the Wadi Ibn Hammat. At these sites *T. perforatus* was recorded to forage along with *Rousettus aegyptiacus* and *Tadarida teniotis* (Az Zara Springs; Fig. 19), *Rhinopoma cystops*, *Taphozous nudiventris*,

Fig. 19. Az Zara Springs above the bank of the Dead Sea (photo by P. Benda). In the area of the springs, individuals of *Rousettus aegyptiacus*, *Taphozous perforatus*, and *T. nudiventris* were netted and echolocation calls of *Rhinopoma cystops* and *Tadarida teniotis* were recorded.

Eptesicus bottae, *Hypsugo ariel* and *Tadarida teniotis* (Wadi Al Hasa), *Rousettus aegyptiacus*, *Rhinopoma microphyllum*, *R. cystops*, *Taphozous nudiventris*, *Eptesicus bottae* and *Pipistrellus kuhlii* (Jufat Al Qafrayn), *Tadarida teniotis* (Wadi Mujib), and *Rhinopoma cystops* and *Hypsugo*

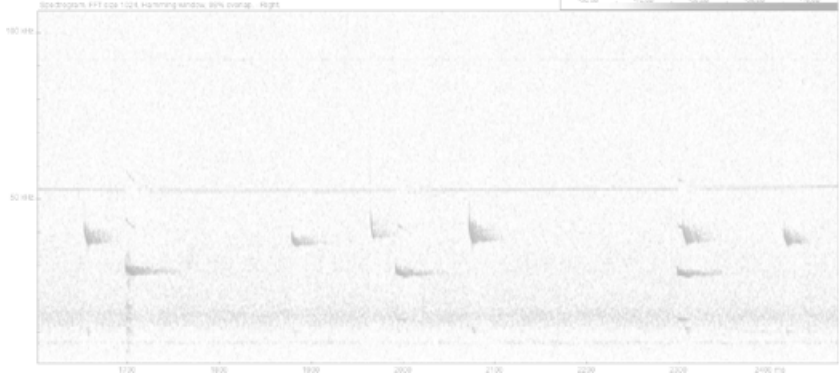


Fig. 20. Spectrogram of echolocation calls of *Taphozous perforatus* Geoffroy, 1818 and *Pipistrellus kuhlii* (Kuhl, 1817); two individuals foraging above a fishpond at Jufat Al Qafrayn.

ariel (Wadi Ibn Hammat). No signs of reproduction were observed in *T. perforatus* of Jordan. This species has not been found in the analysed samples of owl diet from Jordan.

Morphology. External and cranial dimensions of the Jordanian specimens of *Taphozous perforatus* examined are shown in Table 2. For the material examined see Records.

Echolocation. We made 19 recordings of echolocation calls of *Taphozous perforatus* at three sites (Fig. 20). Basic parameters of echolocation are given in Table 4. The only data on echolocation parameters of this species were reported from Palestine and Egypt (Ulanovsky et al. 2004, Dietz 2005, Benda et al. 2008). The echolocation parameters of *T. perforatus* from Jordan conformed to those reported from continental Egypt (Dietz 2005) and the Sinai (Benda et al. 2008).

Taphozous nudiventris Cretzschmar, 1830

Records. **New data**: ʼA m m a n: Az Zara Springs [1] (Fig. 19), April 1999: net. 1 ind. (RSCN unnumbered [A], leg. K. A. Al Omari & M. A. Abu Baker). – B a l q a': Jufat Al Qafrayn [2], above a fishpond, 15 July 2010: det. several

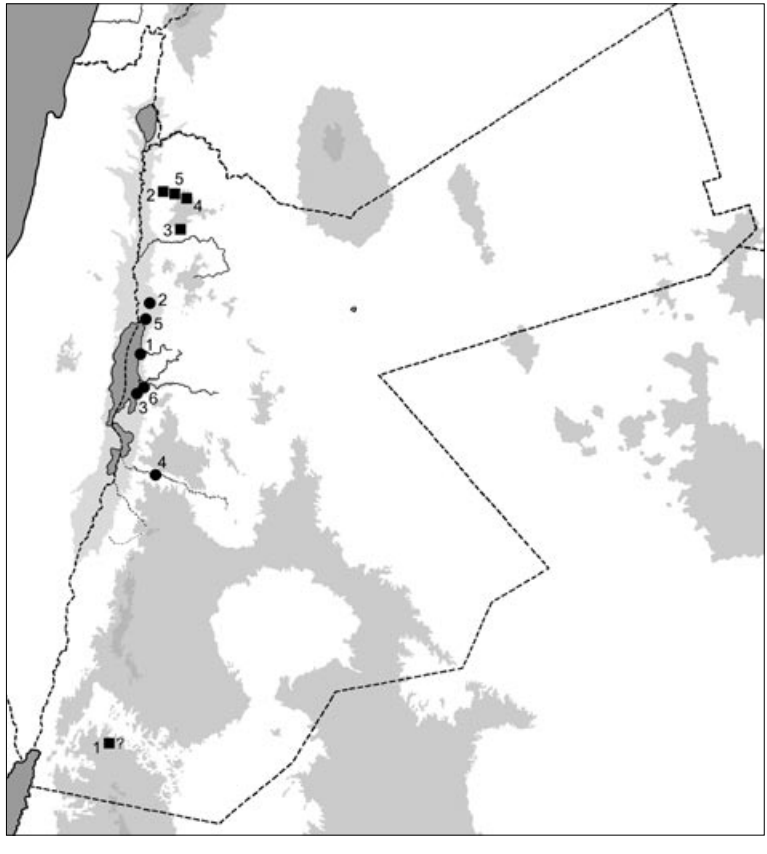


Fig. 21. Records of *Taphozous nudiventris* Cretzschmar, 1830 (circles) and *Rhinolophus hipposideros* (Borkhausen, 1797) (squares) in Jordan.

foraging inds. [2 echolocation recordings]. – K a r a k: Ar Raddass, a cave near the main road (beside the sea) [3], April 1999: net. 1 ind. (RSCN unnumbered [A], leg. K. A. Al Omari & M. A. Abu Baker). – T a f i l a: Wadi Al Hasa [4] (Fig. 23), above a river ca. 1 km E of Hammamat Borbatah, 5 July 2010: det. numerous foraging inds. [10 echolocation recordings]. – **Published data**: B a l q a': near the Dead Sea (between South Shounah [= Ash Shunah Al Janubiyya] and Swymah [= As Suwayma]) [5], 19 April 1997: net. 1 ind. (Darweesh et al. 1997). – K a r a k: vicinity of Ar Raddass [6], south of Wadi Al Mawjib, 1999, net. (Al-Omari et al. 2000).

Distribution. In many aspects, the distribution pattern of *Taphozous nudiventris* in Jordan is very similar to that of its congener, *T. perforatus* (see above). *T. nudiventris* also belongs to rare bat species in Jordan, only six record sites are available, and all records also are associated with the middle part of the Rift Valley of Jordan, surrounding the Dead Sea (Fig. 21). More numerous records known from Palestine show occurrence of the species in the whole northern portion of the territory (Mendelssohn & Yom-Tov 1999). Five (six) well localised records come from the Rift Valley (Dead Sea Basin and Jordan Valley) and five records from the Yizre'el Valley and edges of the Carmel Mts., incl. the sea shore areas, and from Tel Aviv (Theodor & Moscona 1954, Makin 1979). The northernmost Palestinian (as well as Levantine) records are available from Nakhal ʿAmmud at the Sea of Galilee (Harrison 1964, Qumsiyeh 1985) and from Dan, NE of Hula (Ferguson 2002), in the Rift portion of the Levantine distribution and at Acre in the coastal portion (Mendelssohn & Yom-Tov 1999). The northernmost Jordanian record site at Jufat Al Qafrayn lies some 150 km south of the known northern margin of the species range in the Levant.

Since the occurrence of *T. nudiventris* continues in Arabia southwards via the Hijaz Range of Saudi Arabia to Yemen (Harrison & Bates 1991) and in Africa southwards via the Nile Delta and Valley (Qumsiyeh 1985) to sub-Saharan regions, this species may be also found in the southern part of the Rift Valley of the Levant, in areas adjacent to the Wadi Araba, both on the Jordanian and Palestinian sides. Apparently, no records of *T. nudiventris* exist from these regions, although roosting as well as foraging opportunities seem to be available there. This rather surprising situation is identical with that in *Taphozous perforatus* (see above).

T. nudiventris is a common bat species in the belt of fertile landscape along the Euphrates in Syrian Mesopotamia (Benda et al. 2006, Shehab et al. 2007) and reaches also the Turkish part of the valley (Sachanowicz et al. 1999, Karataş & Sachanowicz 2008). However, the Syrian population is considered to belong to a distinct taxon than that of the Holy Land (Kock 1969, Harrison & Bates 1991, Benda et al. 2006, etc.); the nominotypical form is present in the southwestern Levant as well as in northeastern Africa, while *T. n. magnus* von Wettstein, 1913 occurs in Mesopotamia from Turkey to Iran and Bahrain (Harrison & Bates 1991). Thus, the communication between the Levantine and Mesopotamian ranges through the Syrian Desert seems to be rather unprobable.

The few records of *T. nudiventris* in Jordan come from a rather narrow range of altitudes between 380 m b. s. l. and 287 m a. s. l. (n=6); the mean altitude (–192.5 m) shows a preference of very low sites, the mean value is the lowest among the Jordanian bats. However, unlike in the previous species, such a trend is not apparent from the distribution of records of *T. nudiventris* in Palestine, where only a part of the records are associated with the low areas of the Rift Valley.

Field notes. No roost of *Taphozous nudiventris* was documented from Jordan. Records were obtained only by netting or by detection of ultrasound calls. Darweesh et al. (1997) reported netting of an individual of *T. nudiventris* (along with *Pipistrellus kuhlii* bats) in the flattened region between Ash Shunah Al Janubiyya (South Shounah) and As Suwayma in the northern part of the Dead Sea Basin. Al-Omari et al. (2000) mentioned netting of individual(s) in the vicinity of Ar Raddass close to the Wadi Al Mawjib. Foraging calls of *T. nudiventris* were recorded in the Wadi Al Hasa (Fig. 23) where also *Rhinopoma cystops*, *Taphozous perforatus*, *Nycteris thebaica*, *Eptesicus bottae*, *Hypsugo ariel*, and *Tadarida teniotis* were documented, and during the netting session at Jufat Al Qafrayn, when *Rousettus aegyptiacus* and *Pipistrellus kuhlii* were netted and

calls of *Rhinopoma microphyllum*, *R. cystops*, *Taphozous perforatus*, and *Eptesicus bottae* were detected. No signs of reproduction were observed in *T. nudiventris* in Jordan.

Unlike the experience from other parts of the Middle East, where *T. nudiventris* was frequently found to be a part of owl diet (Dor 1947, Nader 1969, Ebenau 1996, Shehab et al. 2004, Benda et al. 2006, Shehab et al. 2007, Obuch & Benda 2009, Obuch unpubl.), remains of this bat were not recorded in owl pellets collected in Jordan.

Echolocation. In total, we obtained 15 recordings of *Taphozous nudiventris* calls from three localities. Basic echolocation parameters are given in Table 4. Only scarce information on echolocation parameters of this species is available in literature, providing no details except for FMAXE and range (Shalmon et al. 1993, Mendelssohn & Yom-Tov 1999, Dietz 2005). Our findings agree with the published data.

Nycteris thebaica (Geoffroy, 1803)

Records. **New data**: A q a b a: Al Qurayqira [1], Wadi Fidan ca. 3 km NW of the village, 27 July 2000: coll. 1 mj, 1 fj (RSCN unnumbered [A]; leg. Mayas & M. Faqir). – T a f i l a: Wadi Al Hasa [2] (Fig. 23), small cave in the wadi ca. 1 km E of Hammamat Borbatah, 5 July 2010: obs. 3 roosting inds. (coll. 1 fa, 1 fj, NMP 92805 [S+A], 92806 [A]). – K a r a k: Ar Raddass Station [3], April 1999: coll. 1 ma (RSCN unnumbered [S+A], leg. K. A. Al Omari & M. Abu Baker), 14 May 2007: coll. 1 fa (RSCN unnumbered [S+A]). – **Published data**: K a r a k: Ar Raddass [3], south of Wadi Al Mawjib, 31 March 1999: 1 m, 1 f [1 fa: JUST unnumbered [A]; leg. RSCN] (Al-Omari et al. 2000).

Distribution. *Nycteris thebaica* is a rare bat species in Jordan, only three record sites adjacent to the Dead Sea Basin are known (Fig. 8), from the middle part of the Jordanian Rift. The record from the Wadi Al Hasa (Fig. 23) represents the easternmost Levantine spot of occurrence of the species (the easternmost records of the whole species range are available from SW Oman; Harrison & Bates 1989, own data); the Levantine part of the distribution range of this African bat represents its northernmost projection (Gray et al. 1999).

In Palestine, *N. thebaica* was reported from the whole extent of the Rift Valley and according to Mendelssohn & Yom-Tov (1999), findings from eleven sites are available. Makin (1977) and Nader & Kock (1983b) reported a cave at Merkhaviya (Yizre'el Valley) to be the northernmost site of *N. thebaica* range in Palestine (and the Levant as well). Mendelssohn & Yom-Tov (1999: 83) mapped a finding more to the north, positioned northwest of the Sea of Galilee (cf. Nakhal ʿAmmud), however, they gave no comment on this apparently important spot. The northernmost Jordanian record site at Ar Raddas lies some 130 and 160 km south of these delimitative points, respectively. Anyway, considering the pattern of distribution in Palestine (Mendelssohn & Yom-Tov 1999) and in the Sinai (Anderson 1902, Benda et al. 2008), *N. thebaica* may be also found in northwestern regions of Jordan, adjacent to the Jordan Valley, as well as in the southwestern regions, adjacent to the Wadi Araba.

The limited records of *N. thebaica* in Jordan come from a medium-wide range of altitudes from 170 m b. s. l. to 287 m a. s. l. (n=3), their mean altitude (59.0 m) suggests a preference of rather lower altitudes.

Field notes. The individuals of *Nycteris thebaica* in Jordan were obtained only by direct collection with the help of hand nets (if the information concerning the record is available). In one case, a roost was documented; three roosting individuals were observed in a small cave some 15 m deep and 1.2–1.6 m high (Fig. 22), localised in the left side wall of the Wadi Al Hasa, ca. 1 km above the resort of Hammamat Borbatah (Fig. 23). From this cave, an adult lactating female carrying an almost grown volant juvenile (LAt 42.4 mm, i.e. 91.8% of the mother's LAt 46.2 mm) was collected with the help of hand net on 5 July. Qumsiyeh (1985) found lactating females in Egypt

in mid-July, Mendelssohn & Yom-Tov (1999) reported parturitions to take place in Palestine in June; our evidence also indicates to an early June parturition term. From Saudi Arabia, Nader & Kock (1983b) reported pregnant females collected in late April and early October, lactating females in July; Yerbury & Thomas (1895) reported pregnant females from mid-March from Yemen. These records suggested seasonal bimodality in reproduction of the southern Arabian populations of *N. thebaica* (Nader & Kock 1983b), however, no sign of such reproduction mode has been reported from the Levant or Egypt, the northernmost living populations of this species (cf. Gray et al. 1999).

Fig. 22. A group of *Nycteris thebaica* (Geoffroy, 1803) roosting in a small cave in the Wadi Al Hasa near the Hammamat Borbatah resort (photo by A. Reiter).

Fig. 23. Wadi Al Hasa, Southern Highlands (photo by A. Reiter). Above a water stream in the wadi, *Hypsugo ariel* wad netted and foraging calls of *Rhinopoma cystops*, *Taphozous perforatus*, *T. nudiventris*, *Eptesicus bottae*, and *Tadarida teniotis* were recorded. In a small cave in the left wadi slope (visible on the left side of the picture), roosting group of *Nycteris thebaica* was discovered (see Fig. 22).

Al-Omari et al. (2000: 5–6) reported a record of *N. thebaica* from at Ar Raddass: "Two specimens (one male and one female) were collected with a butterfly net [...] while flying at low altitude". Al-Omari et al. (2000) also mentioned records of *Roussetus aegyptiacus*, *Taphozous nudiventris*, *Eptesicus bottae*, *Otonycteris hemprichii*, and *Tadarida teniotis*, made during the same survey at Ar Raddass. In the Wadi Al Hasa *Rhinopoma cystops*, *Taphozous perforatus*, *T. nudiventris*, *Eptesicus bottae*, *Hypsugo ariel*, and *Tadarida teniotis* were also documented along with *N. thebaica*.

Although *Nycteris thebaica* was found in the diet of owls in the Middle East (Pokines & Peterhans 1998, Obuch & Benda 2009), it has not been evidenced in the analysed owl pellets from Jordan.

Morphology. External and cranial dimensions of the Jordanian specimens of *Nycteris thebaica* examined are shown in Table 5. For the material examined see Records.

Feeding ecology. *Nycteris thebaica* is a medium-sized insectivorous and carnivorous bat applying the 'flycatching' and gleaning foraging strategies (Fenton & Thomas 1980, Aldridge 1990). Diet of this species was studied particularly in southern Africa, where it is reported to feed mostly on Orthoptera, Coleoptera, Hemiptera, and Lepidoptera (Fenton & Thomas 1980, LaVal & LaVal 1980, Bowie et al. 1999, Seamark & Bogdanowicz 2002). The 'flycatching' foraging strategy associated with consuming of the prey while hanging on a perch enables this relatively small bat to feed on a surprisingly large prey such as Scorpionida (Felten 1956) or frogs and fish (Seamark

Table 5. Basic biometric data on the examined samples of *Nycteris thebaica* (Geoffroy, 1803), *Rhinolophus ferrumequinum* (Schreber, 1774), and *R. clivosus* Cretzschmar, 1828. For abbreviations see pp. 192, 193

	Nycteris thebaica					*Rhinolophus ferrumequinum*					*Rhinolophus clivosus*				
	n	**M**	min	max	SD	n	**M**	min	max	SD	n	**M**	min	max	SD
LC	1	59				8	**73.5**	70	76	2.268	4	**59.0**	53	64	5.354
LCd	1	55				8	**40.0**	33	47	4.071	4	**32.8**	29	37	3.500
LAt	4	**45.58**	44.1	46.2	1.001	12	**57.55**	55.4	61.1	1.477	5	**48.62**	46.7	49.9	1.472
LAu	1	36.6				8	**25.93**	24.6	27.4	0.963	4	**23.13**	22.0	24.6	1.204
LaFE	1	9.5				8	**9.26**	9.1	9.5	0.177	4	**8.40**	8.0	8.7	0.316
LCr	3	**19.42**	19.14	19.75	0.307	7	**24.48**	23.88	24.98	0.358	3	**20.96**	20.42	21.33	0.480
LOc	3	**19.44**	19.05	19.75	0.356	7	**23.99**	23.38	24.52	0.363	3	**20.11**	19.64	20.40	0.409
LCc	3	**17.31**	16.88	17.77	0.445	7	**21.31**	20.53	22.01	0.443	3	**17.81**	17.41	18.04	0.348
LaZ	3	**11.04**	10.58	11.43	0.429	7	**12.55**	12.27	12.81	0.220	3	**10.02**	9.65	10.26	0.327
LaI	3	**4.68**	4.59	4.82	0.121	–	–	–	–	–	–	–	–	–	–
LaPO	3	**3.68**	3.56	3.81	0.125	7	**2.43**	2.18	2.65	0.143	4	**2.34**	2.08	2.54	0.211
LaInf	3	**4.55**	4.47	4.63	0.080	7	**6.29**	6.05	6.47	0.154	4	**5.39**	5.14	5.53	0.172
LaN	3	**8.24**	8.14	8.35	0.106	7	**9.62**	9.44	9.94	0.167	3	**8.26**	8.14	8.38	0.120
LaM	3	**7.42**	7.19	7.58	0.203	7	**10.63**	10.48	10.72	0.085	3	**9.22**	9.05	9.48	0.227
ANc	3	**6.64**	6.54	6.73	0.095	7	**7.37**	6.86	7.76	0.359	3	**6.20**	5.86	6.39	0.293
LBT	3	**3.66**	3.62	3.75	0.075	7	**3.88**	3.41	4.47	0.388	4	**3.44**	3.22	3.59	0.173
CC	3	**4.67**	4.51	4.88	0.189	7	**6.94**	6.52	7.36	0.278	3	**5.37**	5.23	5.52	0.145
M^3M^3	3	**7.13**	6.88	7.46	0.298	7	**9.05**	8.54	9.98	0.504	4	**7.46**	7.18	7.65	0.205
CM^3	3	**6.91**	6.76	7.15	0.210	7	**9.00**	8.62	9.24	0.212	3	**7.39**	7.26	7.48	0.117
LMd	3	**12.41**	12.13	12.69	0.280	7	**16.35**	16.02	16.67	0.242	4	**13.30**	13.07	13.56	0.261
ACo	3	**3.84**	3.69	3.97	0.142	7	**4.25**	4.08	4.41	0.125	4	**3.36**	3.18	3.57	0.166
CM_3	3	**7.21**	7.15	7.26	0.056	7	**9.72**	9.30	9.91	0.208	3	**7.96**	7.81	8.13	0.162

& Bogdanowicz 2002). In the Middle East, the diet of *N. thebaica* was studied by Feldman et al. (2000), who recorded Lepidoptera, Diptera and Coleoptera in the food of this bat in Palestine.

From Jordan, we analysed 15 pellets from two individuals collected in the Wadi Al Hasa. These bats fed especially on Mantodea (50.7% of volume), Orthoptera (48.0%), and Coleoptera (1.3%); no remnants of vertebrates were recorded. The diet composition of our samples from Jordan corresponds well with the results of previous diet analyses and also with the hypotheses concerning foraging behaviour of this species.

Rhinolophus ferrumequinum (Schreber, 1774)

Records. **New data**: I r b i d: ʿArjan [1], at a creek below the village, 12 July 2010: obs., det. & rec. 1 foraging ind. [1 echolocation recording]; – Dibbin, Dibbin Forest [2], system of underground spaces and corridors (Fig. 30), March and April–May 2004: coll. 2 ma (JUST unnumbered [A]; leg. M. Abed & Ibrahim), 11 April 2008: obs. 4 inds., 27 October 2008: obs. torpid 4 ma, 1 fa (coll. 1 m; NMP 92408 [S+A]), 14 July 2010: obs. 1 roosting ind., undated: coll. 1 fa (JUST unnumbered [A]; collector unlisted); – Kufranja [3], Iraq Al Wahaj Cave, 26 May 2009: found rest of 1 ind. (skull with a pair of mandibles) in *Strix aluco* pellet; – Mahna [4], Umm Al Iraq Cave, 13 July 2010: obs. 1 ind.; – Malka [5], an artificial cave below the village, 28 May 2009: found 1 ma (NMP 92562 [S+A]); – Tabaqat Fahl [6], small cave in the Roman nekropolis of Pella, 24 May 2009: obs. 2 inds., coll. 1 fa+j (NMP 92504 [S+A], 92505 [A]); – Zubiya, Zubiya Cave [7] (Fig. 34), 25 October 2008: obs. torpid & coll. 1 ms, 1 fa, 1 fs (NMP 92403, 92404 [S+A], 92405 [A]) in the cave, 24 May 2009: net. 1 ma, 1 ms (NMP 92506, 92507 [S+A]) at the cave entrance. – **Published data**: ʿA m m a n: village near Suelleh [= Suwaylih] [8], near Amman, house cellar, 20 October 1953: 1 m torpid (Harrison 1959a, 1964). – I r b i d: Irbid, Dibbine National Forest [2], cave, 11 m, 10 f (Qumsiyeh et al. 1986), cave, 20 November, hibernating inds., August, active inds. (Qumsiyeh et al. 1998); Dibbin, 15 December 1983 (Amr & Disi 1988), Dibbin National Park, big cave, 15 June 2006: 1 fa (Karatas et al. 2008); – Jerash [9], Roman ruins, a hole in the hillside below the Temple of

Zeus, 13 October 1953: large colony of several hundred inds., coll. 1 m, 4 f, 19 October 1953: coll. 2 m, 5 f (Harrison 1959a, 1964); Jerash, 22 November 1945: 2 m, 1 f (Harrison 1964); Jerash, 12 inds. (Harrison 1959b); Jerash, 43 inds. (Atallah 1977); – Khirbat Sa'ad [10], near Nadira, 1 m (Qumsiyeh et al. 1986); – Quwaylibah [11], 11 December 1991: 1 f [1 fa: JUST ZSA38 [A]; leg. A. Zoubi] (Qumsiyeh 1996, Qumsiyeh et al. 1998); – Tabqat Fahl [6] (Harrison & Bates 1991); – Zubiya forest [7], north Jordan, net. many inds. [= 11 May 1990: net. 4 ma] (Qumsiyeh et al. 1992). – NW Jordan (undef.): Zerka [= Zarqa'] River, 1886: 1 m (Felten et al. 1977, Nader & Kock 1983a).

Distribution. *Rhinolophus ferrumequinum* is a medium-frequent bat species in Jordan, twelve records sites are available from the Mediterranean biogeographical region (Fig. 24). Almost all records come from the Northern Highlands, i.e. from the Mediterranean arboreal zone; an exception is Tabaqat Fahl adjacent to the Jordan Valley (8 m b. s. l.) and its rather arid conditions perhaps represent the ecological limits for this bat in the Holy Land. *R. ferrumequinum* is the most common cave dwelling bat of Jordan among the Mediterranean faunal elements. In the territory north of the Zarqa' River, this species it is the second most common bat species (considering the number of record sites) after *Pipistrellus kuhlii*. The southern margin of the known Jordanian range of *R. ferrumequinum* lies at Suwaylih (Suelleh) in the ʿAmman region (cf. Harrison 1959a); however,

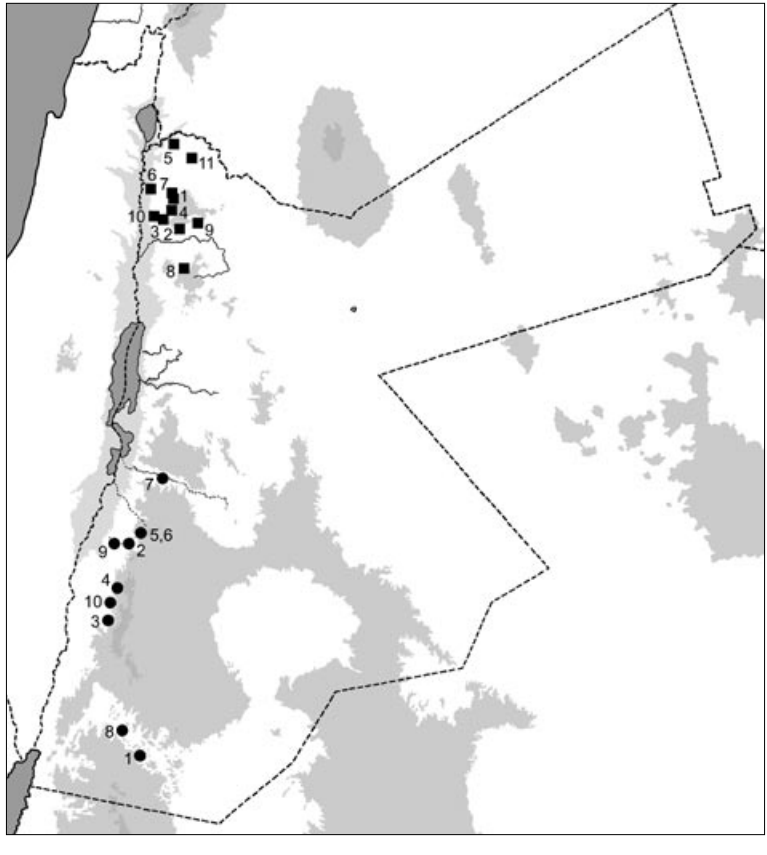


Fig. 24. Records of *Rhinolophus ferrumequinum* (Schreber, 1774) (squares) and *R. clivosus* (Cretzschmar, 1828) (circles) in Jordan.

this area most probably does not represent the southern ecological limit of the possible species occurrence, as suggested by the records in the Judean Hills of Palestine (Mendelssohn & Yom-Tov 1999: 87), where *R. ferrumequinum* lives southwards to ca. 31.5° N. This area lies some 45 km south of Suwaylih (cf. Harrison 1959a) and represents the southern margin of the species range in the Levant as well as the western part of the Middle East (see Harrison & Bates 1991).

The Jordanian range of *R. ferrumequinum* in the distribution and abundance of records well continues north and west of the known Syrian, Lebanese and Palestinian occurrence areas (Mendelssohn & Yom-Tov 1999, Benda et al. 2006, Horáček et al. 2008). The geographical triangle created by the records in Jordan well fits into the gap between the central Palestinian and SW Syrian records. In Syria, the range extends more to the east than in Jordan; a colony was found in the citadel of Bosra, near the northern Jordanian border. This record lies most eastwards in the Holy Land part of the species distribution, some 55 km to east of Jerash, the easternmost point of the *R. ferrumequinum* occurrence in Jordan (Harrison 1959a).

The records of *R. ferrumequinum* in Jordan come from a rather broad range of altitudes from 8 m b. s. l. to 1020 m a. s. l. (n=12) and the mean altitude (591.1 m) shows a preference of rather elevated sites (where only the Mediterranean habitats are available in the Holy Land). Although only two thirds of the records represent findings of bats in their roosts (n=8), the altitudinal preferences of the roost sites (range identical as in all sites; mean 652.0 m) are only slightly shifted up against the general preference of altitudes.

Field notes. In Jordan, *Rhinolophus ferrumequinum* was frequently recorded in its roosts, while only occasionally with the help of other techniques. Harrison (1959a) described a record from the area of Roman ruins in Jerash in 1953, when he found a large colony of several hundred individuals roosting in a hole in the hillside below the Temple of Zeus. However, later Qumsiyeh et al. (1992: 106) noted: "Large colonies of this species were present in the 1950s and early 1960s in Jerash [...] but were absent in the late 1970s." Qumsiyeh (1996) reported a finding of hibernating individuals (of an unspecified number) in the system of artificial underground spaces and corridors in the Dibbin Forest on 20 November (Fig. 30); we observed there five torpid solitary individuals in various rooms on 27 October, and two torpid bats in two rooms on 14 July. In the Zubiya Cave, a several hundred metres deep karstic cave within the Zubiya Forest northwest of Ajlun (Fig. 34), *R. ferrumequinum* was found more times; Qumsiyeh et al. (1992) reported many individuals netted there (in May 1990), we observed three torpid bats in this cave in late October and no bats in May (however, at the cave entrance we netted two individuals; Fig. 25). In a large tomb (ca. 15 m long and 2–3 m high) of the ancient nekropolis of Pella at Tabaqat Fahl, we observed two active adults on 24 May; one examined bat was a lactating female, carrying a nonvolant juvenile (LAt 25.4 mm = 43.8% of the mother's LAt 58.0 mm). This finding roughly conforms to those by Atallah (1977), Mendelssohn & Yom-Tov (1999), and Benda et al. (2006), who suggested the timing of births in *R. ferrumequinum* in the Levant to May/June. We found one torpid adult male in a spacious artificial cave (underground quarry?) at Malka in northernmost Jordan above the Yarmuk Valley on 28 May. Similarly, another torpid adult individual was observed in the Umm Al Iraq Cave at Mahna (Ajlun Mts.) on 13 July. The individuals of *R. ferrumequinum* were regularly found to roost torpid in the underground without any reference to a season or a group size of roosting bats.

Only once *R. ferrumequinum* was recorded by detection of ultrasound calls in Jordan, at a creek below the village of ʿArjan in the Ajlun Mts.; during this session, *Rhinopoma microphyllum*, *Pipistrellus pipistrellus*, and *P. kuhlii* were also recorded. Various other bat species were simultaneously documented from the roosts of *R. ferrumequinum* in Jordan. In the Zubiya Cave, a roosting group of *Rhinolophus euryale* was found on 25 October, while *Rhinolophus hippo-*

Fig. 25. A male of *Rhinolophus ferrumequinum* (Schreber, 1774) netted at the entrance to the Zubiya Cave near Ajlun (photo by A. Reiter).

sideros, *R. euryale*, *R. blasii*, *Myotis nattereri*, and *M. emarginatus* were also netted at the cave entrance on 25 May. In the underground system in the Dibbin Forest, *Rhinolophus hipposideros* and *R. euryale* were also found during two visits, in October 2008 and in July 2010. In or at the tombs and caves of the Tabaqat Fahl nekropolis, *Rhinopoma microphyllum*, *R. cystops*, and *Rousettus aegyptiacus*, perhaps also *Rhinolophus blasii* and *Myotis capaccinii*, were recorded along with *R. ferrumequinum*.

R. ferrumequinum was found in owl diet from one site in Jordan, a mandible pair was discovered in the pellet of *Strix aluco* collected in the Iraq Al Wahaj Cave at Kufranja. It made up 0.32% of all prey items of the tawny owl diet (0.94% of mammal items) from the locality (Table 17). In the Middle East, remains of *R. ferrumequinum* were found also in the diet of *Strix aluco* in Turkey (Obuch 1994), *Tyto alba* in Syria (Benda et al. 2006), and at several sites in the diet of *Bubo bubo* in Iran (Obuch unpubl.).

Morphology. External and cranial dimensions of the Jordanian specimens of *Rhinolophus ferrumequinum* examined are shown in Table 5. For the material examined see Records.

Feeding ecology. *Rhinolophus ferrumequinum* is a large bat seeking prey close to foliage, believed to take prey from the ground, hawking in open air and also hunting from perches (Norberg & Rayner 1987, Jones & Rayner 1989, Gaisler 2001a). Lepidoptera, Coleoptera, Diptera, and Hymenoptera are the most important food items in its European range (Jones 1990, Beck 1995, Flanders & Jones 2009).

Concerning the diet composition of *R. ferrumequinum* populations of southwestern Asia, data are available from Azerbaijan, Turkey and Syria. Rahmatulina (2005) recorded Coleoptera, Lepidoptera, Diptera, and Trichoptera to be the prevalent food items in Azerbaijan. Lepidoptera and Scarabaeidae dominated within the food samples of *R. ferrumequinum* analysed by Whitaker & Karataş (2009) in Turkey. Lepidoptera, Coleoptera (mostly Scarabaeidae) and Nematocera were found in the diet of *R. ferrumequinum* in Syria (Benda et al. 2006). Of Lepidoptera and Scarabaeidae, rather the larger representatives were taken. The presence of Solpugida in one sample recorded in Syria seems to prove ground gleaning in the species.

From Jordan, we analysed 44 feacal pellets from seven bats originating from three sites (Fig. 26). The most important prey categories in the diet of *R. ferrumequinum* were Lepidoptera, Coleoptera and Hymenoptera. Among Coleoptera, larger Scarabaeidae prevailed and among Hymenoptera, Formicoidea represented the most frequent portion. Of Lepidoptera, the large representatives were taken; their wingspans probably exceeded 30–35 mm. The detected diet composition of *R. ferrumequinum* in Jordan well corresponds to the data from other parts of the species distribution range.

Echolocation. We recorded only a single call sequence of *Rhinolophus ferrumequinum* in Jordan (see above). Due to a low quality of the recording, we measured only FMAXE, which was 81.1 kHz (Table 4). While practically identical or lower FMAXE values were recorded in the European populations of *R. ferrumequinum* (Russo & Jones 2002, Papadatou et al. 2008), Shalmon et al. (1993) and Mendelssohn & Yom-Tov (1999) reported the FMAXE values from Palestine somewhat higher (83–85 kHz). However, such high values of frequencies are typical rather for *Rhinolophus clivosus* (see below).

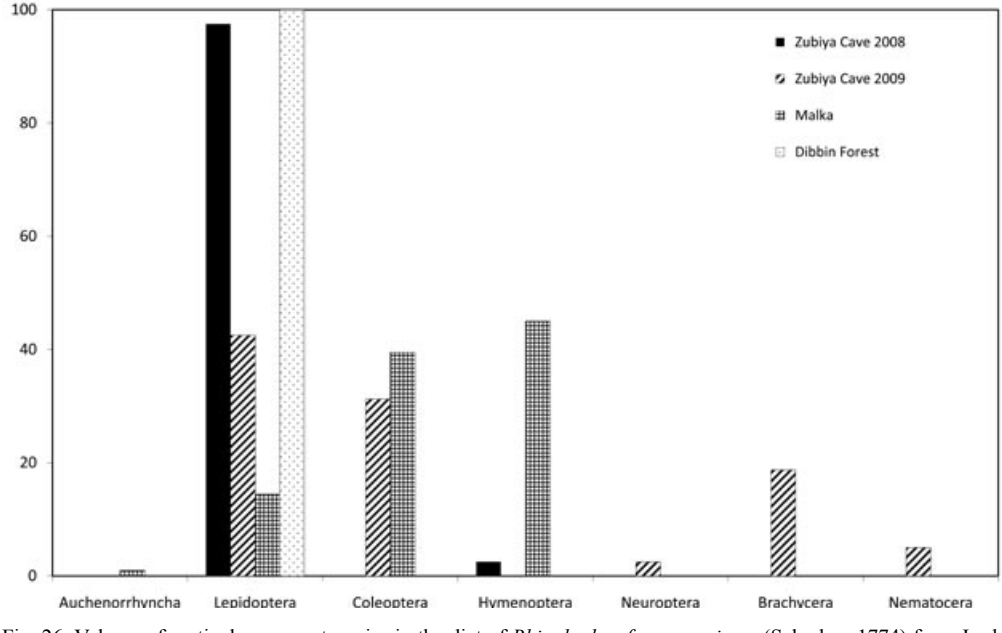


Fig. 26. Volume of particular prey categories in the diet of *Rhinolophus ferrumequinum* (Schreber, 1774) from Jordan. Material: Zubiya Cave 2008 – 12 pellets analysed from three bats; Zubiya Cave 2009 – eight pellets analysed from two bats; Malka – 20 pellets analysed from one bat; Dibbin Forest – 12 pellets analysed from one bat.

Records of ectoparasites. **Original data**: N y c t e r i b i i d a e: *Phthiridium biarticulatum*: 1 fa (UCPN) from 1 fs (NMP 92405), Zubiya, Zubiya Cave, 25 October 2008.

Comments on ectoparasites. Only one ectoparasite species was found on *Rhinolophus ferrumequinum* in Jordan, the bat fly *Phthiridium biarticulatum* Hermann, 1804. From this host species, the parasite was previously reported from Palestine, Lebanon and Turkey (Theodor & Moscona 1954, Kock 1989, Aktaş & Hasbenli 1994, Hasbenli 1997).

However, more insect parasites (Streblidae, Nycteribiidae, Ischnopsyllidae) could be expected to parasitise this bat in Jordan as they were found in the neighbouring countries of the Levant: *Brachytarsina flavipennis* Macquart, 1851, *Phthiridium bilobum* (Theodor et Moscona, 1954), *P. integrum* (Theodor et Moscona, 1954), and *Penicillidia dufourii* (Westwood, 1835) in Palestine (Theodor & Moscona 1954), *Nycteribia pedicularia* Latreille, 1805 and *N. schmidlii* Schiner, 1853 in Turkey (Hůrka 1972, Kock 1989, Hasbenli 1997), and *Rhinolophopsylla u. unipectinata* (Taschenberg, 1880) from Palestine, Lebanon and Turkey (Theodor & Moscona 1954, Lewis 1964, Aktaş 1987, 1990).

Rhinolophus clivosus Cretzschmar, 1828

Records. **New data**: A q a b a: Al Ghal [1], at a camel haunt (Fig. 88), 17 May 2009: det. 2 inds.; – Al Qurayqira, Wadi Ghuweir [2], 2.5 km E of Khirbet Feynan, at a water pool (Fig. 54), 13 May 2009: net. 1 ma (NMP 92425 [S+A]), det. & rec. calls of 1 ind. [1 echolocation recording]. – M a' a n: Ar Rajif, Jebel Masuda, Ain Amshit [3] (Fig. 95), 15 May 2009: net. 1 ms (NMP 92447 [S+A]), det. & rec. calls of 1 ind. [1 echolocation recording]; – Jabal Al Bayda [4], small cave in sandstone rocks ca. 2 km to S, 19 May 2009: obs. & rec. sounds of 3 inds., coll 1 faG, 1 fs (NMP 92495 [S+A], 92496 [A]). – T a f i l a: Dhana [5], at an artificial watering place for birds at the Rummana Camp (Fig. 44), 19 May 2009: det. 2 inds., 4 July 2010: det. 1 ind. [2 echolocation recordings]; – Dhana, Wadi Dhana [6] (Fig. 5), Mahjub Cave, 25 July 2000: coll. 1 ind. ad. s.i. (RSCN unnumbered [S+B]; leg. Mayas & M. Faqir); – Wadi Dharih [7], small cave under stones in the wadi, 8 July 2010: obs. a colony of ca. 20 inds., coll. 1 mj, 1 fj (NMP 92810, 92811 [A]). – **Published data**: A q a b a: Disa (Wadi Rum) [8] [= 31 May 1990: net. 1 ma] (Qumsiyeh et al. 1992); – Quaraiquira (Wadi Fidan) [9] [= 29 May 1990: net. 2 ma] (Qumsiyeh et al. 1992). – M a' a n: Petra [= Al Batra] [10], 2 inds. [coll. 1 ms, NMP 92843 [S+B], leg. P. Boye] (Boye 1983), hillside caves of old ruin (Disi & Hatough-Bouran 1999).

Distribution. *Rhinolophus clivosus* belongs to less frequent but not rare bat species in Jordan. Ten record sites are available from the southwestern portion of the country (Fig. 24), covering two biogeographical regions of Jordan (see above). Most of the records are associated with the Rift Valley, i.e. with the Dead Sea Basin and Wadi Araba; two records were made in the Rum Desert. Although the record sites are located in desert areas of Jordan, most of them are situated in rather elevated areas, characterised by relatively mild climate. Only two records come from the imminent proximity of harsh conditions of the Wadi Araba, although not from its lowest portions (Wadi Fidan at ca. 60 m a. s. l., Wadi Ghuweir at 308 m a. s. l.). In Palestine, numerous records are available from a rather broad area comprising the Negev and Judean Deserts and from the Arava Valley as southwards as Elat (Makin 1977, Yom-Tov et al. 1992a, Mendelssohn & Yom-Tov 1999, Korine & Pinshow 2004, Razgour et al. 2010).

In Palestine and Jordan, *R. clivosus* reaches the northern margin of its distribution range in Asia; this species is distributed in savannas and deserts of the eastern part of Africa from the Cape to the Nile Delta and in southern and western Arabia (Harrison & Bates 1991). The occurrence in the Holy Land is the northeasternmost projection of the whole species range along the Rift Valley. While in Jordan the northernmost record comes from near the southern edge of the Dead Sea (ca. 31° N), in Palestine the northernmost points of occurrence are known from the Judean Desert and Dead Sea basin at Ein Gedi (ca. 31° 30' N) (Mendelssohn & Yom-Tov 1999) and from the northern edge of the Dead Sea (ca. 31° 50' N) (Benda et al. 2008).

Fig. 27. An individual of *Rhinolophus clivosus* Cretzschmar, 1828 found in a pseudokarstic cave of the Wadi Dharih (photo by A. Reiter).

The records of *R. clivosus* in Jordan come from a rather broad altitude range of 60–1155 m a. s. l. (n=10) and the mean altitude (667.1 m) suggests a preference of rather elevated sites. Although less than a half of the records represent findings of bats in their roosts (n=4), the altitudinal preference of the roost sites (range 392–1093 m a. s. l.; mean 718.8 m) is only slightly shifted up against the general preference of altitudes. The actual altitudinal values thus conform with the above suggested preference of rather continental climatic conditions in the elevated desert areas. Such a pattern is similar to that registered in the Sinai (Benda et al. 2008).

Field notes. In Jordan, *Rhinolophus clivosus* was found in roosts only twice, both roosts were natural underground spaces, but relatively well lit inside. A colony of some 20 bats was observed in a cavity under downfallen boulders in the side slope of the Wadi Dharih, a tributary to Wadi Al Hasa. From this colony, a pair of volant juvenile bats was collected, a male and a female (Fig. 27). A small colony of at least three individuals was discovered in a some 10 m high and 20 m deep

sandstone cave at Jabal Al Bayda. From this group found on 19 May, two bats were examined; one was a pregnant female containing one foetus of the crown-rump length 20.9 mm, the other one was a subadult female. Mendelssohn & Yom-Tov (1999) suggested that parturitions occur in Palestine in May and this period conforms to our finding; however, the data gathered by these authors indicated that the birth terms cover a more extensive period than only one month.

R. clivosus was several times netted in Jordan; Qumsiyeh et al. (1992) reported individuals netted in Disa near the Wadi Rum and in the Wadi Fidan near Al Qurayqira. Near Al Qurayqira we netted a male above a small pool on a stream in the Wadi Ghuweir (Fig. 54), another individual was netted at a spring of the small oasis of Ain Amshit in the Jebel Masuda Mts. (Fig. 95). Foraging calls of *R. clivosus* were recorded at a camel haunt in the Al Ghal oasis in the Rum Desert (Fig. 88) and several times in the hilly area of the upper part of the Dhana Reserve, at artificial watering places for birds near the Rummana Camp (Fig. 44).

Various other bat species were registered along with *R. clivosus* in the sites of its occurrence. In the Wadi Ghuweir, *Eptesicus bottae*, *Pipistrellus pipistrellus*, *Otonycteris hemprichii*, and *Tadarida teniotis* were also found. *Pipistrellus pipistrellus* and *Plecotus christii* were netted in Ain Amshit, and *E. bottae* and *P. christii* were registered at the rocks near Jabal Al Bayda. In the Al Ghal oasis, *Eptesicus bottae*, *Hypsugo ariel*, *Otonycteris hemprichii*, *Barbastella leucomelas*, and *Plecotus christii* were netted. At the watering places for birds in the Dhana Reserve, *Myotis nattereri*, *Eptesicus bottae*, *Barbastella leucomelas*, *Plecotus christii*, and *Tadarida teniotis* were recorded. Apparently, *Plecotus christii* is the most frequent companion of *R. clivosus* among bats in Jordan. No rests of *R. clivosus* were evidenced in the analysed samples of owl pellets from Jordan.

Morphology. External and cranial dimensions of the Jordanian specimens of *Rhinolophus clivosus* examined are shown in Table 5. For the material examined see Records.

Feeding ecology. *Rhinolophus clivosus* is a medium-sized bat foraging especially around vegetation under tree level (Fenton et al. 1977, Whitaker et al. 1994). According to the data from southern Palestine and the Sinai, the species feeds predominantly on Coleoptera, Hymenoptera and Lepidoptera (Whitaker et al. 1994, Feldman et al. 2000, Benda et al. 2008). Fenton et al. (1977) found *R. clivosus* to feed particularly on Coleoptera in Rhodesia (Zimbabwe).

From Jordan, we analysed 23 feacal pellets from two bats originating from two sites (Fig. 28) and two contents of digestive tracts from one site. The main prey categories recorded from the samples of faeces were Lepidoptera, Coleoptera, and, rather surprisingly, Nematocera (Chironomidae). The latter diet item was not evidenced as an important prey of *R. clivosus* in the previous studies. However, the collected samples of faeces are too small to enable us to make any considerable conclusion. The digestive tract contents from the bats collected in Jabal Al Bayda contained almost entirely Lepidoptera (90–100% of volume) with a small proportion of Neuroptera (0–10%).

The recorded diet composition indicates that *R. clivosus* is a species with a quite flexible foraging strategy and broad trophic niche. Furthermore, the high volume of Nematocera in the diet is in most cases associated with the bats foraging around the water and using the aerial hawking foraging strategy, well known e.g. in European *Pipistrellus pygmaeus* (Leach, 1825) (cf. Bartonička et al. 2008). More thorough studies with extensive faeces collecting and simultaneous sampling of prey availability are vital for understanding trophic ecology in *R. clivosus*.

Echolocation. In total, we obtained four recordings of *Rhinolophus clivosus* calls from three sites (Fig. 29). Basic echolocation parameters are given in Table 4. Echolocation of this species was first described by Benda et al. (2008) from the Sinai. The FMAXE of Jordanian *R. clivosus* is on average by ca. 3 kHz lower than in the Sinaitic populations. In contrast, Shalmon et al. (1993) and Mendelssohn & Yom-Tov (1999) reported even higher FMAXE (90 kHz) from Palestine.

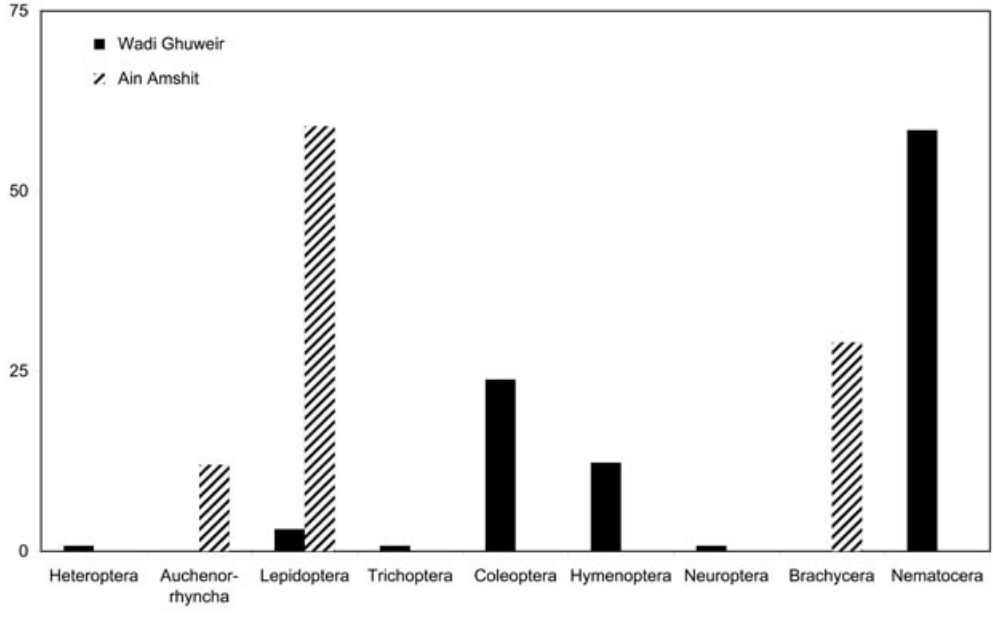


Fig. 28. Volume of particular prey categories in the diet of *Rhinolophus clivosus* Cretzschmar, 1828 from Jordan. Material: Wadi Ghuweir – 13 pellets analysed from one bat; Ain Amshit – 10 pellets analysed from one bat.

Records of ectoparasites. **Original data**: N y c t e r i b i i d a e: *Phthiridium biarticulatum*: 3 ma, 1 fa (UCPN) from 1 mj, 1 fj (NMP 92810, 92811), Wadi Dharih, 8 July 2010. – I s c h n o p s y l l i d a e: *Rhinolophopsylla unipectinata unipectinata*: 1 fa (UCPN) from 1 mj, 1 fj (NMP 92810, 92811), Wadi Dharih, 8 July 2010.

Comments on ectoparasites. Two ectoparasite species were recorded from *Rhinolophus clivosus* in Jordan, the bat fly *Phthiridium integrum* (Theodor et Moscona, 1954) and the flea *Rhinolopho-*

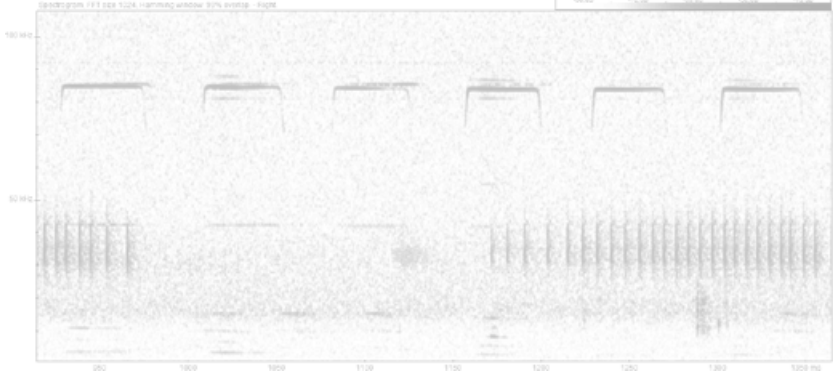


Fig. 29. Spectrogram of echolocation calls of *Rhinolophus clivosus* Cretzschmar, 1828; an individual foraging at an artificial watering place in the Dhana Reserve.

psylla u. unipectinata (Taschenberg, 1880). *P. integrum*, parasitising on bat genera *Rhinolophus* and *Hipposideros*, has a limited distribution range, stretching from the southern Levant (Palestine, Jordan) to Egypt and Yemen (Theodor 1967, 1975, Kock & Nader 1979, Amr & Qumsiyeh 1993). *R. u. unipectinata* belongs to cave dwelling bat parasites, well adapted to horseshoe bats (Sanborn & Hoogstraal 1953, Hopkins & Rothschild 1956, etc.). Our record represents the first evidence of this species from Jordan as well as from this bat host species.

Until now, only three insect ectoparasites were reported from *R. clivosus* from the Middle East, two nycteribiids *Phthiridium integrum* from Saudi Arabia and Yemen (Sanborn & Hoogstraal 1953, Kock & Nader 1979), *P. biarticulatum* Hermann, 1804 from Egypt (Hůrka 1964), and one streblid *Ascodipteron africanum rhinolophi* Jobling, 1958 from Yemen (Theodor 1968); five mites were reported from Yemen (Sanborn & Hoogstraal 1953); viz., *Trombicula knighti* Radford, 1954, *T. filamentosa* Radford, 1953, *T. brevitarsa* Radford, 1952, *Brennanella longispina* Radford, 1953, and *Labidocarpus nasicolus* Lawrence, 1938.

Rhinolophus hipposideros (Borkhausen, 1797)

Records. **New data**: A q a b a: Wadi Rum [1], small watering place at a bedouin camp 1 km east of the village, 24–25 October 2004: det. & rec. calls of 1–2 foraging inds. of *R.* cf. *hipposideros* (see Echolocation) [4 echolocation recordings]. – I r b i d: Bait Idis [2], Jesus' Cave, 15 July 2010: a mummy (NMP 92842 [S+Sk]); – Dibbin, Dibbin Forest [3], system of underground spaces and corridors (Fig. 30), 29 September 2004: coll. 2 ma (JUST unnumbered [A]; collector unlisted), October 2004: coll. 1 ma (RSCN unnumbered [A]; leg. M. Qarqaz & M. Abu Baker), 27 October 2008: obs. torpid 3 m, 3 fa, 2 fs (coll. 2 f; NMP 92409, 92410 [S+A]), 14 July 2010: obs. 7 roosting inds., undated: coll. 1 fa (JUST unnumbered [A]; leg. M. Abed & Ibrahim); – Marj Al Hammam [4], 11 May 2006: rests of 1 ind. (pair of complete mandibles) found in *Asio otus* pellets; – Zubiya, Zubiya Cave [5], at the cave entrance (Fig. 34), 24 May 2009: net. 1 ms, 2 faG (NMP 92508–92510 [S+A]). – **Published data**: I r b i d: Dibbine National Park [3], underground room, 20 November 1977: hib. 1 m (Qumsiyeh 1980); Dibbin National Park, 27 February 1981: 1 m (Amr & Qumsiyeh 1993); Irbid, Dibbine National Forest, cave, 1 m, 3 f (Qumsiyeh et al. 1985, 1986, 1998); Dibbine forest, small cave, 1 ind. [= 20 May 1990: net. 1 ma] (Qumsiyeh et al. 1992); – Zubiya forest in north Jordan [5], net. 2 inds. (Qumsiyeh et al. 1992).

Distribution. According to the records available, *Rhinolophus hipposideros* is a rare species in Jordan. Besides an atypical call recorded in the Wadi Rum (see Echolocation), only four localities have been registered, all situated in the Ajlun Mts. in the Mediterranean part of the country (Fig. 21). The concentration of the records in Jordan to the limited area of the Northern Highlands is rather surprising in this species. Although *R. hipposideros* is a species with a mostly Mediterranean distribution, it also reaches the Afrotropical region via the Rift from the Levant, over the Sinai and western Saudi Arabia to Sudan, Eritrea, Djibouti, and Ethiopia (see Benda et al. 2006 for a review). In Palestine, *R. hipposideros* occurs mainly in the Mediterranean zone north of the Dead Sea (Qumsiyeh 1996), although several records are also known from the central Negev Desert and the northern part of the Arava Valley (Nahal Zin, Ein Ziq, Berekhot Navit, Neot HaKikar, Ein Yahav, Matsok HaZinim Reserve) (Harrison 1964, Yom-Tov et al. 1992a, Korine & Pinshow 2004, Razgour et al. 2010). Because of the relative rarity of the species in the region (cf. Harrison & Bates 1991), the distribution of *R. hipposideros* in Jordan cannot be considered as appropriately known. Regarding the distribution pattern in Palestine (Mendelssohn & Yom-Tov 1999) and in the Sinai (Benda et al. 2008), this bat may be also found in more arid southern regions of Jordan. The recording of an unusual echolocation call in the Wadi Rum may suggest such distribution (see below).

The limited records of individuals of *R. hipposideros* in Jordan (only the northern Jordanian sites are considered here) come from a narrow range of altitudes from 509 m to 812 m a. s. l. (n=3), their mean altitude (676.0 m) suggests a preference of localities situated in upper altitudes, similarly as in other Mediterranean faunal elements (see e.g. *Rhinolophus ferrumequinum*). Such

Fig. 30. Dibbin Forest (Northern Highlands), an example of entrance to an artificial underground corridor (photo by P. Benda). In such underground spaces, which are very abundant in the Forest and substitute natural roost opportunities for bats in the area, a rich community of the Mediterranean bats was recorded, composed of *Rhinolophus ferrumequinum*, *R. hipposideros*, *R. euryale*, *Myotis nattereri*, and *M. emarginatus.*

a preference, however, may not be markedly shifted in the expected south-Jordanian range (see e.g. *Rhinolophus clivosus*).

Field notes. In Jordan, *Rhinolophus hipposideros* was recorded mostly in its roosts. The first Jordanian record was published by Qumsiyeh (1980: 37), who specified: "A male hibernating specimen was collected from an underground room in Dibbine National Park." Later, he added (Qumsiyeh 1996: 103): "I obtained hibernating individuals in Dibbine Forest on 20 November and active individuals on 9 August." We found individuals of *R. hipposideros* in this system of artificial underground spaces and corridors of the Dibbin Forest twice (Fig. 30); eight torpid bats were observed on 27 October, and seven active bats on 14 July (Fig. 31). In the Jesus' Cave, a relatively small karstic cave (ca. 50 m deep and 2–4 m high) in Bait Idis in the Ajlun Mts., we found a mummy of *R. hipposideros*. At the Zubiya Cave, a deep karstic cave within the Zubiya Forest in the Ajlun Mts. (Fig. 34), *R. hipposideros* was netted at two occasions; Qumsiyeh et al. (1992) reported nettings of two bats, we netted three individuals at the cave entrance on 24 May (two of them were pregnant females containing one foetus each, their crown-rump lengths were 15.6 and 16.3 mm, respectively). Benda et al. (2006) suggested occurrence of parturitions in Syria

Fig. 31. An individual of *Rhinolophus hipposideros* (Bechstein, 1797) roosting in an underground corridor of the Dibbin Forest (photo by A. Reiter).

in the period from the end of May to the first half of July; this is also in accordance with our findings from Jordan. During the netting session at the Zubiya Cave, *Rhinolophus ferrumequinum*, *R. euryale*, *R. blasii*, *Myotis nattereri*, and *M. emarginatus* were netted along with *R. hipposideros*. In the underground rooms of the Dibbin Forest, *Rhinolophus ferrumequinum* and *R. euryale* were also found (during both our visits), at other occasions also *Myotis nattereri* and *M. emarginatus* (Qumsiyeh 1980, Qumsiyeh et al. 1986, 1998). Unlike the situation known in other parts of the Middle East (cf. Benda et al. 2006), in Jordan the rests of *R. hipposideros* were found in owl diet; a mandible pair was found in a pellet of *Asio otus* collected at Marj Al Hammam. It made up 1.0% of all prey items (6.7% of mammal items) of the long-eared owl diet from the locality, and 0.09% of all prey items (0.55% of mammal items) of the analysed long-eared owl diet from Jordan (Table 17).

Morphology. External and cranial dimensions of the Jordanian specimens of *Rhinolophus hipposideros* examined are shown in Table 6. For the material examined see Records.

Feeding ecology. *Rhinolophus hipposideros* is a small bat hunting close to vegetation, where it captures startled insects in flight, it can also pick its prey directly from surfaces (Dietz et al. 2007). On bare surfaces of arid habitats, it hunts 5–20 cm above the ground (Benda et al. 2008). According to the wing morphology, *R. hipposideros* resembles rather foliage gleaners than aerial hawkers (Norberg & Rayner 1987).

The diet of *R. hipposideros* was studied mostly in Europe, where mainly Diptera (particularly the nematoceran Tipulidae), Lepidoptera, and Neuroptera (mostly Hemerobiidae) were found (McAney & Fairley 1989, Beck et al. 1989, Beck 1995). Lepidoptera also seem to prevail in the diet of the species studied in the Middle East. Diptera were found to be the second most important prey category recorded in Palestine and Turkey (Feldman et al. 2000, Whitaker & Karataş 2009). Hymenoptera, Homoptera, and Culicidae were observed to be consumed in the Sinai (Benda et al. 2008).

From Jordan, we analysed seven faecal pellets coming from two bats collected in the Dibbin Forest. The most important category of prey found in the *R. hipposideros* diet was Auchenorrhyncha (74.3% of volume), while Lepidoptera made up 25.7% of volume and no other diet item was found. Although the samples were rather limited, results of the analysis indicate that Auchenorrhyncha can play, at least locally and/or temporarily, quite an important role in the diet of *R. hipposideros*, even though the prey category was not found in notable amounts in the previous studies.

Echolocation. Four recordings containing 13 echolocation sequences (39 calls) of *Rhinolophus* sp. were obtained at a watering place in the Wadi Rum in 2004. Echolocation parameters were examined shortly after that field trip and stored in our database, but, unfortunately, the recordings

Table 6. Basic biometric data on the examined samples of *Rhinolophus hipposideros* (Borkhausen, 1797), *R. euryale* Blasius, 1853 and *R. blasii* Peters, 1866. For abbreviations see pp. 192, 193

	Rhinolophus hipposideros					*Rhinolophus euryale*					*Rhinolophus blasii*				
	n	**M**	min	max	SD	n	**M**	min	max	SD	n	**M**	min	max	SD
LC	5	**45.8**	43	48	1.924	18	**57.1**	54	60	1.862	14	**60.9**	58	64	1.730
LCd	5	**28.2**	26	30	1.789	18	**28.9**	25	32	2.541	14	**31.6**	29	35	1.697
LAt	10	**37.17**	35.6	38.0	0.754	20	**45.97**	44.3	48.2	1.098	17	**46.38**	42.6	48.1	1.152
LAu	5	**17.86**	17.4	18.4	0.385	18	**22.50**	21.2	23.6	0.651	14	**21.06**	20.2	21.9	0.508
LaFE	5	**7.14**	6.9	7.4	0.182	18	7**.02**	6.4	7.6	0.309	14	**8.56**	8.2	8.8	0.169
LCr	2	**16.16**	16.11	16.21		3	**18.52**	18.41	18.68	0.140	6	**19.67**	19.33	19.98	0.265
LOc	6	**15.26**	15.02	15.49	0.197	16	**18.07**	17.63	18.38	0.220	14	**19.17**	18.74	19.64	0.235
LCc	6	**13.53**	13.24	13.67	0.170	16	**15.69**	15.34	15.91	0.173	14	**16.77**	16.38	17.21	0.210
LaZ	6	**7.38**	7.16	7.63	0.171	16	**9.21**	9.05	9.39	0.110	14	**9.12**	8.83	9.22	0.107
LaI	6	**1.50**	1.37	1.59	0.087	16	**2.23**	2.02	2.38	0.100	14	**2.30**	1.94	2.51	0.150
LaInf	6	**3.56**	3.47	3.62	0.049	16	**4.55**	4.42	4.63	0.064	14	**4.68**	4.48	4.88	0.121
LaN	6	**6.38**	6.16	6.59	0.149	16	**8.13**	7.95	8.29	0.100	14	**8.38**	8.19	8.58	0.125
LaM	6	**7.36**	7.28	7.43	0.069	16	**9.26**	9.02	9.38	0.103	14	**9.09**	8.94	9.27	0.112
ANc	6	**4.71**	4.61	4.93	0.116	16	**5.78**	5.56	5.93	0.095	14	**6.16**	5.93	6.31	0.119
LBT	5	**2.46**	2.31	2.76	0.183	16	**3.18**	2.81	3.41	0.171	14	**3.46**	3.27	3.67	0.149
CC	6	**3.54**	3.45	3.64	0.068	16	**4.49**	4.31	4.86	0.128	14	**4.45**	4.24	4.64	0.109
M^3M^3	6	**5.35**	5.10	5.48	0.143	16	**6.44**	6.22	6.58	0.103	14	**6.45**	6.02	6.61	0.143
CM^3	6	**5.24**	4.98	5.42	0.188	16	**6.12**	5.93	6.31	0.103	14	**6.68**	6.46	6.81	0.102
LMd	6	**9.54**	9.24	9.75	0.187	16	**11.24**	11.02	11.51	0.147	14	**11.89**	11.53	12.14	0.167
ACo	6	**2.05**	1.83	2.18	0.143	16	**2.47**	2.36	2.61	0.070	14	**2.68**	2.58	2.87	0.083
CM_3	6	**5.45**	5.24	5.57	0.124	16	**6.49**	6.31	6.73	0.102	14	7**.01**	6.87	7.18	0.095

were lost later on and therefore we cannot provide the original spectrograms here. The echolocation parameters (see Table 4) conformed rather to *R. euryale* from Europe (Russo & Jones 2002, Papadatou et al. 2008); however, occurrence of this Mediterranean species in desert habitats of the site is quite unlikely, and particularly, there is a very large geographical distance to the nearest known sites of *R. euryale* in the Levant (ca. 300 km, see below). Another possible identification of these calls could be *R. mehelyi*, a bat with similar echolocation but somewhat higher values (FMAXE ca. 107 kHz; Salsamendi et al. 2005); however, its distribution range in the Levant has a similar character as that of *R. euryale* (see below).

We assigned the recorded echolocation calls tentatively to *R. hipposideros* unless the occurrence of one of the two above mentioned species is confirmed in southernmost Jordan (among horseshoe bats, only *R. clivosus* was evidenced in this area; Fig. 24). While the reported FMAXEs for *R. hipposideros* from Palestine were closer to those recorded in the Wadi Rum (ca. 104–108 kHz; Shalmon et al. 1993, Mendelssohn & Yom-Tov 1999), the single echolocation sequence analysed from the Sinai showed rather higher FMAXE in this context (107 kHz; Benda et al. 2008). Anyway, these values are below those known from the European populations of *R. hipposideros* (FMAXE ca. 106–115 kHz, mean 110.6 kHz; Papadatou et al. 2008) and could indicate a much wider / lower frequency range of *R. hipposideros* calls in extreme habitats in the southern part of its distribution range (cf. Benda et al. 2008). Such an unusually wide range of echolocation parameters could perhaps justify our tentative identification of the recording from the Wadi Rum; however, it certainly should be confirmed by a record of a live bat.

Record of ectoparasites. **Published data**: N y c t e r i b i i d a e: *Phthiridium integrum*: 1 ma, Dibbin National Park, 27 February 1981 (Amr & Qumsiyeh 1993).

Comments on ectoparasites. Only one ectoparasite of *Rhinolophus hipposideros* has been known from Jordan, a bat fly *Phthiridium integrum* (Theodor et Moscona, 1954) (Amr & Qumsiyeh 1993). This parasite is known to occur in the Arabic realm from Egypt to southern Arabia (see under *Rhinolophus clivosus*). However, three other insect ectoparasites were reported to parasitise *R. hipposideros* in the western Middle East, which thus could be expected also in Jordan; viz. a bat fly *Phthiridium bilobum* (Theodor et Moscona, 1954) in Palestine (Theodor & Moscona 1954, Theodor 1967) and two bat fleas *Ischnopsyllus octactenus* (Kolenati, 1856) and *Rhinolophopsylla u. unipectinata* (Taschenberg, 1880) in Turkey (Aktaş 1987, 1990).

Rhinolophus euryale Blasius, 1853

Records. **New data**: I r b i d: Dibbin [1], agricultural station, 30 September 2004: coll. 1 ma, 1 fa (JUST unnumbered [A]; collector unlisted); – Dibbin, Dibbin Forest [2], system of underground spaces and corridors (Fig. 30), 27 October 2008: obs. 1 active ind., 14 July 2010: obs. 2 roosting inds. (coll. 1 ma, NMP 92834 [S+A]); – Khashibah [3], 'Al Wardeh Cave' mine (Fig. 39), 26 May 2009: obs. a mixed colony of *R. euryale* and four other bat species of ca. 350 inds., coll. 1 ma, 1 faL (NMP 92524, 92525 [S+A]), 14 July 2010: obs. a colony of ca. 1000 inds. (of the medium-sized horseshoe bats) in the cave, net. 1 ma, 1 mj, 1 fj (coll. ma; NMP 92835 [S+A]); – Kufranja [4], Iraq Al Wahaj Cave, 26 May 2009: net. 3 ma, 3 ms, 5 fa, 3 fs (coll. 3 ma, 4 fa; NMP 92534–92539 [S+A], 92540 [A]); – Zubiya [5], Zubiya Cave (Fig. 34), 25 October 2008: obs. a colony of ca. 25 inds. (coll. 1 ma, 1 fa; NMP 92406, 92407 [S+A]), 24 May 2009: obs. ca. 25 inds. in the cave, net. 11 ma, 3 faL (coll. 2 m, 3 f; NMP 92511–92514 [S+A], 92515 [A]) at the cave entrance. – **Published data**: I r b i d: Dibbine Forest Park [2] (Qumsiyeh 1985); – Dibbine National Park, Mugharet el Wardeh [3], 2 inds. (Harrison & Bates 1991); – Jerash [6], 1 ind. (Harrison 1972, Atallah 1977); – Zubiya forest [5], artificial caves, 15 June 2006: 2 ma (Karatas et al. 2008).

Distribution. *Rhinolophus euryale* belongs to the rarest bat species in Jordan, only six record sites are known. The oldest mention from Jerash (Harrison 1972, Atallah 1977) has not been revised concerning the accurate identification of the specimen (DeBlase 1972, Harrison & Bates 1991),

therefore possible confusion with *R. mehelyi* cannot be excluded and the record is here listed only tentatively. All the records available are associated with the Ajlun Mts. within the Mediterranean biogeographical region (Fig. 32). This limited area of relatively abundant occurrence represents the southernmost spot of the species range in the Levant. In Palestine, verified records are known only from the northernmost region (Upper Galilee); DeBlase (1972) and Harrison & Bates (1991) re-identified historical records originating from Rosh haNiqra and Galilee, as belonging to *R. euryale* s.str., Mendelssohn & Yom-Tov (1999: 93) stated that "today it is known only from a very few caves in the Upper Galilee" (but they did not mark these records in the respective map). The specimens originating from more southern areas of Palestine (Herzliya, Solomon Quarries in Jerusalem, Cave of Adullam SW of Jerusalem), originally referred as *R. euryale* (Harrison 1964, Atallah 1977), were found to belong to *Rhinolophus mehelyi* (DeBlase 1972, Benda et al. 2006). The Jordanian range of the species distribution is thus a projection of some 90 km SSW from the continuous contemporary occurrence of *R. euryale* in the Levant (similar biogeographical pattern as in *Myotis blythii*, see below). In Upper Galilee the distribution continues from the relatively common occurrence in Lebanon (Tohmé & Tohmé 1985, Horáček et al. 2008).

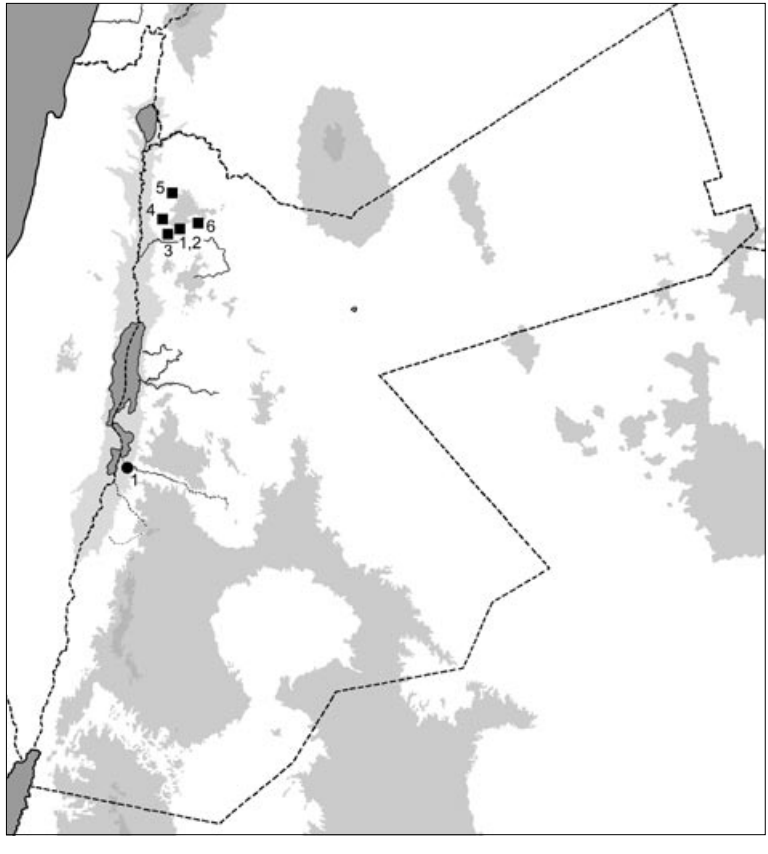


Fig. 32. Records of *Rhinolophus euryale* Blasius, 1853 (squares) and *R. mehelyi* Matschie, 1901 (circle) in Jordan.

Fig. 33. A group of *Rhinolophus euryale* Blasius, 1853 roosting in the Zubiya Cave near Ajlun (photo by A. Reiter).

The few records of *R. euryale* in Jordan come from a narrow altitude range of 580–812 m a. s. l. (n=6); the mean altitude (702.0 m) suggests a preference of mountainous sites. Since all known records most probably represent findings in and/or at roosts, these values are valid also for the preference of roosts.

Field notes. *Rhinolophus euryale* was found to roost at least at three sites in Jordan. Groups of some 25 active bats were observed in the Zubiya Cave (Figs. 33, 34), a large karstic space in the Ajlun Mts., on 24 May and 25 October, and a large group of about 120 active individuals was observed there on 15 July. Karatas et al. (2008) mentioned a record of two bats in artificial caves of the Zubiya forest in June 2006. In the extensive ancient mine named Al Wardeh Cave at Khashibah above the Zarqa' Valley (Fig. 39), a mixed colony of *R. euryale* and four other bat species of ca. 350 individuals was observed in May 2009, a year later a mixed colony of about 1000 bats was found there (July 2010). In a system of underground spaces and corridors in the Dibbin Forest (Fig. 30), two bats were collected on 30 September, one active individual observed on 27 October, and another two bats were observed on 14 July. At two sites *R. euryale* was netted, solely at entrances to underground spaces; at least 14 individuals at the Zubiya Cave on 24 May, and another 14 bats were netted at the spacious Iraq Al Wahaj Cave at Ajlun, a possible roost of a colony.

A number of other Mediterranean bat species were recorded along with *R. euryale*. Common roosts were documented in the Zubiya Cave, 'Al Wardeh Cave' mine, and in the Dibbin Forest; *Rhinolophus ferrumequinum* was found in the Zubiya Cave on 25 October, while *R. ferrumequinum*, *R. hipposideros*, *R. blasii*, *Myotis nattereri*, and *M. emarginatus* were netted there on 24 May. In the 'Al Wardeh Cave' mine, we observed a mixed colony including also *Rhinolophus*

blasii, *Myotis blythii*, *M. emarginatus* and *Miniopterus pallidus*. In the underground of the Dibbin Forest, *R. ferrumequinum* and *R. hipposideros* were also observed on 27 October and 14 July. At the entrance to the Iraq Al Wahaj Cave, *Rousettus aegyptiacus*, *Rhinolophus blasii*, *Myotis blythii*, *M. nattereri*, and *M. emarginatus* were also netted.

Reproduction of *R. euryale* was indirectly documented at three roosts; three lactating females (out of three females examined) were documented at the Zubiya Cave on 24 May, one lactating female at the 'Al Wardeh Cave' mine on 26 May, and four lactating females (of five adult females) were netted at the Iraq Al Wahaj Cave on 26 May.

Although *R. euryale* has been found in owl diet in some parts of the Middle East (Obuch 1994, Obuch unpubl.), no similar data are available from Jordan.

Morphology. External and cranial dimensions of the Jordanian specimens of *Rhinolophus euryale* examined are shown in Table 6. For the material examined see Records.

Feeding ecology. *Rhinolophus euryale* is a medium-sized bat hunting especially in dense vegetation (Gaisler 2001b, Siemers & Ivanova 2004). In Europe, it was found to feed especially on smaller Lepidoptera, followed by Tipulidae, Scarabaeidae and Neuroptera (Koselj 2002, Goiti et al. 2004). Concerning the Middle Eastern populations, *R. euryale* was found to feed particularly on Lepidoptera in Syria and Turkey (Benda et al. 2006, Whitaker & Karataş 2009).

Fig. 34. Entrance to the Zubiya Cave, a large karstic underground space in the Ajlun Mts., Northern Highlands (photo by P. Benda). In and/or at the cave, a rich Mediterranean bat community was registered, composed of *Rhinolophus ferrumequinum*, *R. hipposideros*, *R. euryale*, *R. blasii*, *Myotis nattereri*, and *M. emarginatus*.

From Jordan, we analysed one sample of faecal pellets from one bat netted at the Zubiya Cave and a content of one digestive tract from a bat collected in the Dibbin Forest. The digestive tract content was composed only of Lepidoptera, while the faecal sample contained 99.3% of Lepidoptera and the remaining consumed item was small Coleoptera (0.7%). Apparently, *R. euryale* seems to be a moth-eating specialist in all parts of its distribution range.

Records of ectoparasites. **Original data**: S t r e b l i d a e: *Brachytarsina flavipennis*: 1 fa (UCPN) from 1 ma (NMP 92834), Dibbin Forest, 14 July 2010. – N y c t e r i b i i d a e: *Phthiridium biarticulatum*: 2 ma, 2 fa (UCPN) from 1 ma, 1 fa (NMP 92406, 92407), Zubiya, Zubiya Cave, 25 October 2008.

Comments on ectoparasites. Two arthropod ectoparasites were found on *Rhinolophus euryale* in Jordan, bat flies *Brachytarsina flavipennis* Macquart, 1851 and *Phthiridium biarticulatum* Hermann, 1804. *B. flavipennis* is known to be hosted only by the bat genera *Rhinolophus* or *Miniopterus* (Palestine: Theodor & Moscona 1954, Theodor 1975). All species of the genus *Rhinolophus* are also principal hosts of *P. biarticulatum* (Hůrka 1964, Theodor 1967) and the distribution range of this host group corresponds with the range of this parasite (Hůrka 1964). In the western Middle East, *P. biarticulatum* was found on *R. euryale* also in Palestine and Turkey (Theodor & Moscona 1954, Theodor 1967, Hůrka 1972, Peterson et al. 1976, Kock 1989, Aktaş & Hasbenli 1994, Hasbenli 1997)

R. euryale (in its broader sense covering also *R. mehelyi*) from the western Middle East has been reported to host a wide range of ectoparasites, besides the two mentioned above (which were reported to parasitise also *R. mehelyi* in Turkey; Hůrka 1972, Aktaş & Hasbenli 1994) also six other bat fly species (Nycteribiidae, Streblidae) and one bat flea (Ischnopsyllidae). In Turkey, this bat was found to host *Nycteribia pedicularia* Latreille, 1805, *N. schmidlii* Schiner, 1853, *N. kolenatii* Theodor et Moscona, 1954, *N. vexata* Westwood, 1835, *Brachytarsina flavipennis* Macquart, 1851 (Peterson et al. 1976, Kock 1989, Aktaş & Hasbenli 1994, Hasbenli 1997), and *Rhinolophopsylla u. unipectinata* (Taschenberg, 1880) (Aellen 1960, Aktaş 1990), in Palestine *Penicillidia conspicua* Speiser, 1901 and *P. dufourii* (Westwood, 1835) (Theodor & Moscona 1954, Aktaş & Hasbenli 1994). Most of these species can be expected to parasitise also *R. euryale* in Jordan.

Rhinolophus mehelyi Matschie, 1901

Record. **Published data**: K a r a k: An-Naqah [1], 26 May 1992: 1 ind. (Qumsiyeh 1996, Qumsiyeh et al. 1998).

Distribution. According to the records available, *Rhinolophus mehelyi* is a very rare species in Jordan. Only one finding was made in the country (Fig. 32), in the area adjacent to the southern edge of the Dead Sea Basin (Qumsiyeh 1996). Such a limited evidence is rather surprising, since this species has a relatively broad distribution in the areas along the whole coast of the eastern Mediterranean Sea from Egypt to southern Turkey as well as in Mesopotamia (DeBlase 1972, Harrison & Bates 1991, Benda et al. 2006). In Palestine, *R. mehelyi* is more broadly distributed than its very similar and frequently misidentified congener *R. euryale* (see above). Mendelssohn & Yom-Tov (1999) brought four sites of occurrence from the Mediterranean northern portion of the country only, the Jordanian site thus represents the souhernmost known occurrence spot in the Levant. *R. mehelyi* has, however, the southern limit of its east-Mediterranean distribution range in northern Egypt and perhaps in the Sinai (Qumsiyeh 1985, Benda et al. 2008), therefore, it could be also found in the southern and more arid parts of the Holy Land. The Jordanian record comes from the arid part of the country from the altitude of around 375 m b. s. l. However, such an extreme locality can hardly document a general altitudinal and/or habitat preferences of the species in the Holy Land.

Rhinolophus blasii Peters, 1866

Records. **New data**: ʻA m m a n: Iraq Al Amir [1], artificial caves (Fig. 3), 10 May 2009: net. 1 ma (NMP 92412 [S+A]). – A q a b a: Al Qurayqira, Wadi Ghuweir [2], at Khirbet Feynan, at the wadi wall, 14 May 2009: found dead 1 ind. s.i. (NMP 92429 [S+Sk]). – I r b i d: Khashibah [3], ʻAl Wardeh Caveʼ mine (Fig. 39), 26 May 2009: obs. a mixed colony of *R. blasii* and four other bat species of ca. 350 inds., coll. 2 faL (NMP 92526, 92527 [S+A]), 14 July 2010: obs. a colony of ca. 1000 inds. (of the medium-sized horseshoe bats) in the cave; – Kufranja [4], Iraq Al Wahaj Cave, 26 May 2009: net. 4 ma (coll. 3 m; NMP 92541–92543 [S+A]); – Malka [5], Wadi Al Kurasi, 26 October 2008: det. & rec. call of 1 ind. [1 echolocation recording]; – Zubiya, Zubiya Cave [6], at the cave entrance (Fig. 34), 24 May 2009: net. 7 ma (coll. 3 m; NMP 92516–92518 [S+A]). – M a' a n: Ash Shawbak, Ash Shawbak Castle [7], undeground corridor, 20 October 2008: obs. a colony of 20 inds. (coll. 2 ma, 1 fa, 2 fs; NMP 92387–92390 [S+A], 92391 [A]), 19 May 2009: obs. 1 ind., 7 July 2010: obs. 5 inds. (incl. 2 volant juv.). – **Published data**: ʻA m m a n: Amman (quoted by Amr 2000 and Amr et al. 2004 as reported originally by Qumsiyeh et al. 1986, but these authors did not report this record); – Madaba [8], 1 ind. (Qumsiyeh et al. 1992). – I r b i d: Irbid, Jerash [9], Jerash Refugee Camp, Mogharet Al-Roum Cave, 8 October 1976: colony of some 200 inds., coll. 6 f, 15 October 1976: 1 f obs. & coll. (Qumsiyeh 1980, Qumsiyeh et al. 1998), 1 m, 2 f (Qumsiyeh et al. 1986); – Jordan Valley, Tabqat Fahl [10], 5 f (Qumsiyeh et al. 1986); – Zubiya forest [6], north Jordan, net. inds. [= 11 May 1990: net. 2 ma] (Qumsiyeh et al. 1992), Zubiya forest, artificial caves, 15 June 2006: 2 ma (Karatas et al. 2008). – K a r a k: Al Karak [11] [1 fa, 10 November 1994, Sol, Karak (JUST 296 [A]; collector unlisted)] (Amr 2000). – M a' a n: Ash Shawbak [12] [secondary school], 1992: 1 f [fs (JUST unnumbered [A]; collector unlisted)] (Qumsiyeh

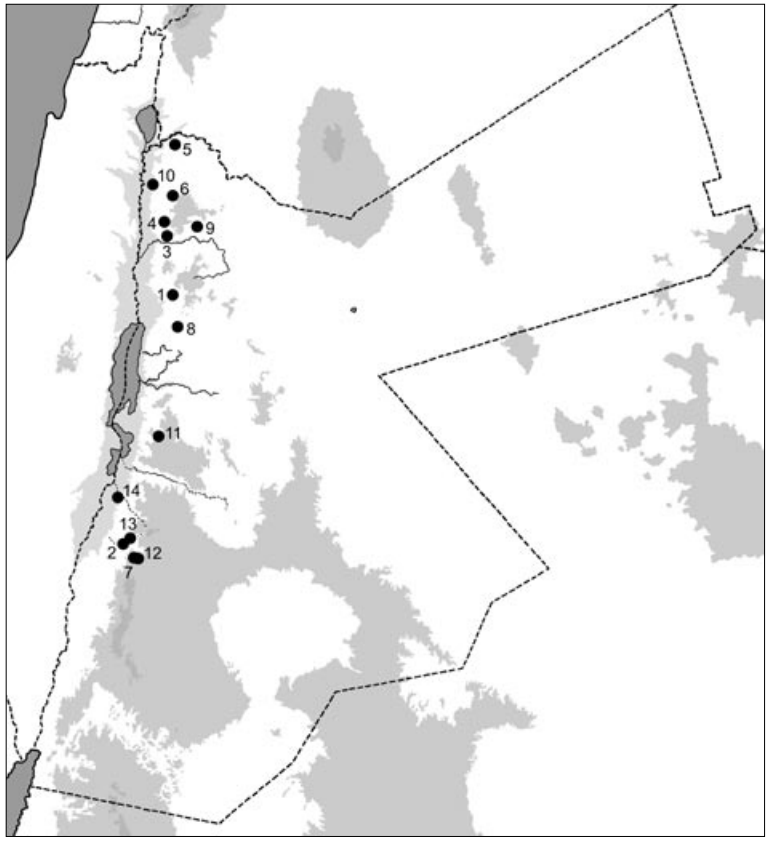


Fig. 35. Records of *Rhinolophus blasii* Peters, 1866 in Jordan.

Fig. 36. Ash Shawbak Castle, Southern Highlands (photo by A. Reiter). In the underground corridors of the castle, roosting individuals of *Rhinolophus blasii*, *Myotis nattereri* and *Plecotus christii* were found.

1996, Qumsiyeh et al. 1998). – T a f i l a: Karat, 5 km NNE Feinan [13], El Mata Cave, a colony of about 30 inds., coll. 9 m, 5 f (Qumsiyeh et al. 1986) = Wadi Finan, 9 February 1981 (Amr & Disi 1988); – Wadi Khanzaireh (Wadi Araba) [14], 9 February 1981: 2 m (Amr & Qumsiyeh 1993).

Distribution. *Rhinolophus blasii* belongs to medium-frequent bat species of Jordan, altogether 14 record sites are available from the western portion of the country more or less adjacent to the Rift Valley (Fig. 35), covering two biogeographical regions of Jordan (Mediterranean and Irano--Turanian regions). According to the number of records, *R. blasii* represents the most common and most widespread *Rhinolophus* species in Jordan. The records are available from the Mediterranean habitats of the northwestern areas of the country, from mountainous parts of southern Jordan, from the areas adjacent to the relatively fertile but hot Jordan Valley and also the arid Wadi Araba. *R. blasii* thus represents a bat species showing one of the widest ranges of habitats and broad ecological plasticity concerning the landscape variety of the Holy Land.

In Palestine, the records of *R. blasii* are available only from the Mediterranean zone of the country (Mendelssohn & Yom-Tov 1999), the southernmost record comes from Hebron (Tristram 1884). The Jordanian distribution thus represent the southermost extent of the Levantine part of the species distribution range. In northern Palestine (Upper Galilee) the distribution continues from the known occurrence in the NE Mediterranean arboreal zone – Lebanon, Syria and Cyprus (Benda et al. 2006, 2007, Horáček et al. 2008). In comparison with other parts of the Levantine range, density and abundance of the records within its Jordanian part seem to be the highest – comp. the data by Mendelssohn & Yom-Tov (1999), Benda et al. (2006, 2007), and Horáček et al. (2008). Spots of occurrence of *R. blasii* are known also from southern Arabia (Harrison & Bates 1991) (as well as from eastern and southern Africa, see Csorba et al. 2003), however, communication between south-Arabian and Levantine populations (or the known occurrence spots, respectively) is rather uncertain.

The records of *R. blasii* in Jordan come from a very broad altitude range –250–1340 m a. s. l. (n=14), however, the mean altitude (599.9 m) suggests a preference of rather elevated sites. A half of the records represents findings of bats in or at their roosts (n=7), the altitudinal preference of the roost sites (range 515–1340 m a. s. l.; mean 718.8 m) is shifted up against the general preference of altitudes. It suggests roost preference for rather continental climatic conditions in the elevated areas, both in the Mediterranean and arid zones.

Field notes. *Rhinolophus blasii* was found almost solely in or at its roosts in Jordan. Qumsiyeh (1980: 37) described the finding from: "a cave locally known as Mogharet Al-Roum, Jerash Refugee Camp [...]. The cave contained some 200 restless bats [...], just a week later, only one bat was present". Later, Qumsiyeh et al. (1998: 279) specified these findings: "We found many individuals (30–40[sic!]) in a visit to Magharat al Roman near the Jerash refugee camp on 8 October 1976. All observed or collected individuals were female. On October 15, only 3 bats were observed, and on 1 May 1977 no bats were in the cave." Another cave finding was reported by Qumsiyeh et al. (1986: 141), who noted: "At El Mata Cave, located 5 km NNE Feinan, near Wadi Araba,

Fig. 37. An individual of *Rhinolophus blasii* Peters, 1866 roosting in an underground corridor of the As Shawbak Castle (photo by A. Reiter).

contained colony of about 30 bats." We found a colony of *R. blasii* roosting in an underground corridor with spring in the As Shawbak Castle in the Southern Highlands (Fig. 36); some 20 semi-torpid individuals were found there on 20 October 2008, one active individual on 19 May 2009 (Fig. 37) and five active bats on 7 July 2010. In the extensive ancient mine of 'Al Wardeh Cave' at Khashibah above the Zarqa' Valley (Fig. 39), a mixed colony of *R. blasii* and four other bat species of ca. 350 individuals was observed in May 2009, a mixed colony of about 1000 bats was found there in July 2010. In a secondary school in the Ash Shawbak town, a subadult female was found in 1992 (cf. Qumsiyeh 1996, Qumsiyeh et al. 1998). We netted four individuals of *R. blasii* at the entrance to the Iraq Al Wahaj Cave above Kufranja in the Ajlun Mts., and three bats at the entrance to the Zubiya Cave (Fig. 34), northwest of Ajlun. Qumsiyeh et al. (1992) reported netting of several individuals in the Zubiya forest.

Numerous bat species were registered along with *R. blasii* in the sites of its occurrence. In the Al Wardeh Cave mine the observed large colony was a mixture composed of *Rhinolophus blasii*, *R. euryale*, *Myotis blythii*, *M. emarginatus*, and *Miniopterus pallidus*. At the Zubiya Cave, *Rhinolophus ferrumequinum*, *R. hipposideros*, *R. euryale*, *Myotis nattereri*, and *M. emarginatus* were also netted, while at the Iraq Al Wahaj Cave, *Rousettus aegyptiacus*, *Rhinolophus euryale*, *Myotis blythii*, *M. nattereri*, and *M. emarginatus* were recorded. In the underground corridors of the Ash Shawbak Castle, we observed also *Myotis nattereri* and *Plecotus christii*. In the Wadi Ghuweir, where a mummy of *R. blasii* was discovered to hang on the wadi wall, *Rhinolophus clivosus*, *Eptesicus bottae*, *Pipistrellus pipistrellus*, *Otonycteris hemprichii*, and *Tadarida teniotis* were also recorded.

Only indirect observations of *R. blasii* reproduction were documented in Jordan; two lactating females were collected in the Al Wardeh Cave mine on 26 May and two volant juveniles (out of five bat observed) were found in the Ash Shawbak Castle on 7 July.

Although *R. blasii* has been found in owl diet in Palestine (Dor 1947), no similar data are available from Jordan.

Morphology. External and cranial dimensions of the Jordanian specimens of *Rhinolophus blasii* examined are shown in Table 6. For the material examined see Records.

Feeding ecology. *Rhinolophus blasii* is a medium-sized bat with agile flight, catching its prey close to vegetation (Dietz et al. 2007), flight experiments showed its ability to pick up the prey from the ground (Siemers & Ivanova 2004). The diet of *R. blasii* was studied in the Balkans (Dietz et al. 2007) and southern Africa (Whitaker & Black 1976), the species was found to feed almost entirely on Lepidoptera.

From Jordan, we studied seven faecal pellets collected from a bat netted in the Wadi As Sir, 32 pellets from three bats netted at the Zubiya Cave, and content of one digestive tract from a bat collected in the Ash Shawbak Castle. The pellet samples from the Wadi As Sir contained Lepidoptera (100% of volume) and the samples from the Zubiya Cave included Lepidoptera (98.5%) and Coleoptera (1.5%). The examined digestive tract contained only Lepidoptera. These data correspond well with the results of previous studies, *R. blasii* seems to be a moth-eating specialist. However, the diet of this species has been studied only insufficiently and more data covering the whole distribution range and activity season are therefore necessary to test such hypothesis.

Echolocation. We obtained a single echolocation sequence of *Rhinolophus blasii* calls from one locality (Table 4). Due to its low quality we measured just FMAXE, which was 93.4 kHz. This value fully corresponded with the data given for both the European (Russo & Jones 2002, Papadatou et al. 2008) and Middle Eastern populations (Shalmon et al. 1993, Mendelssohn & Yom-Tov 1999).

Records of ectoparasites. **Published data**: S t r e b l i d a e: *Brachytarsina flavipennis*: 2 inds. from 2 m, Wadi Khanzaireh (Wadi Araba), 9 February 1981 (Amr & Qumsiyeh 1993). – N y c t e r i b i i d a e: *Phthiridium biarticulatum*: 2 inds. from 2 m, Wadi Khanzaireh (Wadi Araba), 9 February 1981 (Amr & Qumsiyeh 1993).

Comments on ectoparasites. Two ectoparasite species were found to be hosted by *Rhinolophus blasii* in Jordan, the bat flies *Brachytarsina flavipennis* Macquart, 1851 and *Phthiridium biarticulatum* Hermann, 1804 (Amr & Qumsiyeh 1993). Both fly species were found in the southern part of the distribution range of *R. blasii* in Jordan. However, both these parasites were collected from other hosts also in the northern part of the *R. blasii* Jordanian range, one even from the same roost as of *R. blasii* (Zubiya Cave, see under *Rhinolophus ferrumequinum* and *R. euyale*). From the Middle East, *B. flavipennis* was reported to parasitise *R. blasii* also in Palestine and Yemen (Theodor & Moscona 1954, Jobling 1958), while *P. biarticulatum* only in Palestine (Theodor & Moscona 1954, Theodor 1967).

Some other insect ectoparasites were reported to parasitise *R. blasii* in the western Middle East, some of them could be certainly expected also in Jordan; viz. nycteribiids *Penicillidia conspicua* Speiser, 1901 and *P. dufourii* (Westwood, 1835) from Palestine (Theodor & Moscona 1954), *Phthiridium integrum* (Theodor et Moscona, 1954) and *Penicillidia fulvida* (Bigot, 1885) from Yemen (Sanborn & Hoogstraal 1953); a streblid *Ascodipteron africanum rhinolophi* Jobling, 1958 from Yemen (Jobling 1958); and an ischnopsillid *Rhinolophopsylla unipectinata* (Taschenberg, 1880) from Yemen (Sanborn & Hoogstraal 1953).

Asellia tridens (Geoffroy, 1813)

Records. **New data**: M a' a n: Al Batra [1], Wadi An Numayr, 24 September 2005: found rest of 1 ind. (mandible) in *Strix butleri* pellets. – T a f i l a: Al Qurayqira [2], Ratiyah, 8 August 2000: coll. 1 ind. juv. s.i. (RSCN unnumbered [S+B]; leg. Mayas & M. Faqir). – **Published data**: K a r a k: An-Naqah near Ghor as Safi [3], 26 May 1991: 1 f (Qumsiyeh 1996, Qumsiyeh et al. 1998). – M a' a n: Petra [= Al Batra] [1], caves in the western arid areas (Disi & Hatough-Bouran 1999).

Distribution. Considering the available findings, *Asellia tridens* is a rare species in Jordan, only three record sites are available from arid areas adjacent to the northern part of the Wadi Araba (Fig. 38), from the Irano-Turanian and Sudanian Penetration biogeographical regions. With the exception of the records from Al Batra (Petra), represented by the finding of an osteological remain in owl pellet and a rather vague mention of (possible?) occurrence by Disi & Hatough-Bouran (1999), the two actual findings of bats originate from desert habitats of low-lying wadis leading to the Wadi Araba. Such a limited number of records of this desert dweller in Jordan is surprising. In the neighbouring Palestine, *A. tridens* seems to be rather common bat – Mendelssohn & Yom-Tov (1999) marked twelve record sites along the whole Rift Valley in Palestine plus several sites from the Mediterranean zone. Similarly, *A. tridens* belongs to frequently found bats in Syrian Mesopotamia (Benda et al. 2006, Shehab et al. 2007). Anyway, because of the unexpected rarity of the species, the distribution of *A. tridens* in Jordan cannot be considered as appropriately known.

A. tridens is a Saharo-Sindian element that occurs in a broad belt of desert habitats from West Africa and the Maghreb to southern Pakistan (Kock 1969), its occurrence in the Holy Land represents one of projections northwards from this continuous range, which reaches its northern margin in northern Palestine and SW Syria (Mount Hermon) (Mendelssohn & Yom-Tov 1999). The Jordanian occurrence spot thus represents the eastern margin of the continuous Levantine range, delimited by the Rift. However, since an abundant and well prospering population was documented in the isolated desert oasis of Tadmor (Palmyra) in central Syria (Benda et al. 2006), there still remains a possibility that an overlooked population of *A. tridens* occurs in some oasis of eastern Jordan.

The limited records of individuals of *A. tridens* in Jordan come from a wide range of altitudes, at 375 m b. s. l. and 250 m a. s. l. (n=2), their mean altitude (–62.5 m) indicates a preference of localities situated in very low altitudes, similarly as in other desert-dwelling faunal elements (see e.g. the species of the genera *Taphozous*).

Field notes. Similarly as in Mesopotamia (Nader 1969, Benda et al. 2006, Shehab et al. 2007) and Egypt (Goodman 1990), remains of *Asellia tridens* were recorded in owl pellets also in Jordan; a mandible was found in a pellet of *Strix butleri* collected in the Wadi An Numayr within the monument of Al Batra (Petra). It made up 0.25% of all prey items (0.93% of mammal items) of the Hume's owl diet from the locality, and 0.09% of all prey items (0.22% of mammal items) of the analysed Hume's owl diet from Jordan (Table 17).

Myotis blythii (Tomes, 1857)

Records. **New data**: I r b i d: Khashibah [1], 'Al Wardeh Cave' mine (Fig. 39), 26 May 2009: obs. a mixed colony of *M. blythii* and four other bat species of ca. 350 inds., coll. 1 ma, 1 faG, 1 faL+fj (NMP 92528–92530 [S+A], 92531 [A]), 14 July 2010: obs. ca. 10 inds. in the cave, net. 1 mj, 1 fa, 1 fj (coll. fa, NMP 92836 [S+A]); – Kufranja [2], Iraq Al Wahaj Cave, 25 October 2008: found rest of 1 ind. (right mandible) in *Strix aluco* pellet, 26 May 2009: net. 4 ma, 3 ms, 1 faL, 3 faG, 6 fs (coll. 3 ma, 3 fa; NMP 92544–92546, 92548, 92549 [S+A], 92547 [A]).

Distribution. *Myotis blythii* is a bat species reported here for the first time from Jordan, although its occurrence in the country was expected (Qumsiyeh et al. 1992). It was documented from two sites situated in the Ajlun Mts. in the northwestern part of the country (Fig. 38), from the Mediterranean biogeographical region. Thus, *M. blythii* can be considered a very rare species among the Jordanian bat fauna. The limited area of known occurrence represents the southernmost spot of the species range in the Levant. In Palestine, this bat is very rarely found, its verified records are known only from the northern part of the country, the southernmost records are known from the Carmel Ridge and the Yizre'el Valley (Mendelssohn & Yom-Tov 1999). The Jordanian occurrence spot thus represents a projection of some 40 km SSW from the continuous Mediterranean occurrence of *M. blythii* in the Levant. In northern Palestine (Galilee, Yizre'el Valley) the distribution of *M. blythii* continues from the relatively common occurrence in Lebanon (Horáček et al. 2008, 2009, own unpubl. data), western Syria (Benda et al. 2006) and Turkey (Benda & Horáček 1998).

The two known records of *M. blythii* in Jordan come from a very narrow range of altitudes, from the localities situated at 665 m and 741 m a. s. l. Both sites are underground roosts (natural cave and ancient mine) of colonies, their positions indicate a preference of elevated localities, similarly as in other Mediterranean faunal elements in Jordan.

Field notes. *Myotis blythii* was recorded in Jordan at two sites, probably both representing colony roosts. A large colony was documented in the extensive ancient mine of Al Wardeh Cave at Khashibah above the Zarqa' Valley (Figs. 39, 40); a mixed colony of five bat species incl. *M. blythii* numbering some 350 individuals was observed in May 2009, and about 1000 bats were found there in July 2010 – at least ten bats were identified as *M. blythii*. At the latter occasion, three individuals were netted at the mine entrance (Fig. 41), another 17 individuals were netted at the entrance to the spacious Iraq Al Wahaj Cave above Kufranja in the Ajlun Mts. In the Al Wardeh Cave mine, *Rhinolophus euryale*, *R. blasii*, *Myotis emarginatus*, and *Miniopterus pallidus* were recorded along with *M. blythii*, while at the Iraq Al Wahaj Cave, *Rousettus aegyptiacus*, *Rhinolophus euryale*, *R. blasii*, *Myotis nattereri*, and *M. emarginatus* were found.

Two females collected in the 'Al Wardeh Cave' mine on 26 May were breeding, one female was lactating and carrying a nonvolant juvenile (LAt 37.0 mm, i.e. 63.4% of the mother's LAt 57.8 mm), the other female was pregnant, containing a foetus of the crown-rump length of 20.0 mm.

Out of ten females netted on the same day at the Iraq Al Wahaj Cave, one was lactating and two were pregnant; they contained one foetus each, the foetal crown-rump lengths were 24.4 and 25.1 mm, respectively. These data suggest that parturitions in Jordan occur in late May and/or early June. This evidence conforms to the findings from Turkey (Aşan Baydemir & Albayrak 2006), where pregnant females were recorded in May and June.

Similarly as in other parts of the Middle East, where *M. blythii* was found in the diet of at least three owl species (Nadachowski et al. 1990, Obuch 1994, 2010, Benda & Horáček 1998, Benda et al. 2006, Obuch & Benda 2009, Obuch unpubl.), it was detected in owl diet also in Jordan. A right mandible was recorded in a pellet of *Strix aluco* collected in the Iraq Al Wahaj Cave at Kufranja (where most probably also a colony of this bat roosts); it made up 0.64% of all prey items (1.5% of mammal items) of the tawny owl diet from the sample, and 0.32% of all prey items (0.94% of mammal items) of the analysed tawny owl diet from Jordan (Table 17).

Morphology. External and cranial dimensions of the Jordanian specimens of *Myotis blythii* examined are shown in Table 7. For the material examined see Records.

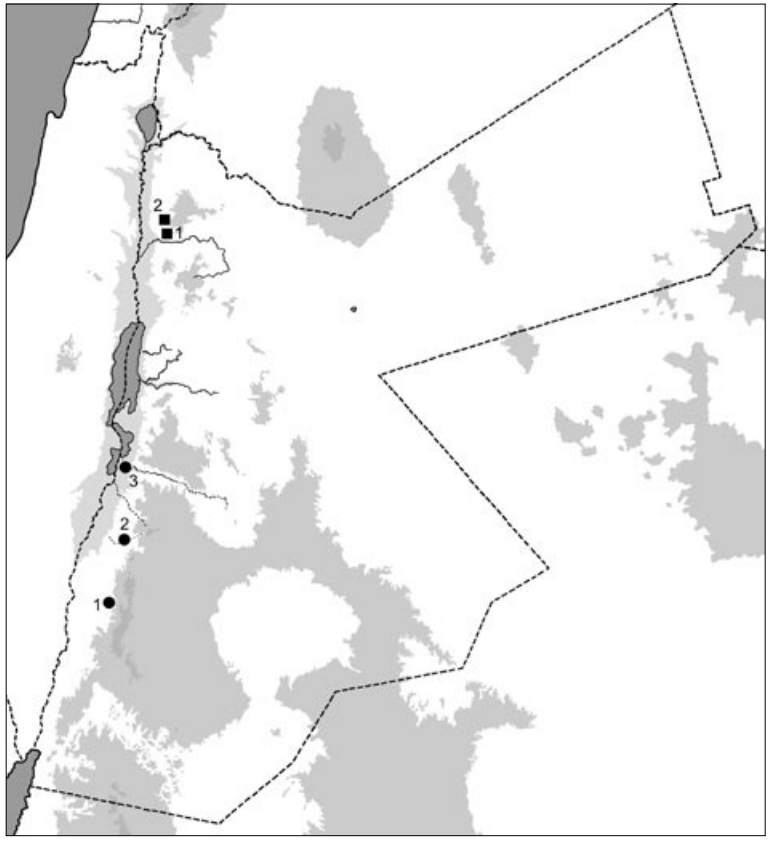


Fig. 38. Records of *Asellia tridens* (Geoffroy, 1813) (circles) and *Myotis blythii* (Tomes, 1857) (squares) in Jordan.

Table 7. Basic biometric data on the examined samples of *Myotis blythii* (Tomes, 1857), *M. nattereri* (Kuhl, 1817), and *M. emarginatus* (Geoffroy, 1806). For abbreviations see pp. 192, 193

	Myotis blythii					*Myotis nattereri*					*Myotis emarginatus*				
	n	**M**	min	max	SD	n	**M**	min	max	SD	n	**M**	min	max	SD
LC	10	**75.7**	71	79	2.669	18	**49.3**	45	53	2.421	8	**53.1**	49	56	2.416
LCd	10	**61.0**	56	66	3.590	18	**48.4**	44	54	2.953	8	**47.1**	44	50	1.885
LAt	10	**59.01**	57.3	62.2	1.620	20	**40.14**	38.9	41.4	0.626	8	**40.34**	39.4	41.1	0.602
LAu	10	**26.04**	24.6	28.0	1.085	18	**20.06**	18.9	21.2	0.606	8	**18.79**	18.0	19.4	0.467
LTr	10	**10.58**	9.9	11.4	0.496	18	**10.68**	9.9	11.6	0.487	8	**9.23**	8.6	9.9	0.459
LCr	9	**21.91**	20.93	22.37	0.418	15	**15.90**	15.62	16.64	0.259	7	**15.99**	15.68	16.18	0.206
LCb	9	**20.83**	19.92	21.12	0.371	15	**14.88**	14.58	15.52	0.225	7	**15.03**	14.75	15.25	0.170
LaZ	8	**14.01**	13.24	14.36	0.379	14	**10.01**	9.74	10.51	0.258	7	**9.75**	9.61	9.89	0.107
LaI	9	**5.23**	5.09	5.47	0.137	16	**3.67**	3.52	3.97	0.123	7	**3.66**	3.48	3.94	0.158
LaInf	9	**5.59**	5.37	6.12	0.224	16	**3.86**	3.41	4.12	0.161	7	**3.87**	3.75	3.93	0.063
LaN	9	**9.82**	9.54	9.97	0.134	16	**7.91**	7.56	8.33	0.168	7	**7.38**	7.28	7.52	0.093
LaM	9	**10.34**	10.02	10.72	0.216	16	**8.05**	7.75	8.31	0.168	7	**8.13**	7.99	8.31	0.108
ANc	9	**7.69**	7.32	7.85	0.161	15	**5.74**	5.37	5.94	0.163	7	**5.83**	5.60	6.05	0.141
LBT	9	**3.84**	3.72	4.03	0.117	15	**2.95**	2.69	3.24	0.179	7	**2.98**	2.84	3.09	0.084
CC	9	**5.81**	5.48	6.13	0.174	16	**4.04**	3.90	4.22	0.096	7	**4.10**	4.01	4.25	0.081
M^3M^3	9	**9.11**	8.41	9.44	0.313	16	**6.28**	6.07	6.49	0.122	7	**6.27**	6.01	6.45	0.149
CM^3	9	**9.10**	8.65	9.46	0.278	16	**6.19**	6.01	6.44	0.119	7	**6.53**	6.42	6.64	0.085
LMd	9	**16.64**	15.79	17.08	0.390	16	**11.45**	11.04	12.07	0.216	7	**11.85**	11.56	12.19	0.211
ACo	9	**5.33**	5.04	5.53	0.191	16	**3.51**	3.31	3.68	0.103	7	**3.62**	3.51	3.73	0.078
CM_3	9	**9.75**	9.18	10.09	0.260	16	**6.52**	6.37	6.87	0.146	7	**6.88**	6.74	7.07	0.109

Fig. 39. Area at the entrance to the 'Al Wardeh Cave' mine above the Zarqa' Valley, Northern Highlands (photo by A. Reiter). In or at the mine (entrance is visible in foreground of the picture on the right side), five bat species were found; viz. *Rhinolophus euryale*, *R. blasii*, *Myotis blythii*, *M. emarginatus*, and *Miniopterus pallidus*. All these species roost in the mine and most probably also reproduce there.

Feeding ecology. *Myotis blythii* is a large species with a ground gleaning and slow hawking foraging strategy (Arlettaz 1996, Arlettaz et al. 1997, Güttinger et al. 1998). The diet of this species was studied in Central Europe (Arlettaz 1996, Güttinger et al. 1998), Iran (Benda et al. 1999), Azerbaijan (Rahmatulina 2005), Syria (Benda et al. 2006) and Turkey (Whitaker & Karataş 2009). All the studies showed particularly Orthoptera and Coleoptera to be the most important prey categories taken by *M. blythii*.

From Jordan, we examined only two contents of digestive tracts from bats collected at the Iraq Al Wahaj Cave. The samples contained few insect remnants only; one tract contained larger Scarabaeidae and the other one Orthoptera. Despite their scarcity, such data well correspond with the results of previous studies.

Records of ectoparasites. **Original data**: S p i n t u r n i c i d a e: *Spinturnix myoti*: 1 fa (IZB; det. J. Krištofík) from 1 fa (NMP 92836), Khashibah, 'Al Wardeh Cave' mine, 14 July 2010. – N y c t e r i b i i d a e: *Penicillidia dufourii dufourii*: 2 ma (UCPN) from 1 fa (NMP 92836), Khashibah, 'Al Wardeh Cave' mine, 14 July 2010.

Comments on ectoparasites. From *Myotis blythii*, a bat species reported here for the first time from Jordan (see above), two ectoparasite species were found, which also represent newly recorded species for the fauna of the country. *M. blythii* ranks among the principal hosts of *Spinturnix myoti* (Kolenati, 1856). The distribution range of this mite comprises Europe and western Asia up to Afghanistan (Deunff 1977), roughly the geographical range of the recorded host bat. Similarly, the distribution range of the bat fly *Penicillidia dufourii* (Westwood, 1835) (Fig. 42) is similar to that of its host – Europe and western Asia, but in addition also North Africa (Hůrka 1964, Theodor 1967).

Fig. 40. Roosting group of *Myotis blythii* (Tomes, 1857) in the 'Al Wardeh Cave' mine, Khashibah (photo by A. Reiter).

Fig. 41. Portrait of a female *Myotis blythii* (Tomes, 1857) from the 'Al Wardeh Cave' mine at Khashibah (photo by A. Reiter).

Within the Middle Eastern realm, a diversity of ectoparasites of *M. blythii* was reported from Turkey; some of these arthropods could be expected also in Jordan. These parasites include four nycteribiids, *Nycteribia latreillii* (Leach, 1817), *N. schmidlii* Schiner, 1853, *N. vexata* Westwood, 1835, and *Penicillidia dufourii* (Theodor 1967, Hůrka 1972, Peterson et al. 1976, Aktaş & Hasbenli 1994, Hasbenli 1997); one ischnopsyllid *Rhinolophopsylla u. unipectinata* (Taschenberg, 1880) (Aktaş 1987); one listophorid *Alabidocarpus calcaratus* Lawrence, 1952 (Anciaux de Faveaux 1987); and one sarcoptid *Nycteridocoptes poppei* Oudemans, 1897 (Anciaux de Faveaux 1987). However, the parasite records from Palestine reported by Theodor & Moscona (1954) to originate from *Myotis myotis* (Borkhausen, 1797) certainly represent also some from *M. blythii* (Qumsiyeh 1996) as these bats were not distinguished properly at that time (Harrison & Lewis 1961).

Myotis nattereri (Kuhl, 1817)

Records. **New data**: ʻA m m a n: Iraq Al Amir [1], artificial cave (Fig. 3), 10 October 2008: net. 1 ms (NMP 92364 [S+A]), det. & rec. calls of 1 ind. [1 echolocation recording], 10 May 2009: net. 2 ma (NMP 92413, 92414 [S+A]), 2 July 2010: obs. & det. 2 inds. – I r b i d: ʻArjan [2], area of the RSCN camp, at an artifitial watering place for birds, 12 July 2010: det. 1 foraging ind.; – Dibbin [3], agricultural station, 30 September 2004: coll. 1 ma (JUST unnumbered [A]; collector unlisted), October 2004: coll. 1 ma (RSCN unnubered [A]; leg. M. Qarqaz & M. Abu Baker), May 2006: coll. 1 ind. (JUST unnumbered); – Kufranja [4], Iraq Al Wahaj Cave, 26 May 2009: net. 1 ma, 3 ms, 6 fa, 1 faG, 3 fs (coll. 1 ma,

Fig. 42. A male *Penicilidia d. dufourii* (Westwood, 1835) collected from its primary host *Myotis blythii* (Tomes, 1857) at the 'Al Wardeh Cave' mine near Khashibah (photo by O. Balvín). The record represents the first evidence of this parasite from Jordan.

3 faL; NMP 92551–92553 [S+A], 92550 [A]); – Zubiya, Zubiya Cave [5], at the cave entrance (Fig. 34), 24 May 2009: net. 1 ma (NMP 92519 [S+A]). – M a' a n: Ash Shawbak [6], Ash Shawbak Castle, undeground corridor, 20 October 2008: obs. a colony of 10 inds. torpid (coll. 5 ma, 3 fa; NMP 92396–92402 [S+A], 92395 [A]). – T a f i l a: Dhana [7], at an artificial watering place for birds at the Rummana Camp (Fig. 44), 4 July 2010: det. & rec. 1 ind. [1 echolocation recording]; – Dhana [8], at an artificial watering place for birds ca. 1 km E of the Rummana Camp, 19 October 2008: net. 1 fa (NMP 92386 [S+A]), det. & rec. calls of several inds. [2 echolocation recordings]; – Dhana [9], at a stream in the village gardens, 20 May 2009: net. 1 ma (NMP 92500 [S+A]), det. 1 ind.; – Dhana [10], Wadi Dhana (Fig. 5), Mahjub cave, 25 July 2000: coll. 1 ind. ad. s.i. (RSCN unnumbered [S+B]; leg. Mayas & M. Faqir). – **Published data**: I r b i d: Dibbine National Park [3], underground room, 7 July 1977: 250 inds., coll. 1 m, 9 f (Qumsiyeh 1980, Qumsiyeh et al. 1998), 27 February 1981: 1 ind. (Amr & Qumsiyeh 1993, Qumsiyeh et al. 1998), 9 August 1981: 3 fa (Amr & Qumsiyeh 1993, cf. Saliba et al. 1990), 20 November 1981: fewer inds. than in 1977 (Qumsiyeh et al. 1998); Dibbin, 22 February 1978 (Amr & Disi 1988).

Distribution. *Myotis nattereri* belongs to less frequent but not rare bat species in Jordan, it is most frequent and widespread species of the genus *Myotis*. Ten record sites are available from two separated areas of the country, from the Mediterranean arboreal zone of the Northern Highlands in northwestern Jordan ('Amman and Irbid regions) and from mountainous habitats of the Dhana-Shawbak region in the Southern Highlands (Fig. 43). For a long time, *M. nattereri* remained known only from one site in Jordan, it was repeatedly reported from artificial underground spaces in the Dibbin Forest (Qumsiyeh 1980, Amr & Disi 1988, Amr & Qumsiyeh 1993, Qumsiyeh et al. 1998, new records). The presented records thus significantly extended the known distribution range of this bat not only in Jordan but also in the whole Middle East. The occurrence of *M.*

nattereri in the Southern Highlands is probably not too surprising for this species dwelling the Mediterranean habitats, since the respective area of the Dhana Reserve and its surroundings (Fig. 44) represent the southernmost spots of occurrence of some other Mediterranean elements among mammals of Jordan (Amr 2000), e.g. *Erinaceus concolor* Martin, 1838, *Meles meles* (Linnaeus, 1758), and *Apodemus mystacinus* (Danford et Alston, 1877). After all, upper areas of the Southern Highlands belong to the Mediterranean biogeographical region of Jordan.

The record of *M. nattereri* from the Ash Shawbak Castle represents the southernmost known occurrence of this bat in the Levant and in the Middle East as well (see Benda et al. 2006: 112). In Palestine, this species is known to occur solely in the Mediterranean zone of the country, the southernmost records come from southern Judea (Makin 1977, Mendelssohn & Yom-Tov 1999), from Aqua Bella and Hartuv (Bodenheimer 1958, Harrison 1964). The Ash Shawbak record thus represents a projection of some 140 km SSE from the continuous Mediterranean occurrence of *M. nattereri* in the Levant. In northern parts of Palestine and Jordan the distribution range of this bat continues from the relatively common occurrence in Lebanon and western Syria (Benda et al. 2006, Horáček et al. 2008, own unpubl. data).

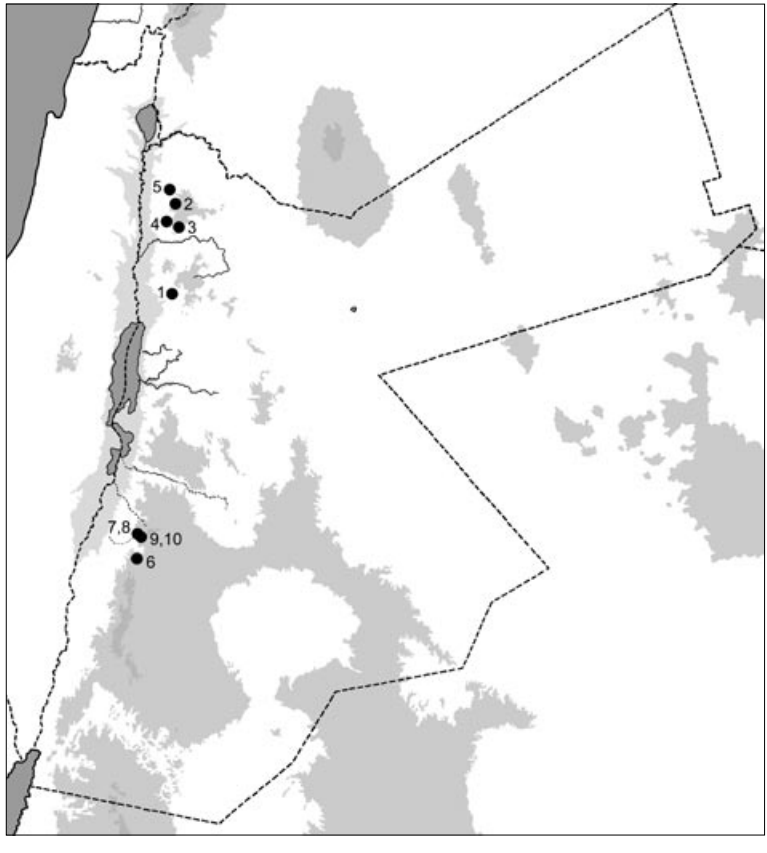


Fig. 43. Records of *Myotis nattereri* (Kuhl, 1817) in Jordan.

Fig. 44. Upper part of the Dhana Reserve (Southern Highlands) with the Rummana Camp, the Dhana village is in the background (photo by P. Benda). In this area a manifold bat community combining the Mediterranean and desert faunas was recorded, composed of *Rhinolophus clivosus*, *Myotis nattereri*, *Eptesicus bottae*, *Otonycteris hemprichii*, *Barbastella leucomelas*, *Plecotus christii*, and *Tadarida teniotis*.

The records of *M. nattereri* in Jordan come from a medium-wide altitude range of 510–1340 m a. s. l. (n=11), this range as well as the mean altitude (903.0 m) suggest a preference of very elevated sites. Concerning the mean altitude value, *M. nattereri* represents the third 'most montane' species among the Jordanian bats (after *Barbastella leucomelas* and *Plecotus christii*, see below). Approximately a half of the records represent findings of bats in or at their roosts (n=6), the altitudinal preference of the roost sites (range 510–1340 m a. s. l.; mean 771.7 m) is shifted down against the general preference of altitudes. However, such values still suggest preference of roosts in rather elevated areas in the Mediterranean zone of Jordan.

Field notes. *Myotis nattereri* was found to roost at two sites in Jordan, both being artificial shelters. At least one of the other sites where this bat was netted, probably also represents a roost. Qumsiyeh (1980: 37) reported: "A group of around 250 bats of this species were clustered in a crevice in the roost of an old underground room in Dibbine". We found a cluster of ten torpid individuals of *M. nattereri* in an underground corridor with spring in the As Shawbak Castle in the Southern Highlands on 20 October. Fourteen bats were netted at the entrance to the Iraq Al Wahaj Cave, a large karstic cave at Kufranja near Ajlun. At the system of artificial caves and rocky fissures of Iraq Al Amir in the Wadi As Sir near ʿAmman (Fig. 3), *M. nattereri* was netted twice, one individual in 2008 and two individuals in 2009. At other places, only single individuals of *M. nattereri* were netted; at the large karstic Zubiya Cave in the Ajlun Mts. (Fig. 34), and at two

Figs. 45, 46. Portraits of *Myotis nattereri* (Kuhl, 1817) from northern and southern Jordan, respectively. 45 – a female from the Rummana Camp, Dhana Reserve (photo by P. Benda). 46 – a male netted at the Zubiya Cave at Ajlun (photo by A. Reiter).

places in the Dhana Reserve – at a stream in the old village gardens and at an artificial watering place near the Rummana Camp (Fig. 44).

In the underground corridors of the Ash Shawbak Castle, *Rhinolophus blasii* and *Plecotus christii* were observed along with *M. nattereri*. At the Iraq Al Wahaj Cave, *Rousettus aegyptiacus*, *Rhinolophus euryale*, *R. blasii*, *Myotis blythii*, and *M. emarginatus* were also netted, while *Rhinolophus ferrumequinum*, *R. hipposideros*, *R. euryale*, *R. blasii*, *Myotis emarginatus* at the Zubiya Cave, together with *M. nattereri*. Four other species were recorded at Iraq Al Amir, *Rousettus aegyptiacus*, *Rhinopoma cystops*, *Rhinolophus blasii*, and *Pipistrellus kuhlii*. During the same netting sessions in the Dhana Reserve, calls of *Eptesicus bottae* and *Tadarida teniotis* were also recorded (on other occasions, also *Rhinolophus clivosus*, *Hypsugo ariel*, *Pipistrellus pipistrellus*, *Otonycteris hemprichii*, *Barbastella leucomelas*, and *Plecotus christii*).

Reproduction of *M. nattereri* was documented at one place in Jordan. Out of the group of 14 bats netted at the Iraq Al Wahaj Cave on 26 May, ten were females, one of them was pregnant and at least three were lactating. Existence of a nursery colony was indirectly reported by Qumsiyeh et al. (1998: 279–280): "One of us [...] found a colony of about 250 (mostly non-pregnant females and sub-adults) on 7 July 1977 in Dibbin Forest. Fewer animals were found on a return visit on 20 November and only one was found on 27 February 1981." Numerous authors reported data on reproduction of *M. nattereri* from the Middle East (Harrison 1964, Atallah 1977, Qumsiyeh 1996, Mendelssohn & Yom-Tov 1999, Aşan Baydemir & Albayrak 2006, Benda et al. 2006); summary of these data suggests a long interval of parturitions in the Levant, running from early April to early June. The available data from Jordan, suggesting the occurrence of parturitions in the second half of May, fit well into this period.

In the Middle East, *M. nattereri* was found in owl diet in Turkey (Obuch 1994), however, no similar data are available from Jordan.

Table 8. Comparison of biometric data on four *Myotis nattereri* (Kuhl, 1817) population sample sets from the Levant. For abbreviations see pp. 192, 193

	N Jordan					S Jordan					N Levant				
	n	**M**	min	max	SD	n	**M**	min	max	SD	n	**M**	min	max	SD
LAt	10	**40.09**	38.9	41.1	0.570	10	**40.18**	39.2	41.4	0.705	24	**40.37**	38.5	42.0	1.011
LCr	7	**16.01**	15.62	16.64	0.339	8	**15.79**	15.72	15.97	0.094	18	**15.72**	14.68	16.42	0.421
LCb	7	**14.98**	14.58	15.52	0.287	8	**14.79**	14.64	14.89	0.105	18	**14.67**	14.05	15.20	0.305
LaZ	7	**9.97**	9.74	10.51	0.307	7	**10.04**	9.76	10.44	0.217	15	**10.00**	9.72	10.37	0.201
LaN	7	**7.88**	7.56	8.33	0.237	9	**7.93**	7.77	8.04	0.097	19	**7.80**	7.31	8.00	0.160
ANc	7	**5.81**	5.58	5.94	0.147	8	**5.68**	5.37	5.91	0.159	17	**5.63**	5.32	5.92	0.155
CC	7	**4.08**	3.91	4.22	0.107	9	**4.02**	3.90	4.17	0.082	18	**4.04**	3.54	4.33	0.194
CM^3	7	**6.24**	6.05	6.44	0.135	9	**6.16**	6.01	6.28	0.100	18	**6.09**	5.82	6.41	0.139
LMd	7	**11.42**	11.04	12.07	0.324	9	**11.47**	11.37	11.59	0.090	19	**11.39**	11.05	11.85	0.208
CM_3	7	**6.54**	6.37	6.87	0.167	9	**6.50**	6.39	6.80	0.136	19	**6.54**	6.30	6.84	0.133

Morphology and variation. External and cranial dimensions of the Jordanian specimens of *Myotis nattereri* examined are shown in Table 7. For the material examined see Records.

The records of *M. nattereri* from the Ash Shawbak Castle and the Dhana Reserve in the Southern Highlands of Jordan belong to the newly discovered population living far from the continuous range of the species in the Levant (see Distribution). The individuals of these populations differ from those inhabiting Lebanon and Syria as well as the Mediterranean zones of Jordan and Palestine in their colouration (Figs. 45, 46). The dorsal pelage colouration of these southern Jordanian bats

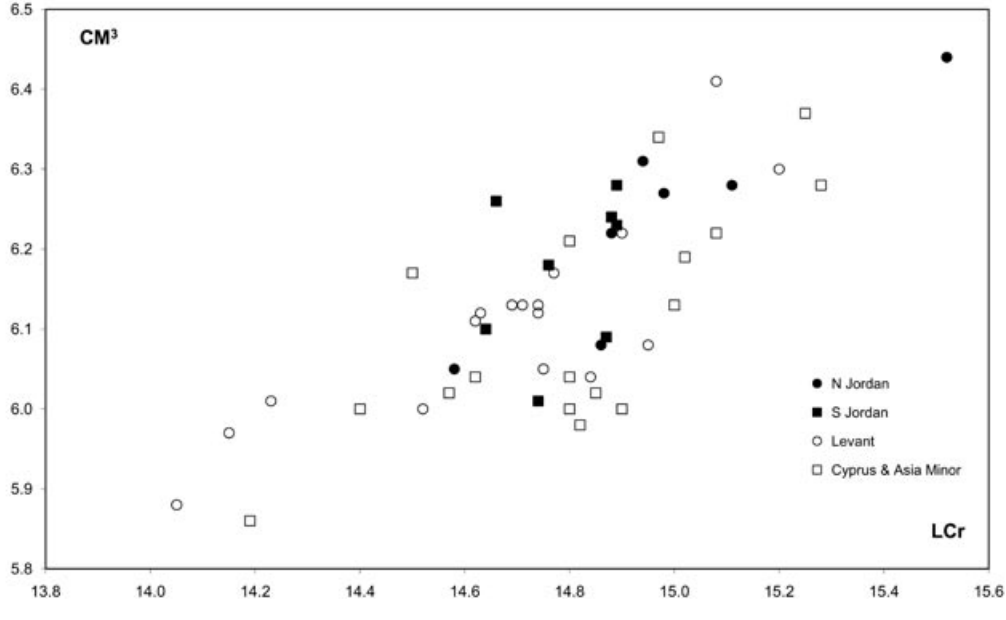


Fig. 47. Bivariate plot of the examined Jordanian and comparative samples of *Myotis nattereri* (Kuhl, 1817): greatest length of skull (LCr) against the length of upper tooth-row (CM^3).

is pale brown to beige with an appreciable rusty tinge, while that of the ventral pelage is whitish; the colouration of the naked parts is very pale brown or is almost unpigmented. The individuals of *M. nattereri* from the Mediterranean zone of the Levant are darker in most aspects, particularly in dorsal pelage colouration, which is dark brown or dark rusty brown (Benda et al. 2006). However, the morphometric comparison of the Jordanian and other Levantine specimens of *M. nattereri* did not show any remarkable differences, the mean values and dimension ranges are very similar in all examined sample sets (Table 8, Fig. 47). The difference in pelage colouration perhaps represents a reflection of environmental influences of more arid conditions in southern Jordan (see also Morphology and variation in *Pipistrellus pipistrellus* below).

Feeding ecology. *Myotis nattereri* is a medium-sized bat applying especially the foliage gleaning foraging strategy, however, the ground gleaning as well as its ability to hunt swarming small insects (like Nematocera and Trichoptera) in the open air were also reported (Topál 2001, Swift 1997). The species was studied especially in Europe, where it was evidenced to feed mainly on Diptera, Araneae, Coleoptera, Trichoptera, Lepidoptera and Dermaptera (Bauerová & Červený 1986, Gregor & Bauerová 1987, Beck 1991, 1995, Shiel et al. 1991, Taake 1992, Swift 1997, etc.). However, the results of diet analyses indicated high regional and seasonal variation.

The diet composition of *M. nattereri* was also studied in the Middle East; Heteroptera, Coleoptera, Araneae and Diptera were found in two pellets from Palestine (Whitaker et al. 1994), Brachycera and Lepidoptera, complemented by Araneae, made up the analysed samples from Syria (Benda et al. 2006), and one bat examined in Turkey fed mainly on Orthoptera and Diptera (Whitaker & Karataş 2009).

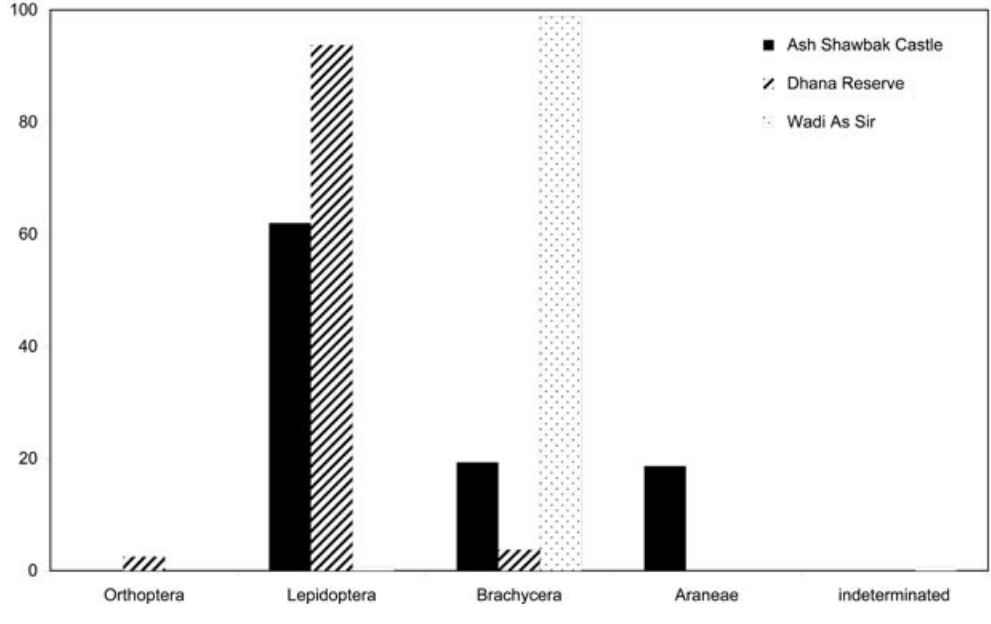


Fig. 48. Volume of particular prey categories in the diet of *Myotis nattereri* (Kuhl, 1817) from Jordan. Material: Ash Shawbak Castle – 17 pellets analysed from eight bats; Dhana Reserve – eight pellets analysed from one bat; Wadi As Sir – 16 pellets analysed from one bat.

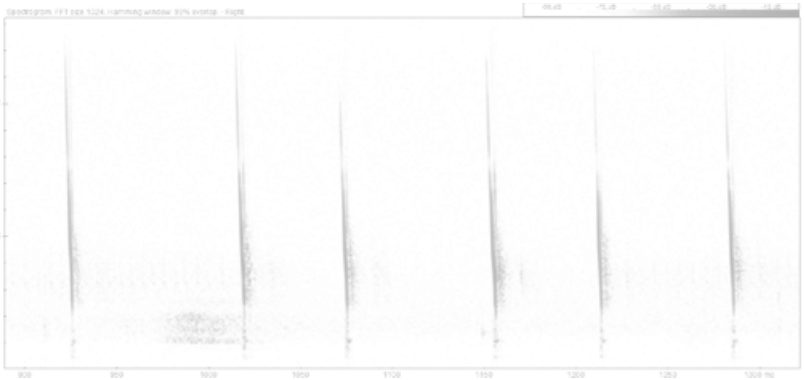


Fig. 49. Spectrogram of echolocation calls of *Myotis nattereri* (Kuhl, 1817); an individual foraging at an artificial watering place in the Dhana Reserve.

From Jordan, we analysed 41 faecal pellets from ten bats collected at three sites (Fig. 48) and a content of one digestive tract from a bat collected in the Dhana Village. The pellet analysis showed Lepidoptera and Brachycera to be the main prey items (Fig. 48), the tract contained Lepidoptera (80% of volume), Heteroptera (10%), and Hymenoptera (10%). The diet composition recorded is quite similar to the results of analyses of the Syrian samples (Benda et al. 2006), as the most representative sample from eight bats from the Ash Shawbak Castle contained mainly Lepidoptera and smaller proportions of Brachycera and Araneae. Relatively regular presence of Araneae and Brachycera suggests gleaning foraging strategy in *M. nattereri* in the Levant. However, it cannot be proven whether the most consumed Lepidoptera are gleaned or hunted by aerial hawking.

Echolocation. In total, we obtained four recordings of *Myotis nattereri* calls from three localities (Fig. 49). Basic echolocation parameters are given in Table 4. The SF, EF and FMAXE values of Jordanian *M. nattereri* were slightly lower than those in the European populations (Russo & Jones 2002), although general characteristics of the calls were very similar in both populations (i.e., short and very broadband calls). The echolocation parameters of the calls recorded in Jordan agreed with the data reported by Shalmon et al. (1993) and Mendelssohn & Yom-Tov (1999) from the neighbouring Palestine.

Records of ectoparasites. **Original data**: N y c t e r i b i i d a e: *Basilia nana*: 1 fa (UCPN) from 1 ma (NMP 92814), Iraq Al Amir, 10 May 2009. – **Published data**: N y c t e r i b i i d a e: *Basilia nana*: 1 ma, 3 fa, Dibbin National Park, 27 February and 9 August 1981 (Amr & Qumsiyeh 1993). – A r g a s i d a e: *Argas* sp. (*vespertilionis* group): 20 nymphs, Dibbin National Park, 9 August 1981 (Saliba et al. 1990).

Comments on ectoparasites. Two parasites were detected to be hosted by *Myotis nattereri* in Jordan, a bat fly *Basilia nana* Theodor et Moscona, 1954 and a tick of the genus *Argas* Latreille, 1795. The records come from the northern part of the host distribution range in Jordan, Dibbin (Saliba et al. 1990, Amr & Qumsiyeh 1993) and Iraq al Amir at ˙Amman (new data). The findings of *B. nana* are probably conditioned by the ecological requirements of the parasite – it belongs to the group of arboreal bat flies (Hůrka 1964) and its occurrence in Jordan is thus probably limited to the Mediterranean arboreal zone. *B. nana* has been rarely found mainly in Western and Central Europe, its southernmost records are known from Turkey and Palestine (Theodor & Moscona 1954, Hůrka 1964, Theodor 1967, Aktaş & Hasbenli 1994, Hasbenli 1997). From Palestine, two

other bat fly species were also reported, *Nycteribia pedicularia* Latreille, 1805 and *Penicillidia dufourii* (Westwood, 1835) (Theodor & Moscona 1954), these parasites are thus expected also in Jordan.

The tick *Argas* sp. was identified as belonging to the *vespertilionis* group (Saliba et al. 1990). Three species of the group can be considered in the Levant (Hoogstraal 1955, Filippova 1966), *A. vespertilionis* (Latreille, 1802), *A. boueti* Roubaud et Colas-Belcour, 1933, and *A. confusus* Hoogstraal, 1955. Two of these species (*A. vespertilionis*, *A. confusus*) were found to parasite bats in Jordan, see under *Rousettus aegyptiacus*, *Rhinopoma cystops*, *Pipistrellus pipistrellus*, and *P. kuhlii*.

Myotis emarginatus (Geoffroy, 1806)

Records. **New data**: I r b i d: ʻArjan [1], cave above the village, 25 May 2009: net. 1 faL (NMP 92523 [S+A]); – Khashibah [2], ʻAl Wardeh Cave' mine (Fig. 39), 26 May 2009: obs. a mixed colony of *M. emarginatus* and four other bat species of ca. 350 inds., obs. 1 faL+j; – Kufranja [3], Iraq Al Wahaj Cave, 26 May 2009: net. 2 ms, 3 fa, 1 faG (coll. 4 f; NMP

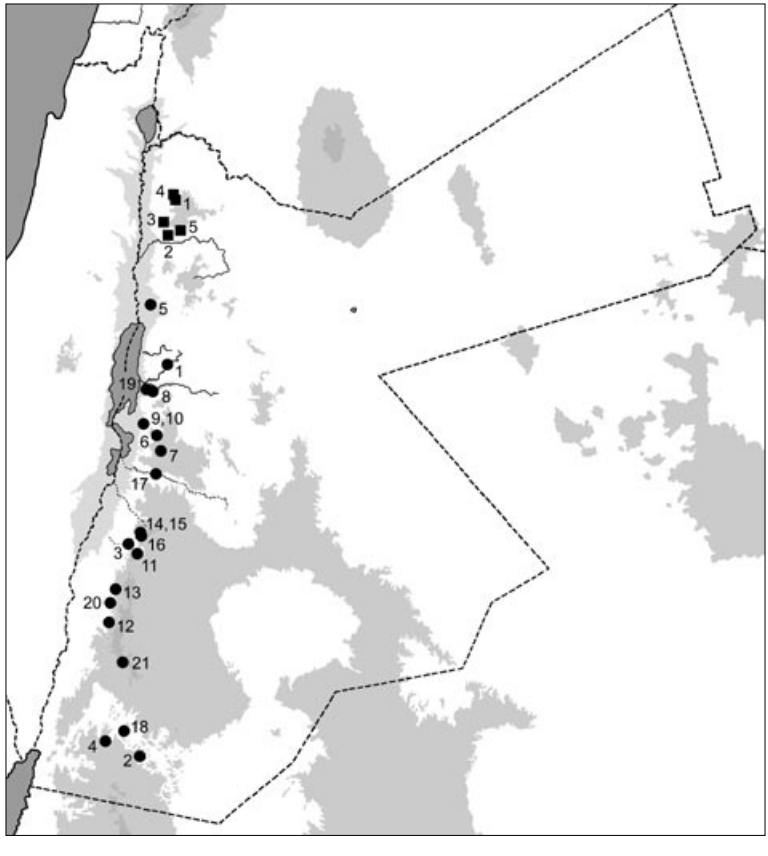


Fig. 50. Records of *Myotis emarginatus* (Geoffroy, 1806) (squares) and *Eptesicus bottae* (Peters, 1869) (circles) in Jordan.

Fig. 51. Portrait of a female *Myotis emarginatus* (Geoffroy, 1806) netted at the Zubiya Cave at Ajlun (photo by A. Reiter).

92554–92557 [S+A]); – Zubiya, Zubiya Cave [4], at the cave entrance (Fig. 34), 24 May 2009: net. 2 faL, 1 faG (NMP 92520, 92521 [S+A], 92522 [A]). – **Published data**: I r b i d: Irbid, Dibbine National Forest [5], 1 f (Qumsiyeh et al. 1986), Dibbin, 1981 (Amr & Disi 1988).

Distribution. *Myotis emarginatus* is a rare bat species in Jordan, only five record sites are known from a limited area of the Ajlun Mts. in the northwestern part of the country, from the Mediterranean biogeographical region (Fig. 50). Similarly as the previous species, *M. emarginatus* was until now known only from one area in Jordan, the Dibbin Forest (Qumsiyeh et al. 1986, Amr & Disi 1988). However, the four new record sites presented here do not extend significantly the geographical distribution and ecological delimitation of the species in Jordan, all localities lie in the Mediterranean arboreal zone. This occurrence spot belongs to the southernmost projection of the species range in the Levant (see Benda et al. 2006: 112), the southernmost Levantine record comes from Rekhovot (Qumsiyeh 1996; however, Makin 1987 and Mendelssohn & Yom-Tov 1999 do not map this site), only slightly more to the south (ca. 30 km) from the Iraq Al Wahaj Cave of Jordan. In northern Palestine the distribution range of *M. emarginatus* continues from the occurrence in Lebanon and western Syria (Benda et al. 2006, Shehab et al. 2007, Horáček et al. 2008, own unpubl. data).

The limited records of *M. emarginatus* from Jordan come from a very narrow altitude range of 665–812 m a. s. l. (n=5), this range as well as the mean altitude (744.0 m) suggest a preference of

rather elevated sites. Probably four of these sites represent findings of bats in or at their roosts; the altitudinal preference of the roost sites (range 665–812 m a. s. l.; mean 731.3 m) is only slightly shifted down against the general preference of altitudes.

Field notes. *Myotis emarginatus* was found to roost at two sites in Jordan, at three other sites it was netted, two of them also represented its roosts with most probability. Qumsiyeh (1996: 120) reported on a finding probably in one of the artificial underground rooms or corridors of Dibbin: "The single male specimen I found at Dibbine Forest on 9 August was in a torpid state." In the 'Al Wardeh Cave', a spacious ancient mine at Khashibah in the Ajlun Mts. (Fig. 39) a mixed colony of *M. emarginatus* and four other bat species of some 350 individuals was observed. Three individuals were netted at the entrance to the Zubiya Cave (Figs. 51, 34), a large karstic cave in the Ajlun Mts. Seven individuals were netted at the entrance to the Iraq Al Wahaj Cave, a large karstic cave above Kufranja near Ajlun. At a portal of a smaller cave (some 15 m deep, with entrance 12 m wide and some 3 m high) above the village of ʿArjan, one bat was netted.

In the 'Al Wardeh Cave' mine, the large colony was composed of five species, besides *M. emarginatus* including also *Rhinolophus euryale*, *R. blasii*, *Myotis blythii*, and *Miniopterus pallidus*. In the Zubiya Cave, *Rhinolophus ferrumequinum*, *R. hipposideros*, *R. blasii*, and *Myotis nattereri* were netted along with *M. emarginatus*, while at the Iraq Al Wahaj Cave, *Rousettus aegyptiacus*, *Rhinolophus euryale*, *R. blasii*, *Myotis blythii*, and *M. nattereri* were also netted. At the cave above ʿArjan, calls of *Pipistrellus kuhlii* were recorded.

The reproduction of *M. emarginatus* was documented at three sites in Jordan. Four of five females, examined from the Iraq Al Wahaj Cave on 26 May, were adults, three of them were

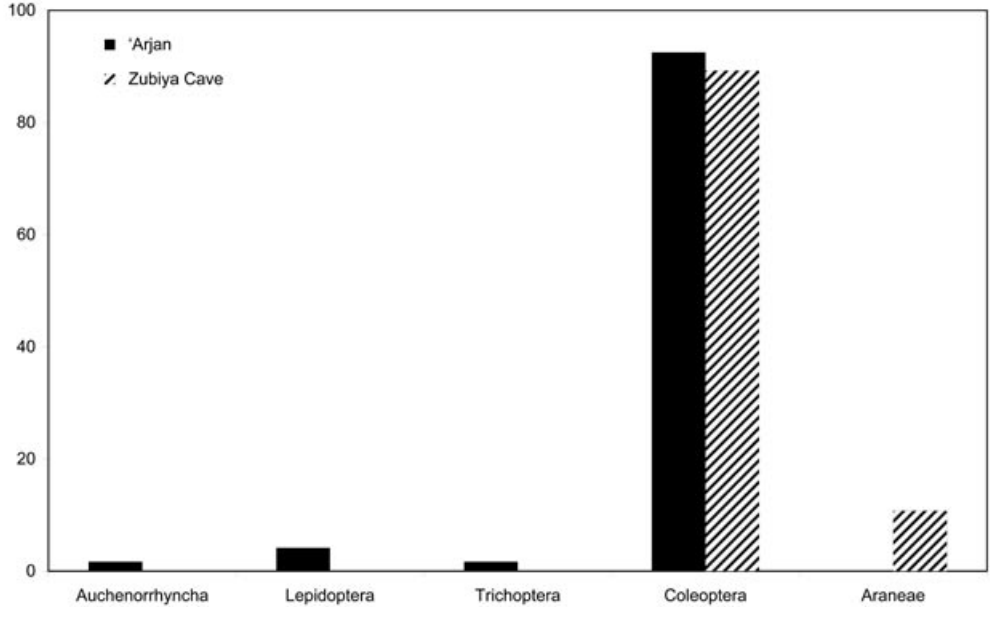


Fig. 52. Volume of particular prey categories in the diet of *Myotis emarginatus* (Geoffroy, 1806) from Jordan. Material: ʿArjan – 12 pellets analysed from one bat; Zubiya Cave – 23 pellets analysed from three bats.

lactating and one was pregnant; it contained one foetus of the crown-rump length of 22.4 mm. Three adult females were netted at the Zubiya Cave on 24 May, two of them were lactating and one pregnant. However, the latter female shortly after the netting, being placed into a cloth bag, gave birth to a juvenile; the LAt of the newborn was 10.8 mm (= 26.8% of the mother's LAt 40.3 mm). One lactating female was netted at the cave above ʿArjan on 25 May, however, this bat might have come from the colony in the Zubiya Cave, since the sites are situated only some 2.7 km from each other. These data suggest that parturitions in Jordan occur in the second half of May. It conforms with the data from other parts of the Middle East (Harrison 1964, DeBlase 1980, Mendelssohn & Yom-Tov 1999, Aşan Baydemir & Albayrak 2006, Benda et al. 2006), which suggest the period of parturitions to occur from late May to mid-June.

In the Middle East, remnants of *M. emarginatus* were found in owl diet in Turkey (Obuch 1994) and Syria (Benda et al. 2006), however, such data are not available from Jordan.

Morphology. External and cranial dimensions of the Jordanian specimens of *Myotis emarginatus* examined are shown in Table 7. For the material examined see Records.

Feeding ecology. *Myotis emarginatus* is a medium-sized bat using mainly the gleaning foraging strategy (Krull et al. 1991, Qumsiyeh 1996). The diet of this species was studied mainly in various parts of Europe; Araneae, Lepidoptera, brachyceran Diptera, and Lepidoptera larvae were found to be the most important prey categories (Bauerová 1986, Beck 1995, Steck & Brinkmann 2006).

Concerning diet composition of *M. emarginatus* populations of southwestern Asia, data are available from Azerbaijan, Turkey and Syria. Rahmatulina (2005) reported Diptera, Lepidoptera, Coleoptera and Orthoptera to be a dominant part of the diet in Azerbaijan, complemented by Heteroptera, Odonata, Blattodea, Neuroptera, and Araneae. Two samples from Turkey analysed by Whitaker & Karataş (2009) contained mostly Hemiptera. Araneae and Brachycera also made up an overwhelming majority of the analysed diet of *M. emarginatus* in Syria (Benda et al. 2006).

From Jordan, we analysed 35 faecal pellets from four bats originating from two sites (Fig. 52) and two contents of digestive tracts from bats collected at the Zubiya Cave. The analysis of pellets showed dominance of Coleoptera in the diet (Fig. 52) as well as did the examination of digestive tract contents, which contained Coleoptera (50–90% of volume) and Araneae (10–50%). The composition of *M. emarginatus* diet recorded in Jordan remarkably differs from the results of previous studies from Europe and Syria, as surprisingly high proportions of medium-sized scarabaeid beetles were recorded. A relevant conclusion cannot be made as the samples come from four individuals only that were collected at two sites 2.7 km from each other (Zubiya Cave – ʿArjan) within two days when an extraordinary event in local conditions (e.g. an outbreak of the scarabaeid beetles) cannot be excluded. However, the recorded data at least showed that the trophic niche of *M. emarginatus* is wider and its foraging behaviour more flexible than supposed by previous authors.

Myotis capaccinii (Bonaparte, 1837)

Records. **Published data**: I r b i d: Jordan Valley, Tabqat Fahl [1], 1 f (Qumsiyeh et al. 1986), Tabaqat Fahl, December 1983 (Amr & Disi 1988).

Distribution. *Myotis capaccinii* is a very rare bat species in Jordan, only one record was published (Fig. 53) from the area adjacent to the Jordan Valley (Qumsiyeh et al. 1986, Amr & Disi 1988). Such a limited evidence seems to be surprising in comparison with the occurrence known from Palestine, where Mendelssohn & Yom-Tov (1999: 118) concluded: "It is the most common species of its genus […], but populations are now (1996) small, estimated at 5000 […]". Since *M. capa-*

ccinii is a bat well recognisable with the help of a bat detector – which we broadly used during the bat fauna survey in Jordan – the here given picture of the distribution of this bat seems to be realistic; no foraging bats were detected either in the Mediterranean or arid zones of Jordan. (On the other hand, places of the most typical occurrence of this species – larger water bodies – were not preferred during our survey.). The Jordanian record of *M. capaccinii* from Tabaqat Fahl most probably represents the southernmost localised finding of this bat in the Levant, as in Palestine the southernmost record perhaps comes from Ha-Zore'a in the Carmel region, some 20 km to the north (Makin 1977, cf. Mendelssohn & Yom-Tov 1999). Therefore, the only Jordanian record could be understood as the most extreme in the region. In northern Palestine the distribution range of *M. capaccinii* continues from the rather common occurrence in Lebanon (Horáček et al. 2008, 2009, own unpubl. data) as well as in Syria, incl. Mesopotamia (Benda et al. 2006, Shehab et al 2007). The Jordanian record originates from a fertile part of the Jordan Valley, but not from the Mediterranean zone of the country, from the altitude around 8 m b. s. l. However, such a geographically and ecologically extreme locality can hardly represent general altitudinal preference of the species in the Holy Land, particularly in comparison with the sites of abundant records in northern Palestine and Lebanon (o.c.).

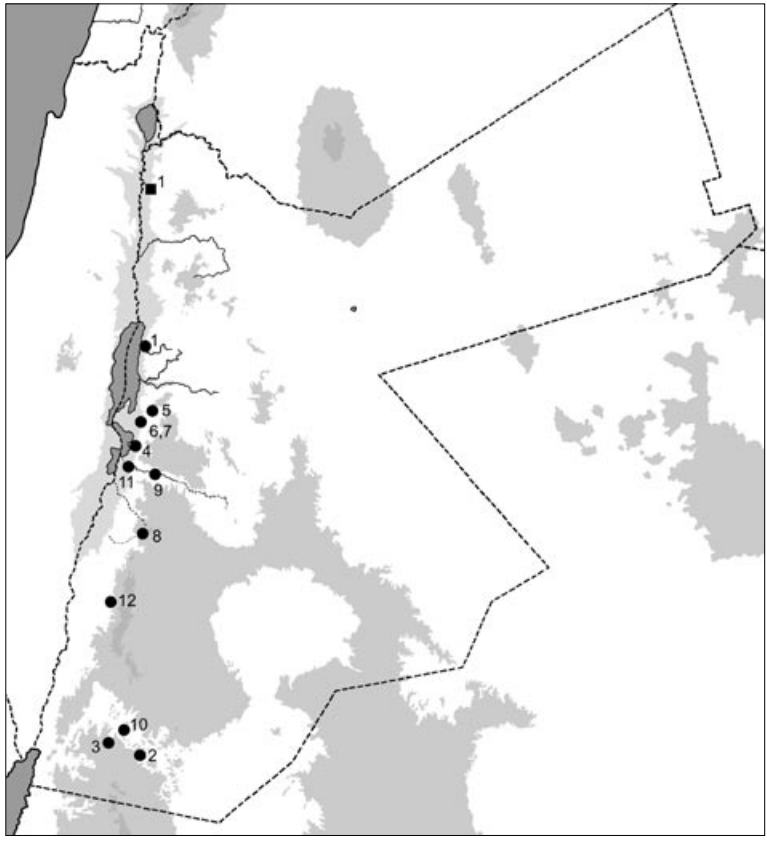


Fig. 53. Records of *Myotis capaccinii* (Bonaparte, 1837) (square) and *Hypsugo ariel* (Thomas, 1904) (circles) in Jordan.

Eptesicus bottae (Peters, 1869)

Records. **New data**: ʿA m m a n: An Nuzha [1], Wadi Al Wala, above a river (Fig. 103), 11 July 2010: det. & rec. 1 ind. [1 echolocation recording]. – A q a b a: Al Ghal [2], above a camel haunt (Fig. 88), 17 May 2009: net. 10 ma, 1 faG (NMP 92477–92485 [S+A], 92476 [A]); – Al Qurayqira [3], Wadi Ghuweir, 2.5 km E of Khirbet Feynan (Fig. 54), at a rest water pool, 13 May 2009: net. 1 faG (NMP 92426 [S+A]), det. & rec. calls of several inds.; – Wadi Rum [4], Lawrence's Pool, 24–25 October 2004: net. 1 ms, 2 fa (NMP 92098–92100 [S+A]) (cf. Benda et al. 2006). – B a l q a': Jufat Al Qafrayn [5], above a fishpond, 15 July 2010: det. 1 foraging ind. [1 echolocation recording]. – K a r a k: As Salihiyyah [6], at rest pools in a wadi below the village (Fig. 90), 8 July 2010: det. & rec. 1 ind. [2 echolocation recordings]; – Mu'ta [7], 2 April 1994: 1 fa (JUST unnumbered [A]; leg. R. Auran); – Rashah [8], Mujib Reserve, 20 April 1999: coll. 1 fa (RSCN unnumbered [A]; leg. K. A. Al Omari, F. l. Amerian & R. Heil), May 2007: 1 ind.; – Wadi Weida'a [9], a pool at water pumping station, 3 July 2010: net. 1 fa (NMP 92799 [S+A]), 1 ind., det. numerous foraging inds. [3 echolocation recordings]; – Wadi Weida'a [10], at a spring ca. 1 km from the wadi estuary, 3 July 2010: obs. numerous foraging inds. – M a' a n: Al Maqar'iyya [11], at a reservoir at village spring (Fig. 63), 7 July 2010: det. & rec. 1 ind. [1 echolocation recording]; – Ar Rajif, Jebel Masuda, Ain Amshit [12] (Fig. 95), 21 October 2008: det. & rec. calls of 1 foraging ind. [2 echolocation recordings], 15 May 2009: det. & rec. calls of 1 ind.; – Jabal Al Bayda [13], rocks ca. 2 km to S, 18 May 2009: det. calls of several inds. – T a f i l a: Dhana [14], at an artificial bird waterng place ca. 1 km E of the Rummana Camp (Fig. 44), 4 July 2010: det. 1 foraging ind.; – Dhana [15], at an artificial watering place for birds at the Rummana Camp, 19 May 2009: det. 2 inds., 4 July 2010: det. & rec. 1 ind.; – Dhana [16], village, 22 July 2000: coll. 1 ind. ad. s.i. (RSCN unnumbered [S+B]; leg. Mayas & M. Faqir); at a stream in the village gardens and at a cave above the village gardens, 22 April 2008: det. 1 foraging ind., 6 July 2010: det. several foraging inds. [13 echolocation recordings]; – Wadi Al Hasa [17] (Fig. 23), above a river ca. 1 km E of Hammamat Borbatah, 5 July 2010: det. numerous foraging inds. [2 echolocation recordings]. – **Published data**: A q a b a: Disa [18] (Wadi Rum), [= 31 May 1990:] 3 inds. [1 fa (JUST unnumbered)] (Qumsiyeh et al. 1992); – [Wadi] Rum [4], Lawrence's Pool, small pool nearby, [October] 1989: net. 2 inds. (Bates & Harrison 1989). – K a r a k: vicinity of Ar Raddass [19], south of Wadi Al Mawjib, 1999, net. (Al-Omari et al. 2000). – M a' a n: Petra [= Al Batra] [20] (Disi & Hatough-Bouran 1999); – 'probably An Naqab' [21] (Amr et al. 2004).

Distribution. *Eptesicus bottae* belongs to rather common bat species in Jordan, 21 record sites are available from the mostly arid southwestern portion of the country (Fig. 50), i.e. from the Irano-Turanian and Sudanian Penetration biogeographical regions. However, in this limited area adjacent to the Dead Sea Basin and the Wadi Araba incl. the Rum Desert, *E. bottae* is the most frequently recorded bat species. A very similar occurrence pattern is shown by this species also in Palestine, Mendelssohn & Yom-Tov (1999) mapped 18 sites from areas widely adjacent to the Rift Valley and specified (p. 129): "it is not uncommon in the Negev and Judean Deserts, and along the ʿArava Valley from Elat to ʿEn Gedi"; other records from the central Negev were reported by Korine & Pinshow (2004) and Razgour et al. (2010). In the southern Holy Land the distribution range of *E. bottae* continues from the rather uncommon occurrence in the Cairo region and Sinai of Egypt (Qumsiyeh 1985, Nader & Kock 1990, Benda et al. 2008). The area comprised of northeastern Egypt, southern parts of Palestine and Jordan (and possibly also the adjacent area in Saudi Arabia) demarcates the restricted range of the subspecies *E. bottae innesi* (Lataste, 1887), one of six subspecies recognised within the species (Nader & Kock 1990, Benda et al. 2006). In Jordan, this range reaches its northernmost extent in Jufat Al Qafrayn, north of the Dead Sea Basin (some 52 km ENE of ʿEn Geddi on the western bank of the Dead Sea).

The records of *E. bottae* in Jordan come from an extremely broad altitude range (the widest among the Jordanian bats) –235–1546 m a. s. l. (n=21); however, the mean altitude (681.6 m) suggests a preference of rather elevated sites. Since all records represent evidences of foraging bats (see Records), roost preferences cannot be evaluated. However, considering the extreme altitudinal range of the records, the roosts of *E. bottae* could be found in all altitude categories of the southern deserts of Jordan.

Field notes. No roosts of *Eptesicus bottae* were found in Jordan; nevertheless, this species was netted at least at five sites and its typical echolocation calls were recorded at many others. Bates & Harrison (1989) netted two bats above a small pool near the Lawrence's Pool in the Rum Desert in

Fig. 54. Wadi Ghuweir, Dhana Reserve, Southern Highlands (photo by A. Reiter). On this place (308 m a. s. l.), *Rhinolophus clivosus*, *Eptesicus bottae*, and *Pipistrellus pipistrellus* were netted. Some kilometres below in this wadi, *Rhinolophus blasii*, *Otonycteris hemprichii* and *Tadarida teniotis* were recorded.

1989, and at this site three bats were netted in 2004. In this desert also 11 bats were netted above a camel haunt in the Al Ghal oasis (Fig. 88). Al-Omari et al. (2000) netted *E. bottae* near the Ar Raddass station in the Al Mawjib Reserve. Above a stream in the Wadi Ghuweir near Khirbet Feynan (Fig. 54) in the desert portion of the Dhana Reserve one individual was netted (Fig. 55). One individual was netted above a pool at the water pumping station in the estuary of the Wadi Weida'a in the Dead Sea Basin. The very distinctive calls of foraging bats were recorded at many places, above rivers in the Wadi Al Wala (Fig. 103) and Wadi Al Hasa (Fig. 23), at an artificial watering place for birds and in the old village of the Dhana Reserve, above a water reservoir at village spring in Al Maqar'iyya (Fig. 63), at a spring of the oasis of Ain Amshit in the Jebel Masuda Mts. (Fig. 95), in the desert rocky area at Jabal Al Bayda, and at a fishpond near Jufat Al Qafrayn in the Jordan Valley.

Numerous other species were recorded at the sites of *E. bottae* occurrence in Jordan. *Rousettus aegyptiacus*, *Rhinopoma microphyllum*, *R. cystops*, *Taphozous perforatus*, *T. nudiventris*, and *Pipistrellus kuhlii* at Jufat Al Qafrayn, *Rousettus aegyptiacus*, *Rhinopoma cystops*, *Pipistrellus pipistrellus*, and *Tadarida teniotis* were recorded in the Wadi Al Wala, *Rhinopoma cystops*, *Hypsugo ariel*, and *Tadarida teniotis* in the Wadi Weida'a, *Nycteris thebaica*, *Rhinopoma cystops*, *Taphozous perforatus*, *T. nudivetris*, *Hypsugo ariel*, and *Tadarida teniotis* in the Wadi Al Hasa, *Rhinolophus clivosus*, *R. blasii*, *Pipistrellus pipistrellus*, *Otonycteris hemprichii*, and *Tadarida teniotis* in the Wadi Ghuweir, *Rhinolophus clivosus*, *Hypsugo ariel*, *Pipistrellus pipistrellus*, *Otonycteris hemprichii*, *Barbastella leucomelas*, *Plecotus christii*, and *Tadarida teniotis* in various close sites in the upper part of the Dhana Reserve, *Pipistrellus pipistrellus* in Al Maqar'iyya, *Rhinolophus clivosus* and *Plecotus christii* at Jabal Al Bayda, *Rhinolophus clivosus*, *Pipistrellus pipistrellus*, and *Plecotus christii* in the Ain Amshit oasis, *Hypsugo ariel*, *Otonycteris hemprichii*,

Table 9. Basic biometric data on the examined samples of *Eptesicus bottae* (Peters, 1869), *Hypsugo ariel* (Thomas, 1904), and *Pipistrellus kuhlii* (Kuhl, 1817). For abbreviations see pp. 192, 193

	Eptesicus bottae					*Hypsugo ariel*					*Pipistrellus kuhlii*				
	n	**M**	min	max	SD	n	**M**	min	max	SD	n	**M**	min	max	SD
LC	13	**60.3**	58	64	1.750	11	**40.1**	37	42	1.514	22	**49.4**	43	53	3.064
LCd	13	**52.4**	49	55	1.710	10	**39.0**	36	44	2.160	22	**42.4**	39	45	1.787
LAt	18	**42.27**	40.3	45.2	1.275	12	**30.32**	28.9	33.7	1.212	28	**34.59**	32.8	36.3	0.951
LAu	13	**18.75**	17.7	20.4	0.822	11	**13.17**	12.5	14.0	0.476	22	**14.55**	12.7	15.6	0.726
LTr	13	**8.15**	6.0	17.8	2.953	11	**5.00**	4.4	5.6	0.429	22	**6.08**	5.3	7.1	0.455
LCr	14	**15.95**	15.28	16.38	0.426	11	**11.50**	11.18	11.89	0.269	21	**13.17**	12.48	13.64	0.289
LCb	14	**15.66**	14.98	16.22	0.386	11	**11.00**	10.67	11.51	0.249	19	**12.71**	12.13	13.06	0.264
LaZ	14	**10.57**	10.27	11.39	0.277	10	**6.93**	6.41	7.18	0.208	19	**8.54**	8.27	8.81	0.167
LaI	14	**3.58**	3.42	3.68	0.060	11	**2.68**	2.46	3.04	0.147	19	**3.28**	3.05	3.46	0.107
LaInf	14	**4.97**	4.75	5.32	0.185	11	**3.49**	3.26	3.86	0.188	19	**3.93**	3.72	4.14	0.133
LaN	14	**7.56**	7.42	7.76	0.103	11	**5.62**	5.33	5.83	0.133	19	**6.51**	6.26	6.83	0.162
LaM	14	**8.53**	8.23	8.78	0.148	11	**6.13**	5.82	6.53	0.186	19	**7.61**	7.32	7.89	0.177
ANc	14	**5.43**	5.21	5.79	0.165	11	**3.94**	3.79	4.17	0.109	19	**4.66**	4.35	4.87	0.150
LBT	14	**3.47**	3.16	3.85	0.168	11	**2.62**	2.28	2.93	0.194	19	**2.95**	2.76	3.16	0.101
CC	14	**4.91**	4.67	5.34	0.193	11	**3.39**	3.25	3.59	0.107	19	**4.21**	4.03	4.38	0.107
M^3M^3	13	**6.88**	6.54	7.37	0.265	11	**4.63**	4.42	4.87	0.147	19	**5.62**	5.38	5.84	0.146
CM^3	14	**5.73**	5.47	5.89	0.134	11	**3.92**	3.75	4.08	0.092	19	**4.88**	4.58	5.12	0.156
LMd	14	**11.37**	10.93	11.96	0.305	11	**7.76**	7.46	8.17	0.222	18	**9.52**	8.97	9.84	0.229
ACo	14	**4.04**	3.75	4.27	0.158	11	**2.36**	2.24	2.57	0.096	18	**3.01**	2.75	3.19	0.106
CM_3	14	**6.33**	5.92	7.18	0.318	11	**4.10**	3.87	4.29	0.128	18	**5.25**	4.92	5.44	0.147

Fig. 55. Portrait of a female *Eptesicus bottae* (Peters, 1869) netted in the Wadi Ghuweir, ca. 2.5 km E of Khirbet Feynan, at Al Qurayqira, Dhana Reserve, see Fig. 54 (photo by A. Reiter).

and *Plecotus christii* in the Wadi Rum, and *Rhinolophus clivosus*, *Hypsugo ariel*, *Otonycteris hemprichii*, *Barbastella leucomelas*, and *Plecotus christii* in the Al Ghal oasis.

Two records of reproduction of *E. bottae* were documented in Jordan. An adult female collected in the Wadi Ghuweir on 13 May was pregnant, containing two very small foeti. In Al Ghal, only one female of the eleven bats netted on 17 May was pregnant, it contained two foeti of the crown-rump lengths 20.5 mm. These data suggest that parturitions in *E. bottae* in Jordan occur in the second half of May and/or in early June, which conforms to the data available from other parts of the Middle East (Harrison 1964, Al-Robaae 1966, Nader & Kock 1990, Mendelssohn & Yom-Tov 1999, Benda et al 2006), suggesting the occurrence of births from late April to early June.

Although *E. bottae* was found in owl diet in Palestine (Obuch & Benda 2009), Syria (Shehab et al. 2004, 2007, Benda et al. 2006), Iran (Obuch unpubl.), and Kirghizstan (Obuch & Rybin 1993), no similar data are available from Jordan.

Morphology. External and cranial dimensions of the Jordanian specimens of *Eptesicus bottae* examined are shown in Table 9. For the material examined see Records.

Feeding ecology. *Eptesicus bottae* ranks among small to medium-sized bats applying mostly the slow hawking foraging strategy (Norberg & Rayner 1987, Korine & Pinshow 2004). Its diet was analysed in the Dead Sea area of Palestine (Feldman et al. 2000), where Hymenoptera, Lepidoptera and Coleoptera were reported to be the most important prey items. A considerably different diet composition was described from the Syrian Mesopotamia, where Hymenoptera and Lepidoptera were much less consumed and the most important food items were Coleoptera followed by Heteroptera and Auchenorrhyncha (Benda et al. 2006).

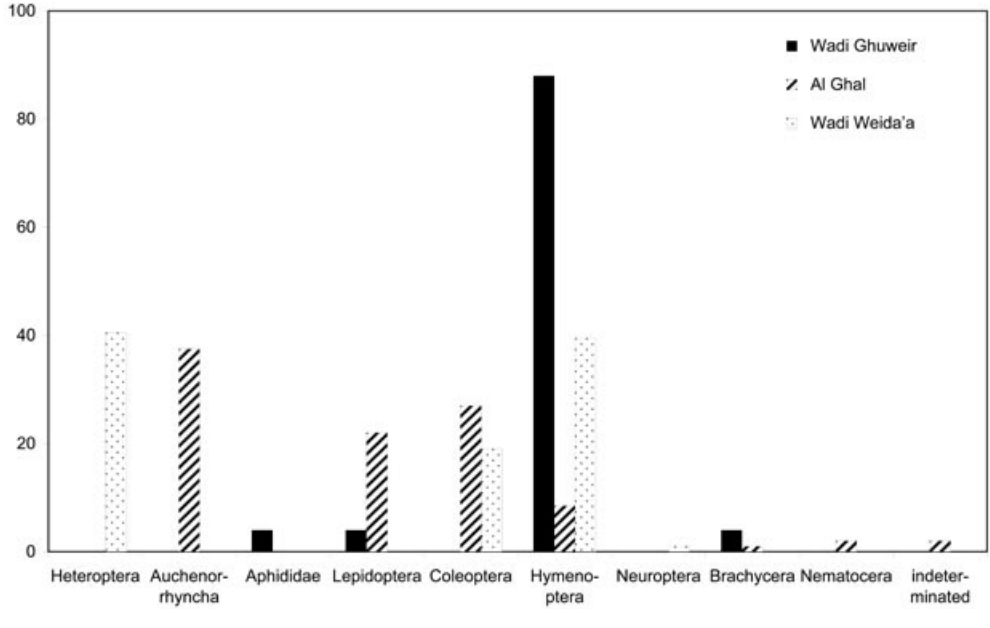
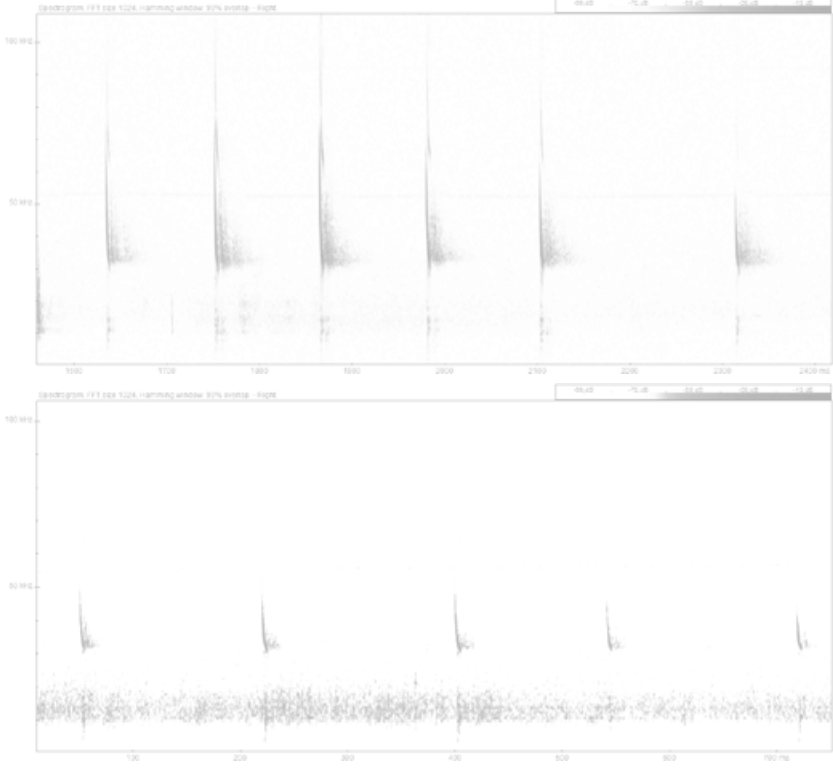


Fig. 56. Volume of particular prey categories in the diet of *Eptesicus bottae* (Peters, 1869) from Jordan. Material: Wadi Ghuweir – 10 pellets analysed from one bats; Al Ghal – 40 pellets from 11 bats; Wadi Weida'a – 20 pellets from one bat.

From Jordan, we analysed 70 faecal pellets from 13 bats originating from three sites (Fig. 56) and a content of one digestive tract. The most representative set of pellets comes from the Al Ghal oasis (Rum Desert), where faeces of 11 individuals were collected. Their composition is dominated by Auchenorrhyncha, Coleoptera and Lepidoptera (Fig. 56). The pellet sets from the Wadi Ghuweir and Wadi Weida'a come only from a single individual each. The first set contained almost entirely Hymenoptera and resembled the data by Feldman et al. (2000), while the other one was dominated by Heteroptera and Hymenoptera, followed by Coleoptera. The consumed Hymenoptera were represented almost entirely by ants (Formicoidea). Scarabaeid beetles of different body sizes prevailed among Coleoptera. The Lepidoptera in the diet of *E. bottae* were represented by small individuals with a wingspan of ca. 25 mm or even less. The digestive tract from a specimen collected in the Wadi Rum contained a small amount of the Lepidoptera remnants. Concerning the representation of the main prey categories, there are very conspicuous differences between literature data and our new results. This suggests remarkable feeding flexibility in *E. bottae*.

Echolocation. In total, we obtained 25 recordings of *Eptesicus bottae* calls from eight localities (Figs. 57, 58, 71). Basic echolocation parameters are given in Table 4. The obtained FMAXE



Figs. 57, 58. Spectrograms of echolocation calls of *Eptesicus bottae* (Peters, 1869). 57 (above) – an individual foraging at pools in the wadi below the village of As Salihiyyah. 58 (below) – an individual foraging at a water reservoir at the pumping station in the Wadi Weida'a.

values were similar to those reported from the Sinai (Benda et al. 2008) and slightly exceeded those reported by Shalmon et al. (1993), Mendelssohn & Yom-Tov (1999), and Holderied et al. (2005) from Palestine. In contrast, the PDUR values found in Jordan were rather lower than those evidenced from Palestine.

Hypsugo ariel (Thomas, 1904)

Records. **New data**: ʿA m m a n: Wadi Abu Al ʾAsal [1], 15 October 2010: found rests of 1 ind. (pair of mandibles) in *Strix butleri* pellets. – A q a b a: Al Ghal [2], above a camel haunt (Fig. 88), 17 May 2009: net. 7 ma, 1 faG (NMP 92488–92494 [S+A], 92487 [A]); – Wadi Rum [3], small watering place at a bedouin camp 1 km east of the village, 24–25 October 2004: net. 1 ms (NMP 92095 [S+A]; cf. Benda et al. 2008), det. & rec. min. 1–2 foraging inds. [4 echolocation recordings]. – K a r a k: Tall Numiera [4], at water pools (Fig. 59), 17 October 2008: net. 1 ma, 1 fs (NMP 92378, 92380 [S+A]), det. & rec. calls of several inds. [4 echolocation recordings]; – Wadi Ibn Hammat [5], at a river in rocky canyon, 23 October 2008: det. & rec. calls of 1 ind. [2 echolocation recordings]; – Wadi Weida'a [6], at a spring ca. 1 km from the wadi estuary, 12 May 2009: det. & rec. calls of several inds., 3 July 2010: obs. numerous foraging inds.; – Wadi Weida'a [7], a pool at water pumping station, 3 July 2010: net. 1 ind., obs. numerous foraging inds. – T a f i l a: Dhana [8], village, 6 August 2000: coll. 1 fa (RSCN unnumbered [A]; leg. Mayas & M. Faqir); at a stream in the village gardens, 6 July 2010: det. several foraging inds., rec. 2 calls; – Wadi Al Hasa [9] (Fig. 23), above a river ca. 1 km E of Hammamat Borbatah, 5 July 2010: net. 1 fa (NMP 92804 [S+A]), det. numerous foraging inds., rec. 1 call. – **Published data**: A q a b a: Disa in Wadi Rum [10], [at least] 2 inds. (Qumsiyeh et al. 1992; as *Pipistrellus ariel* and *P. bodenheimeri*). – K a r a k: 2 km E Ghor es-Safi [Ghor As Safi] in Wadi el-Hasa [11], [at least] 1 ind. [= 28 May 1990: net. 1 fa] (Qumsiyeh et al. 1992; as *Pipistrellus bodenheimeri*). – M a' a n: Petra [= Al Batra] [12], caves near water sources (Disi & Hatough-Bouran 1999; as *Pipistrellus bodenheimeri*).

Distribution. *Hypsugo ariel* is a medium-frequent bat species of Jordan, 12 record sites are known from the mostly arid southwestern portion of the country (Fig. 53), i.e. from the Irano-Turanian and Sudanian Penetration biogeographical regions. The few records published previously (Qumsiyeh 1996, Qumsiyeh et al. 1992, Disi & Hatough-Bouran 1999) were originally assigned to *Pipistrellus ariel* and/or *P. bodenheimeri*; however, we consider both these names as synonyms of *Hypsugo ariel* in accordance with results of the revision by Benda et al. (2008). Occurrence pattern of *H. ariel* in Palestine is similar to that in Jordan; Mendelssohn & Yom-Tov (1999) mapped numerous records from areas widely adjacent to the Rift Valley and additional data are available from the central Negev Desert (Korine & Pinshow 2004, Razgour et al. 2010). In the southern Holy Land the distribution range of *H. ariel* continues from the rather uncommon occurrence in continental Egypt (Qumsiyeh 1985, own unpubl. data), Sinai (Benda et al. 2008) and south-western Arabia (Gaucher & Harrison 1995, Benda et al. in press). In Jordan, the distribution of *H. ariel* reaches its northernmost extent in the Wadi Abu Al ʿAsal near the eastern Dead Sea bank, some 9 km south of ʿEn Fashkha on the western bank of the Dead Sea, the northernmost point of known distribution in Palestine and in the whole range as well (Yom-Tov et al. 1992b) (Mendelssohn & Yom-Tov 1999 did not map this site and marked ʿEn Gedi as the northernmost site, cf. Makin 1977, Riskin 2001).

The general distribution pattern of *H. ariel* in Jordan resembles that of *Eptesicus bottae* and the characters of occurrence of these species in the whole Holy Land (incl. Sinai) are almost identical (see Mendelssohn & Yom-Tov 1999, Benda et al. 2008, and above). Difference between these species, however, consists in the altitude preferences; *H. ariel* favours lower habitats, they are on average more than 350 m below the localities of *E. bottae*. At least four records of *H. ariel* originate in very low altitudes below sea level in the Rift Valley. However, the records of *H. ariel* in Jordan come from a very broad altitude range from 345 m b. s. l. to 1224 m a. s. l. (n=11) and the mean altitude (436.2 m) suggests a preference of rather low to medium elevated sites. Similarly as in the previous species, all records of *H. ariel* in Jordan are evidences of foraging bats (see Records) and its roost preferences thus cannot be evaluated properly.

Field notes. No roosts of *Hypsugo ariel* were found in Jordan. However, this species was netted at least at five sites and its typical echolocation calls were recorded at four others. Qumsiyeh et al. (1992) reported a record (netting) of an individual in the Wadi Al Hasa, to east of Ghor As Safi, in the Dead Sea Basin. Other individuals were also netted in this basin, one above a water reservoir of the pumping station in the estuary of the Wadi Weida'a and two above a water reservoir of the pumping station and at a small pool on a creek at Tall Numiera in the estuary of the Wadi Numiera (Fig. 59). Another netted individual originated from the Wadi Al Hasa (Fig. 23), from more elevated and more humid site above the Hammamat Borbatah resort. In the Rum Desert, *H. ariel* was netted at two places; eight individuals above a camel haunt in the Al Ghal oasis (Fig. 60, 88) and one individual at a watering place in the Wadi Rum. Echolocation calls of foraging individuals were recorded in the rocky canyon of the Wadi Ibn Hammat, at a small spring in the Wadi Weida'a, and in the old village gardens of the Dhana Reserve.

In the Wadi Ibn Hammat, calls of *Rhinopoma cystops* and *Taphozous perforatus* were detected together with those of *H. ariel*. At Tall Numiera, *Pipistrellus pipistrellus* and *Tadarida teniotis* were also recorded, and in the Wadi Weida'a, *Rhinopoma cystops*, *Eptesicus bottae*, and *Tadarida teniotis* were documented. *Rhinopoma cystops*, *Taphozous perforatus*, *T. nudiventris*, *Nycteris thebaica*, *Eptesicus bottae*, and *Tadarida teniotis* were also recorded in the Wadi Al Hasa, and *Myotis nattereri*, *Eptesicus bottae*, *Pipistrellus pipistrellus*, and *Barbastella leucomelas* in the old gardens of the Dhana village. In the Rum Desert, *Eptesicus bottae*, *Otonycteris hemprichii*, and *Plecotus christii* were recorded in the Wadi Rum, and *Rhinolophus clivosus*, *Eptesicus bottae*, *Otonycteris hemprichii*, *Barbastella leucomelas*, and *Plecotus christii* in the Al Ghal oasis.

Fig. 59. Tall Numiera area in the Dead Sea Basin, estuary of the Wadi Numiera (photo by P. Benda). At two water bodies in this small oasis, *Hypsugo ariel* and *Pipistrellus pipistrellus* were netted and their calls recorded, foraging calls of *Tadarida teniotis* were also detected there.

Reproduction of *H. ariel* was documented in Jordan only once; one female out of eight bats netted at Al Ghal on 17 May was pregnant, containing two foeti of the crown-rump lengths of 13.8 mm. This finding suggests occurrence of parturitions in Jordan in late May. It is in accordance with the data from Palestine (Harrison 1964, Yom-Tov et al. 1992b, Mendelssohn & Yom-Tov 1999), where the births are estimated to occur from late April to May.

Rests of *H. ariel* were documented in owl diet in Jordan; a pair of mandibles from one individual was found in a small sample of *Strix butleri* pellets collected in the Wadi Abu Al ʿAsal above the Dead Sea bank. The remains made up 4.35% of mammal items and 1.43% of all prey items of the respective sample; in the whole analysed Hume's owl diet from Jordan they made up 0.043% of all prey items and 0.22% of mammal items (Table 17).

Morphology. External and cranial dimensions of the Jordanian specimens of *Hypsugo ariel* examined are shown in Table 9. For the material examined see Records.

Feeding ecology. *Hypsugo ariel* is a small aerially hawking bat hunting above water pools and around vegetation edges (Yom-Tov et al. 1992b, Korine & Pinshow 2004, own data); in Palestine, it was reported to feed opportunistically on Diptera, Hymenoptera, Coleoptera and Lepidoptera (Yom-Tov et al. 1992b, Whitaker et al. 1994, Feldman et al. 2000). The analysis of digestive tracts collected in the Sinai showed high proportion of small Coleoptera, while other prey categories (Auchenorrhyncha, Brachycera and Lepidoptera) made up altogether 20% of the volume (Benda et al. 2008).

Fig. 60. Portrait of a male *Hypsugo ariel* (Thomas, 1904) netted at Al Ghal (photo by A. Reiter).

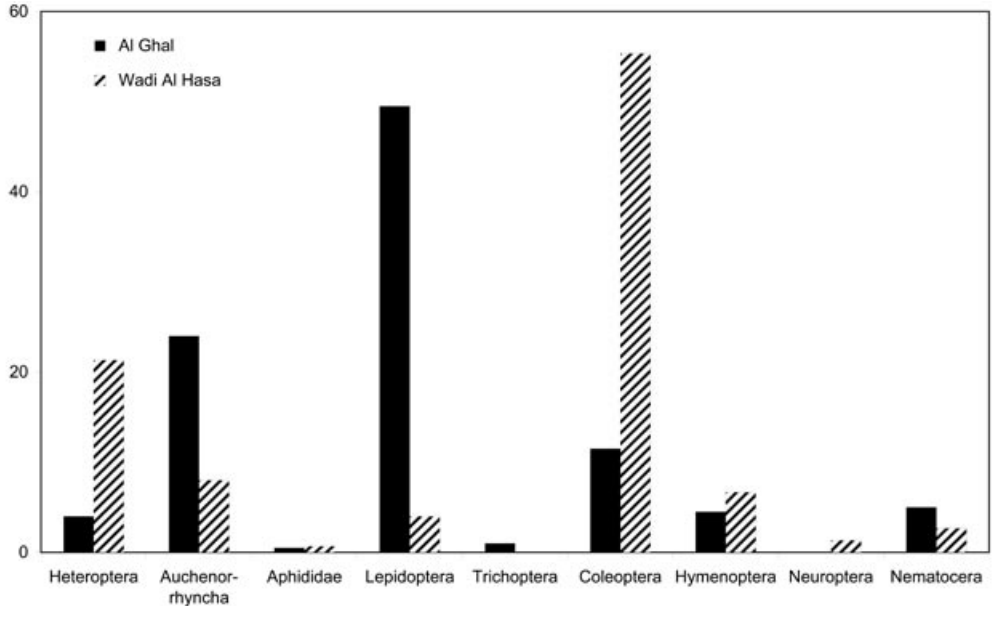


Fig. 61. Volume of particular prey categories in the diet of *Hypsugo ariel* (Thomas, 1904) from Jordan. Material: Al Ghal – 40 pellets analysed from eight bats; Wadi Al Hassa – 15 pellets analysed from one bat.

From Jordan, we analysed 55 faecal pellets from nine bats originating from two sites (Fig. 61) and a content of one digestive tract. The diet composition of *H. ariel* from the pellet set collected at Al Ghal was dominated by small Lepidoptera, while Coleoptera prevailed in the diet sample from the Wadi Al Hasa. One digestive tract from a bat collected at Tall Numeira contained mainly Heteroptera (90% of volume) and a small proportion of Nematocera (10%). The results suggest flexible aerial foraging in *H. ariel*. Based on our observations as well as literature data, we may conclude that the diet of *H. ariel* varies opportunistically according to the availablity of suitable flying prey.

Echolocation. In total, we obtained 11 recordings of *Hypsugo ariel* calls from four sites. Basic echolocation parameters are given in Table 4. As we already stated (Benda et al. 2008), the echolocation design of *H. ariel* is in most characters nearly identical with European *Pipistrellus pipistrellus*, except for shorter PDUR (see Russo & Jones 2002, Papadatou et al. 2008). However, the Middle Eastern populations of the latter species had higher FMAXE values (see Benda et al. 2006 and below). Consequently, despite a syntopical occurrence of *H. ariel* and *P. pipistrellus* in several localities, the two species can be well distinguished due to ca. 5 kHz lower FMAXE and shorter PDUR in the former species.

Pipistrellus pipistrellus (Schreber, 1774)

Records. **New data**: ʻA m m a n: An Nuzha [1], Wadi Al Wala, above a river (Fig. 103), 11 July 2010: net. 1 ma (NMP 92825 [S+A]). – A q a b a: Al Qurayqira [2], Wadi Ghuweir, 2.5 km E of Khirbet Feynan (Fig. 54), at a water pool, 13 May 2009: net. 1 faG (NMP 92427 [S+A]), det. & rec. calls of 1 ind. – I r b i d: ʻArjan [3], above a creek below the village,

12 July 2010: net. 1 ma, 1 mj, 1 fa, 7 faL, 2 fj (coll. 1 ma, 5 fa, NMP 92827–92831 [S+A], 92832 [A]), det. numerous foraging inds. [10 echolocation recordings]; – Nahla [4], above a spring in the village (Fig. 64), 13 July 2010: det. several foraging inds. – K a r a k: As Salihiyyah [5], at rest pools in a wadi below the village (Fig. 90), 8 July 2010: net. 2 mj, 1 fa (NMP 92815 [S+A], 92813, 92814 [A]), det. numerous foraging inds. [12 echolocation recordings]; – Tall Numiera [6], at water pools (Fig. 59), 17 October 2008: net. 1 fa (NMP 92379 [S+A]), det. numerous foraging inds. [12 echolocation recordings]. – M a' a n: Al Batra [7], 15 June 2006: 1 faL (JUST 197 [S+A]; collector unlisted); – Ar Rajif, Jebel Masuda, Ain Amshit [8] (Fig. 95), 21 October 2008: det. & rec. calls of ca. 10 foraging inds. [5 echolocation recordings], 15 May 2009: net. 1 ma, 3 faL (one female bearing 1 fj) (NMP 92458–92460 [S+A], 92461, 92462 [A]), det. & rec. calls of several inds.; – Al Maqar'iyya [9], at a reservoir at village spring (Fig. 63), 7 July 2010: net. 1 ms, 2 fa (NMP 92807, 92808 [S+A], 92809 [A]), det. numerous foraging inds. [17 echolocation recordings]. – T a f i l a: Dhana [10], at a stream in the village gardens, 6 July 2010: det. 1–2 foraging inds. [2 echolocation recordings]. – **Published data**: northern Jordan, 1 ind. (based on a photograph) (Qumsiyeh 1996).

Distribution. Although *Pipistrellus pipistrellus* ranks among less frequent but not rare bat species of Jordan, here it is reported from the country for the first time. Although Qumsiyeh (1996) suggested presence of *P. pipistrellus* in northern Jordan (based on a photograph of an individual),

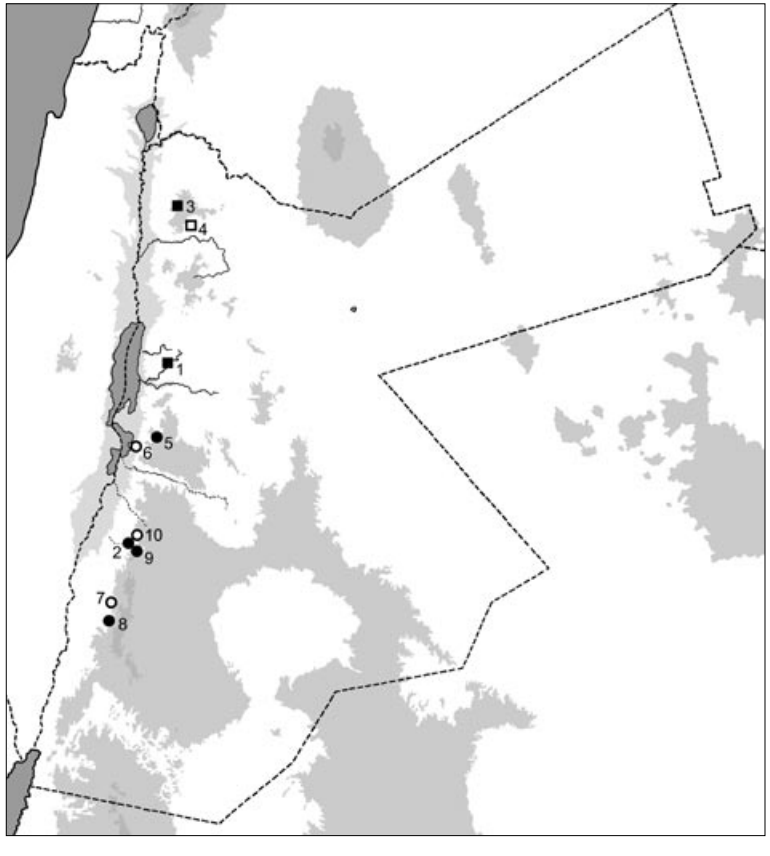


Fig. 62. Records of *Pipistrellus pipistrellus* (Schreber, 1774) in Jordan; squares = records of the northern haplotype group, circles = records of the southern haplotype group (see text; open symbols represent presumable affiliations).

this record was not fully accepted by Qumsiyeh et al. (1998), and the species was not mentioned by Amr (2000) and Amr et al. (2004, 2006) as a member of the Jordanian fauna.

At least ten record sites are available from the western part of Jordan from a belt of areas comprising a surprisingly wide variety of habitats (Fig. 62); two findings were made in the true Mediterranean arboreal zone of the Ajlun Mts. in the Northern Highlands, four records are known from the Rift Valley or areas closely adjacent to it (i.e. in the Irano-Turanian and Sudanian Penetration biogeographical regions) and four records are available from rather arid, elevated sites of the Southern Highlands (but a part of the Mediterranean biogeographical region). This newly revealed occurrence in Jordan significantly shifts the margin of distribution range of *P. pipistrellus* in the Levant. Hitherto Levantine records covered mainly the territories of western Syria and Lebanon (Benda et al. 2006, Horáček et al. 2008, own unpubl. data), and only one record is available from Palestine, from Mount Meiron in Upper Galilee (Makin 1989). The southernmost Levantine finding has been known from the Golan Heights, SW Syria (Mendelssohn & Yom-Tov 1999). The extension of the range in Jordan thus represents a shift of some 300 km to the south. While the occurrence of *P. pipistrellus* in the Mediterranean arboreal zone of Jordan is fully in accordance with the general conception of ecological rank of this species in the Middle East (see e.g. DeBlase 1980, Harrison & Bates 1991, or Benda et al. 2006), the occurrence in semi-arid and arid areas of the Southern Highlands and particularly of the Rift Valley represents a shift in consideration of ecological limits of the possible distribution range of this species.

The records of *P. pipistrellus* in Jordan come from a broad altitude range of –345–1224 m a. s. l. (n=10) and the mean altitude (630.6 m) suggests a preference of medium-elevated to elevated sites. While the altitudes of two record sites in the Mediterranean zone of the Northern Highlands (575 and 728 m a. s. l.; mean 651.5 m) are in accordance with the preference of other Mediterranean bats in Jordan (see e.g. *Rhinolophus euryale*, *Myotis blythii*, or *M. emarginatus*), the southern group of records comes from a broad range of altitudes of –345–1224 m a. s. l. (mean 625.4 m; n=8), suggesting that the populations of the arid habitats inhabit most of the available altitude categories of the respective landscape (remembering the occurrence patterns of *Rhinolophus clivosus*, *Eptesicus bottae*, *Hypsugo ariel* or *Plecotus christii*).

Field notes. No roosts of *Pipistrellus pipistrellus* were found in Jordan. However, this species was netted at seven sites and its echolocation calls were recorded at least at another one. Twelve individuals – probably a part of a nursery colony – were netted above a creek in the valley below the village of ʿArjan covered by orchards of old trees, possibly providing roost opportunities for the bats. A group of *P. pipistrellus*, possibly also representing a colony, was recorded to forage at the village of Al Maqar'iyya (Fig. 63); three individuals were netted above a reservoir at a village spring and numerous other individuals foraged close to the spring and surrounding vegetation. Three individuals were netted at rest pools in a wadi below the village of As Salihiyyah near the Karak Castle (Fig. 90). Four bats were netted above a water reservoir under the spring in the Ain Amshit oasis in the Jebel Masuda Mts. (Fig. 95). At other places, only single individuals of *P. pipistrellus* were netted, all these places are adjacent to the Rift Valley; above a river in the Wadi Al Wala, above a water reservoir of the pumping station at Tall Numiera in the estuary of the Wadi Numiera (Fig. 59), and at a water pool in the Wadi Ghuweir (Fig. 54), east of Khirbet Feynan. Calls of foraging individuals were additionally recorded at a water reservoir in Nahla near Jerash in the Ajlun Mts.

Numerous bat species were recorded together with *P. pipistrellus*; calls of *Rhinopoma microphyllum*, *Rhinolophus ferrumequinum* and *Pipistrellus kuhlii* were recorded at ʿArjan, and *Rousettus aegyptiacus* and *Pipistrellus kuhlii* were netted at Nahla (Fig. 64). At Tall Numiera, two individuals of *Hypsugo ariel* were also netted and calls of *Tadarida teniotis* detected. *Rhinolophus clivosus*,

Figs. 63, 64. Sites of occurrence of *Pipistrellus pipistrellus* (Schreber, 1774) in Jordan (photos by A. Reiter). 63 (above) – spring and reservoir at Al Maqar'iyya, Southern Highlands; a foraging site of numerous individuals of *Pipistrellus pipistrellus* and *Eptesicus bottae*. 64 (below) – reservoir at a spring in the village of Nahla near Jerash, Northern Highlands; at this water body, *Rousettus aegyptiacus* and *Pipistrellus kuhlii* were netted and calls of *Pipistrellus pipistrellus* detected.

Eptesicus bottae and *Plecotus christii* were simultaneously recorded in the Ain Amshit oasis, while *Rhinolophus clivosus*, *Eptesicus bottae*, *Otonycteris hemprichii*, and *Tadarida teniotis* in the Wadi Ghuweir. Calls of *Eptesicus bottae* were also detected at Al Maqar'iyya, and *Pipistrellus kuhlii* and *Barbastella leucomelas* netted at As Salihiyyah. In the Wadi Al Wala, *Rousettus aegyptiacus* and *Tadarida teniotis* were netted, while calls of *Rhinopoma cystops* and *Eptesicus bottae* were

Table 10. Basic biometric data on the examined samples of *Pipistrellus pipistrellus* (Schreber, 1774) and results of the analysis of variance, comparing the northern and southern Jordanian population sample sets. For abbreviations see pp. 192, 193

	N Jordan					S Jordan					ANOVA		
	n	**M**	min	max	SD	n	**M**	min	max	SD	df	F	p
LC	7	**45.6**	41	47	2.149	9	**43.1**	41	46	2.028	–	–	–
LCd	7	**34.9**	33	36	1.215	9	**36.2**	34	39	1.481	–	–	–
LAt	7	**30.30**	29.1	31.6	0.956	10	**30.86**	29.8	31.6	0.583	15	2.256	0.154
LAu	7	**12.31**	11.6	13.3	0.959	9	**12.24**	11.4	13.1	0.536	–	–	–
LTr	7	**5.16**	4.4	5.5	0.369	9	**4.77**	3.9	5.7	0.524	–	–	–
LCr	6	**11.58**	11.43	11.81	0.162	9	**11.67**	11.15	12.03	0.281	13	0.491	0.496
LCb	6	**11.11**	10.44	11.38	0.353	9	**11.20**	10.73	11.57	0.294	13	0.299	0.594
LaZ	5	**7.31**	6.91	7.48	0.231	6	**7.34**	7.04	7.54	0.192	9	0.047	0.833
LaI	6	**3.01**	2.84	3.18	0.116	9	**3.02**	2.86	3.23	0.113	13	0.093	0.765
LaInf	6	**3.43**	3.26	3.62	0.122	9	**3.43**	3.28	3.59	0.103	13	0.000	0.993
LaN	6	**5.90**	5.58	6.09	0.182	9	**5.93**	5.67	6.13	0.159	13	0.132	0.722
LaM	6	**6.55**	6.19	6.78	0.200	9	**6.62**	6.36	6.74	0.124	13	0.843	0.375
ANc	6	**4.10**	3.93	4.37	0.149	9	**4.19**	4.03	4.40	0.100	13	1.186	0.195
LBT	6	**2.74**	2.60	2.82	0.080	9	**2.77**	2.63	2.89	0.085	13	0.372	0.553
CC	6	**3.44**	3.25	3.64	0.125	9	**3.48**	3.31	3.57	0.073	13	0.535	0.477
M^3M^3	6	**4.67**	4.33	4.83	0.183	9	**4.81**	4.61	4.95	0.122	13	3.439	0.087
CM^3	6	**4.08**	3.73	4.21	0.179	9	**4.14**	4.02	4.28	0.093	13	0.666	0.429
LMd	5	**8.03**	7.56	8.29	0.287	9	**8.14**	7.96	8.43	0.137	12	0.951	0.349
ACo	5	**2.34**	2.06	2.46	0.163	9	**2.30**	2.14	2.41	0.081	12	0.424	0.527
CM_3	5	**4.31**	4.02	4.48	0.184	9	**4.34**	4.22	4.44	0.072	12	0.268	0.614

recorded. In the old gardens of the Dhana village also *Myotis nattereri* was netted and calls of *Eptesicus bottae*, *Hypsugo ariel*, and *Barbastella leucomelas* were recorded.

Reproduction of *P. pipistrellus* was documented at several sites in Jordan. Three of four bats netted in the Ain Amshit oasis on 15 May were females, two of them were lactating and one was pregnant. However, the latter female shortly after the netting, being placed into a cloth bag, gave birth to a juvenile; the LAt of the newborn female was 9.4 mm (= 31.5% of the mother's LAt 29.8 mm). One of three bats netted at Al Maqar'iyya on 7 July, was a volant juvenile male, the other bats were adult non-lactating females; two of the three bats netted at As Salihiyyah were juvenile males, the third bat was an adult non-lactating female; seven bats of the twelve netted at ʿArjan on 12 July were lactating females, three others were volant juveniles. These data suggest the occurrence of parturitions in southern Jordan in the second ten-day period of May, while in northern Jordan probably somewhat later. Such observation is in accordance with the findings from northern Palestine and western Syria (Mendelssohn & Yom-Tov 1999, Benda et al. 2006), suggesting timing of births in the Levant in early June.

P. pipistrellus was detected to be an item of owl diet in Turkey, Lebanon, Syria and Iran (Obuch 1994, 2010, Obuch & Krištín 2004, Benda et al. 2006, Obuch unpubl.), however, no similar data are available from Jordan.

Morphology and variation. External and cranial dimensions of the Jordanian specimens of *Pipistrellus pipistrellus* examined are shown in Table 10. For the material examined see Records.

As pointed out above, *P. pipistrellus* was recorded in Jordan from several different bioregions, two records are available from the Mediterranean arboreal zone of the Ajlun Mts., the other records come from upper parts of valleys in the Southern Highlands sparsely covered by the



Figs. 65–67. Portraits of *Pipistrellus pipistrellus* (Schreber, 1774) from northern and southern Jordan, respectively (photos by A. Reiter). 65 (left) – an individual from Al Maqar'iyya, southern Jordan. 66 (middle) – an individual from the Wadi Ghuweir, southern Jordan. 67 (right) – an individual from ʿArjan, northern Jordan.

Mediterranean vegetation, from lower parts of the valleys leading to the Rift, or from sites lying in the Rift Valley itself (Tall Numiera), close to or even in the desert habitats. As also already stressed, while in northern Jordan the occurrence pattern of *P. pipistrellus* resembles that of the Mediterranean faunal elements, in the southern part of Jordan this pattern resembles that of the southern desert fauna.

However, this 'biogeographical difference' is also obvious from the external appearace of the bats, i.e. from their colouration (Figs. 65–67). The representatives of *P. pipistrellus* from the Mediterranean zone are similar to the bats from other Mediterranean populations (Maghreb, Europe, most of Turkey, NW Levant), their pelage colouration is dark rusty brown, naked parts (face, ears and wing membranes) are dark brown or blackish. The representatives of *P. pipistrellus* from the Southern Highlands and areas adjacent to the Rift are of pale 'desert' appearance, their pelage is pale brown, buff or beige, the colouration of naked parts varies from pale brown

Fig. 68. External genitalia of *Pipistrellus pipistrellus* (Schreber, 1774) from an individual netted at Al Maqar'iyya, southern Jordan (photo by A. Reiter).

(even partly unpigmented) to dark brown; the appearance of these bats is incomparable to that of any other population of *P. pipistrellus*, but in extreme cases it is very similar to the colouration of *Hypsugo ariel* (compare Figs. 60 and 65). Possible confusions of the latter species with *P. pipistrellus* may be the reason why this species was overlooked for a long time in the southern parts of the Holy Land.

Morphometric comparison of the two populations of *P. pipistrellus* from Jordan did not show any remarkable differences (Table 10); although the south-Jordanian bats were slightly larger in some skull length dimensions than the north-Jordanian bats, the metric differences were not significant in the analysis of variance (Table 10). External appearance of male genitalia in the specimens from southern Jordan (Fig. 68) agree in shape and colour with specimens from the European populations.

We also performed a molecular genetic comparison of partial sequences (402 bp) of the mitochondrial gene for cytochrome *b* (cyt*b*) of the Jordanian samples of *P. pipistrellus* with the

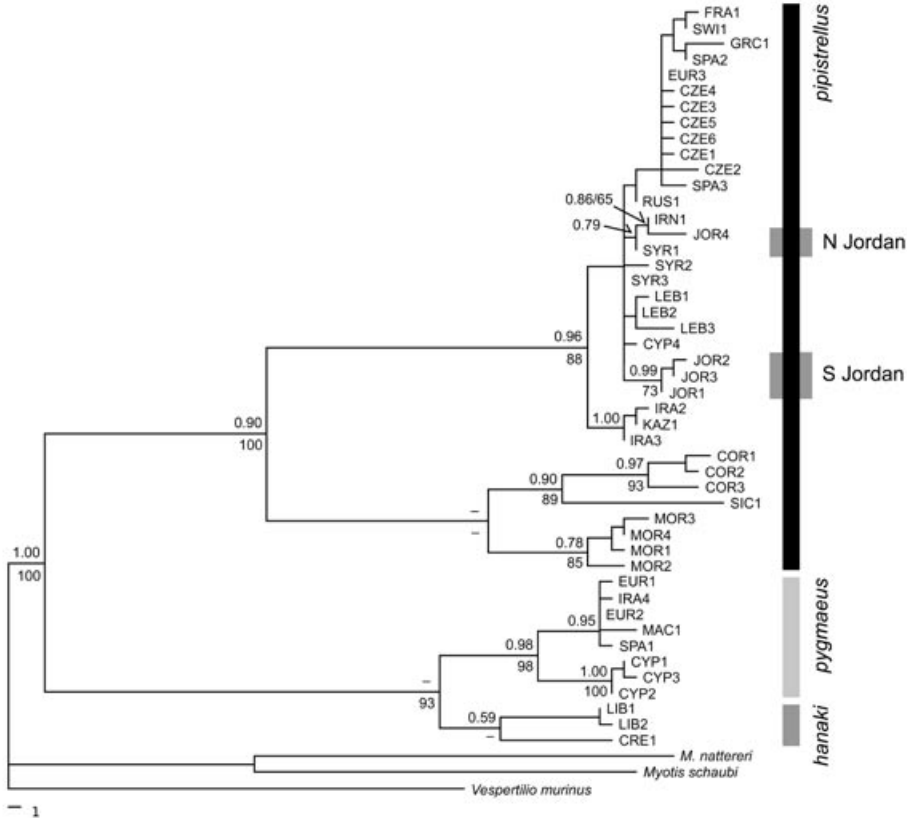


Fig. 69. Neighbour-joining tree based on K2p distances showing position of *Pipistrellus pipistrellus* haplotypes from Jordan (grey boxes). Maximum parsimony (heuristic search of 100 sequence addition replicates and TBR swapping) and Bayesian consensus (3.5 million generations run under the GTR+Γ substitution model) trees were similar in topology. Bootstrap support of maximum parsimony (1000× bootstrap) is indicated above and posterior probability of Bayesian analysis below the respective branches. For the haplotype acronyms see text and Hulva et al. (2007b).

Table 11. GenBank Accession Numbers (GBAN) of the examined Jordanian specimens of *Pipistrellus pipistrellus* (Schreber, 1774) (402 bp of the cytochrome *b* gene)

haplotype	GBAN	voucher	sex	collection site & date
JOR1	JN087548	NMP 92427	f	Wadi Ghuweir, east of Khirbet Feynan, 13 May 2009
		NMP 92807	f	Al Maqar'iyya, 7 July 2010
JOR2	JN087549	NMP 92458	m	Ain Amshit, Jebel Masuda, 15 May 2009
		NMP 92460	f	Ain Amshit, Jebel Masuda, 15 May 2009
JOR3	JN087550	NMP 92808	f	Al Maqar'iyya, 7 July 2010
		NMP 92813	m	As Salihiyyah, 8 July 2010
		NMP 92814	m	As Salihiyyah, 8 July 2010
JOR4	JN087551	NMP 92825	m	Wadi Al Walah, 11 July 2010
SYR1	AY316337	NMP 92827	m	ʿArjan, 12 July 2010

available sequences of other SW Palaearctic populations of bats of the *P. pipistrellus* group (cf. Benda et al. 2003, 2004b, Hulva et al. 2004, 2007b). Nine examined Jordanian specimens gave five unique haplotypes (Table 11), four of them were new (hereafter labelled as JOR1–4), while the remaining one was identical with the published haplotype SYR1 (Benda et al. 2004b, Hulva et al. 2007b) from specimens originating in Syria and Lebanon. Three haplotypes (JOR1–3) originated from seven bats collected in the southern part of the Jordanian range of the species (As Salihiyyah, Wadi Ghuweir, Al Maqar'iyya, Ain Amshit), the haplotype JOR4 from one bat collected in the Wadi Al Wala above the Dead Sea, and the haplotype SYR1 from one bat collected at ʿArjan in northern Jordan. All these haplotypes belonged to the 'Continental lineage' of the 'Clade I' (= *P. pipistrellus* s.str.) by Hulva et al. (2007b) (Fig. 69). While the haplotypes from the northern part of the Jordanian range of *P. pipistrellus* (SYR1, JOR4) clustered with other haplotypes originating from the Middle East (Iran, Syria, Lebanon) (K2p distance within the sublineage 0.2–1.0%), the haplotypes from southern Jordan (JOR1–3) clustered together and created a common sublineage (K2p distance within the sublineage 0.2–0.5%) well supported by bootstrap values (Fig. 69). Although the geographical distance between the closest sites of the northern and southern haplotype groups in Jordan (Wadi Al Wala – As Salihiyyah) is some 43 km only, the K2p genetic distance between the respective haplotypes (JOR3 vs. JOR4) made up 2.0%. This relatively extensive genetic distance as well as the adaptation to arid conditions of southern Jordan (registerable also in the 'desert' colouration) indicate isolated evolution of the south-Jordanian population/sublineage of *P. pipistrellus*.

Feeding ecology. *Pipistrellus pipistrellus* is a small-sized aerial hawker (Norberg & Rayner 1987). Its diet was studied particularly in Europe, where it was found to feed especially on swarming small Nematocera above water surface or close to water bodies, other frequently consumed prey categories were Lepidoptera, Heteroptera and Hymenoptera (Swift et al. 1985, Hoare 1991, Sullivan et al. 1993, Beck 1995, Barlow 1997, etc.).

Concerning diet composition of *P. pipistrellus* populations of southwestern Asia, data are available from Azerbaijan, Turkey and Syria. Rahmatulina (2005) found the diet in Azerbaijan to be composed of Coleoptera (particularly small Carabidae, Elateridae, Scarabaeidae), Ephemeroptera, Plecoptera, Blattodea, and Hymenoptera (particularly Symphyta). Whitaker & Karataş (2009) found that *P. pipistrellus* bats feed especially on Lepidoptera and Coleoptera in Turkey. Formicoidea, Nematocera, Heteroptera, Coleoptera, and Auchenorrhyncha were the most important food items in the diet of *P. pipistrellus* in Syria (Benda et al. 2006). Compared to the results from Europe, Nematocera are with some exceptions nearly absent from the Asian diet samples.

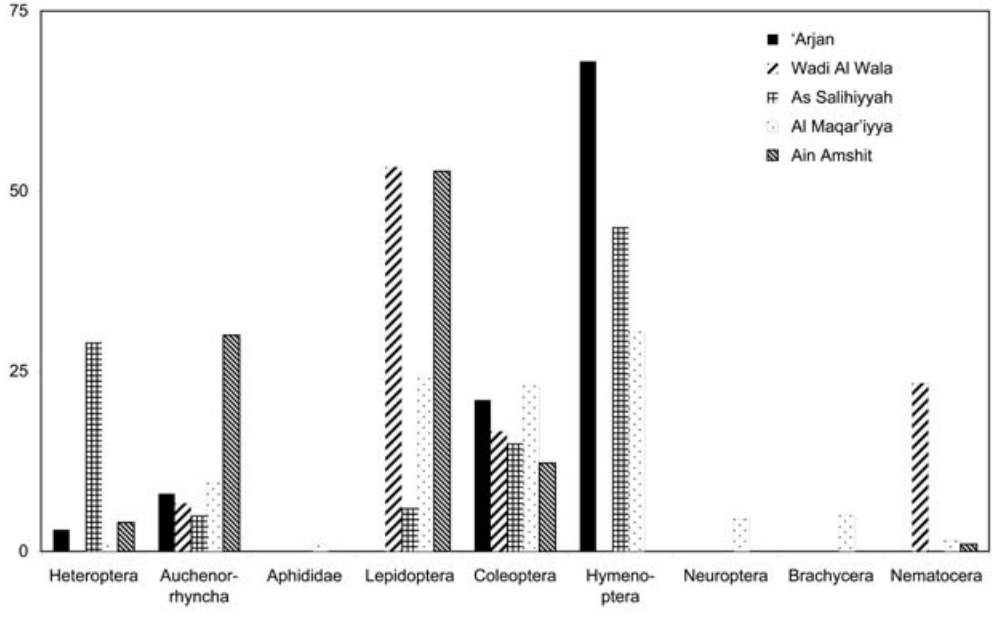


Fig. 70. Volume of particular prey categories in the diet of *Pipistrellus pipistrellus* (Schreber, 1774) from Jordan. Material: Ain Amshit – 40 pellets analysed from four bats; ʿArjan – 40 pellets from six bats; Wadi Al Wala – three pellets from one bat; Al Maqar'iyya – 20 pellets from three bats; As Salihiyyah – 20 pellets from three bats.

From Jordan, we analysed 123 faecal pellets from 17 individuals originating from five sites (Fig. 70). The composition of *P. pipistrellus* diet was characterised by infrequent presence of Nematocera, due to the scarcity of larger fresh water bodies. The most consumed items were Formicoidea and Lepidoptera, other important prey categories were Coleoptera, Auchenorrhyncha and Heteroptera.

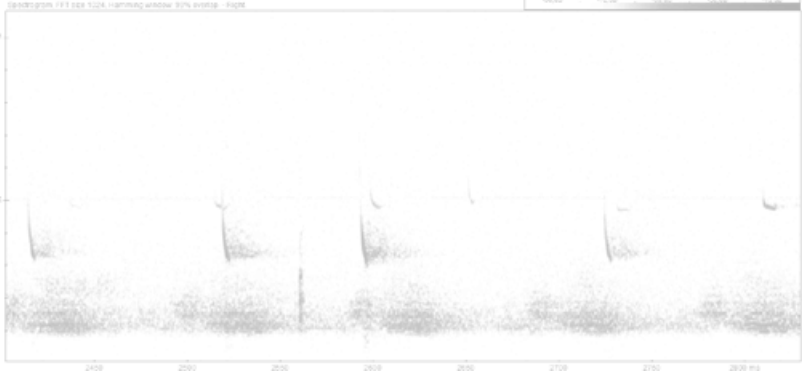
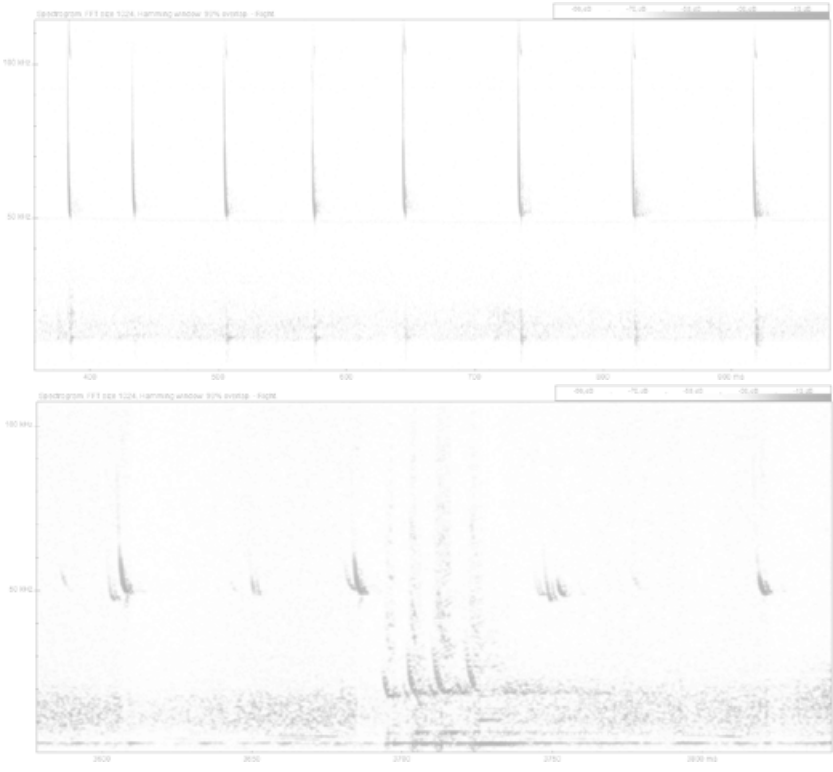


Fig. 71. Spectrogram of echolocation calls of *Eptesicus bottae* (Peters, 1869) and *Pipistrellus pipistrellus* (Schreber, 1774); individuals foraging in gardens of the Dhana Village.



Figs. 72, 73. Spectrograms of echolocation calls of *Pipistrellus pipistrellus* (Schreber, 1774). 72 (above) – an individual foraging at a water reservoir near Al Maqar'iyya. 73 (below) – several foraging individuals and one individual performing a display call at a water pool at Tall Numiera.

Among the consumed Coleoptera, smaller Curculionoidea, Carabidae and Scarabaeidae prevailed. Lepidoptera in the Jordanian diet of *P. pipistrellus* were represented by small individuals with a wingspan of ca. 25 mm or less. The results suggest aerial hawking as the prevailing foraging strategy and indicate considerable flexibility and regional variation in the diet.

Echolocation. In total, we obtained 58 recordings of *Pipistrellus pipistrellus* calls from seven localities (Figs. 71–73, 78, 79). Basic echolocation parameters are given in Table 4. The echolocation parameters, especially the FMAXE values, in the desert Jordanian populations of *P. pipistrellus* were somewhat higher* than in the populations of the northern Levant (Benda et al. 2006, own unpubl. data).

Records of ectoparasites. **Original data**: A r g a s i d a e: *Argas vespertilionis*: 1 larva (IZB; det. J. Krištofík) from 1 ind., ʿArjan, 12 July 2010. – M a c r o n y s s i d a e: *Macronyssus* sp.: 1 ma (IZB; det. P. Mašán) from 1 ind., ʿArjan, 12 July 2010. – *Steatonyssus periblepharus*: 2 protonymphs and 2 fa (IZB; det. P. Mašán) from 3 inds., ʿArjan, 12 July 2010. – *Parasteatonyssus hoogstraali*: 1 ma (IZB; det. P. Mašán) from 1 ind., ʿArjan, 12 July 2010. – C i m i c i d a e: *Cacodmus vicinus*: 2 fa (CUP; det. O. Balvín) from 2 mj, 1 fa, As Salihiyyah, 8 July 2010. – N y c t e r i b i i d a e: *Basilia daganiae*: 1 fa from 1 fa (NMP 92427), Wadi Ghuweir, 13 May 2009; – 1 fa (UCPN) from 1 mj (NMP 92809), Al Maqar'iyya, 7 July 2010. – I s c h n o p s y l l i d a e: Ischnopsyllidae sp., 6 inds. from 1 ind., ʿArjan, 12 July 2010.

Comments on ectoparasites. From *Pipistrellus pipistrellus*, a bat species reported here for the first time from Jordan (see above), an unusually high number of seven ectoparasite species was recorded (some of them also for the first time from the country); viz., one tick *Argas vespertilionis* (Latreille, 1802), three mites *Macronyssus* sp., *Steatonyssus periblepharus* Kolenati, 1858, and *Parasteatonyssus hoogstraali* Keegan, 1956, one bug *Cacodmus vicinus* Horvath, 1932, one bat fly *Basilia daganiae* Theodor et Moscona, 1954, and one bat flea (Ischnopsyllidae sp.). While all species of Acari and the flea were found solely at one site in the northern part of the host distribution range in Jordan (ʿArjan), the other insect parasites (bug and bat fly) were found only in the southern part of that range.

The species of the genus *Pipistrellus* are reported to rank among the principal hosts of *Argas vespertilionis* (Fillipova 1966, Dusbábek 1972). Distribution of this parasite covers Europe, North Africa and Asia to Australia (Filippova 1966). The present record represents the first evidence of this tick species from Jordan (it was also collected from *Rousettus aegyptiacus* and *Pipistrellus kuhlii*). The mite *Steatonyssus periblepharus* parasitises mainly bats of the genus *Pipistrellus*, but it was also found on species of the genera *Myotis*, *Plecotus* and *Eptesicus* (Kolenati 1859, Till & Evans 1964). It occurs also in the neighbouring countries to Jordan: Egypt, Palestine and Lebanon (Costa 1966, Radovsky 1967, Anciaux de Faveaux 1976). *Parasteatonyssus hoogstraali* was originally described from *Tadarida teniotis* and documented on this host in more regions of the southwestern Palaearctic (Radovsky 1967; see under *T. teniotis*), *Pipistrellus pipistrellus* is a new host species for this parasite. It is here reported for the first time from Jordan (found also on *Tadarida teniotis*, see below) and from the Arabian Peninsula as well.

The bug *Cacodmus vicinus* is here reported from Jordan for the first time. Theodor & Moscona (1954) mentioned a record of this bug from *Pipistrellus kuhlii* from Palestine. The bat fly *Basilia daganiae* parasitises mainly on *Pipistrellus kuhlii* (Theodor 1956, 1967), our new record from *P. pipistrellus* represents the first evidence from this host species and from Jordan. A few records of this parasite are available from Cyprus, Turkey, Syria, Palestine and Kenya (Theodor & Moscona 1954, Theodor 1956, 1967). Three bat flea species are known to parasitise *P. pipistrellus* in the Middle East, *Ischnopsyllus octactenus* (Kolenati, 1856) and *I. dolosus* Dampf, 1912 from Turkey (Aktaş 1987, 1990), and *I. consimilis* (Wahlgren, 1904) from Lebanon (Lewis 1962). We suppose that the unidentified flea collected at ʿArjan belonged to one of these forms.

Pipistrellus kuhlii (Kuhl, 1817)

Records. **New data**: ʿA m m a n: Ash Shunah Al Janubiyya [1], Wadi Shu'ayb ca. 5 km NE, at a stream, 22 May 2009: det. calls of several inds.; – Dir Deglah [2], 1995: coll. 2 fa (JUST ZSA339 [A], unnumbered [S+B]; leg. Z. Amr & M. Yousef); – Iraq Al Amir [3], at artificial caves (Fig. 3), 10 October 2008: det. & rec. calls of numerous foraging inds. [13 echolocation recordings], 10 May 2009: det. & obs. ca. 5 inds., 2 July 2010: det., obs. & rec. ca. 5 foraging inds. [5 echolocation recordings]; – Qasr Kharana [4], ancient caravanserai, 2 April 2008: found rest of 1 ind. (skull with a pair

* It is worth mentioning that no other species of the genus *Pipistrellus* with a similarly high-frequency echolocation as in *P. pipistrellus* has been recorded in Jordan. Contrastingly, researchers conducting bat-detector studies in the Negev Desert of Palestine (Korine & Pinshow 2004, Razgour et al. 2010) assigned all the high-frequency echolocating bats of the genus *Pipistrellus* to *P. rueppellii* (Fischer, 1829) and not to *P. pipistrellus*. Razgour et al. (2010) used FMAXE 49–53 kHz as a diagnostic frequency for *P. rueppellii*, but this frequency range perfectly fits to the desert population of *P. pipistrellus* discovered in southwestern Jordan. According to our data from the Western Desert of Egypt, in *P. rueppellii* the FMAXE is higher (55–60 kHz; Lučan, unpubl.) than in *P. pipistrellus* from Jordan. Although we recorded a relatively abundant occurrence of *P. pipistrellus* along the Jordanian side of the Rift Valley, no records of this species are available from Palestine, neither from the Rift or from the Negev Desert. It seems highly improbable that *P. pipistrellus* is absent from Palestine; it rather was overlooked due to its close similarity to *Hypsugo ariel* in external appearance (see Morphology and variation in *P. pipistrellus*). Therefore, it seems likely that at least some of the Palestinian detector records of *P. rueppellii* were in fact registrations of the desert form of *P. pipistrellus*.

of mandibles) in *Athene noctua* pellets, 12 October 2008: coll. 1 ma (NMP 92365 [S+A]) from a wall fissure of the second floor, 23 May 2009: obs. 1 ind. in a ceiling fissure of the second floor, 9 July 2010: obs. 1 ind. in a ceiling fissure of the second floor, 5 October 2010: obs. 2 inds. in a ceiling fissure of the second floor; – Quseir Amra [5], at the ancient bath, 12 October 2008: det. & rec. calls of 1 ind. – A q a b a: Aqaba [6], corniche at the Ottoman fortress, 16 May 2009: det. calls of numerous inds. – B a l q a': Dayr ʿAlla [7], deserted house, 14 October 2010: obs. a colony of ca. 20 inds. (3 inds. exam.); – Jufat Al Qafrayn [8], above a fishpond, 15 July 2010: net. 1 ma, 1 mj, 1 fa (coll. 1 m, 1 f, NMP 92840, 92841 [S+A]), det. numerous foraging inds. [18 echolocation recordings]. – I r b i d: Al Khrba, Beni Kinan [9], 24 November 1994: coll. 1 fs (JUST ZSA339 [A]; leg. F. Suleiman); – Al Mustaba [10], Az Zarqa' River Valley, above a spring in valley slope, 11 October 2008: det. & rec. calls of several foraging inds. [12 echolocation recordings]; – ʿArjan [11], cave above the village, 25 May 2009: det. calls of several inds.; – ʿArjan [12], above a creek below the village, 12 July 2010: det. & rec. numerous foraging inds. [22 echolocation recordings]; – ʿArjan [13], area of the RSCN camp, 12 July 2010: det. 1 foraging ind., rec. 3 calls; – Ar Ramtha [14], campus of the Jordan University of Science and Technology, 7 October 1991: coll. 1 fs (JUST ZSA028 [A]; leg. B. Gharaybeh), 18 October 2000: coll. 1 ind. s.i. (JUST unnumbered [S+B]; leg. M. Abu Baker); – Az Zarqa' River valley above the King's Talal Dam [15], 21 October 2004: det. calls of numerous inds.; – Jerash [16], garden, 13 July 2010: det. & rec. several foraging inds. [8 echolocation recordings]; – Majdal [17], living house, fissure between ceiling bricks, 14 July 2010: obs. a colony of 9+ inds.; – Malka [18], a spring below the village, 27 May 2009: net. 2 ma, 1 faL (NMP 92559–92561 [S+A]), det. several inds.; – Malka [19], Wadi Al Kurasi, 26 October 2008: det. & rec. calls of numerous inds. [12 echolocation recordings], 27 May 2009: det. calls of several inds.; – Nahla [20], above a spring in the village (Fig. 64), 13 July 2010: net. 1 ma, 1 faL (coll. m, NMP 92833 [S+A]), det. several foraging inds. – K a r a k: As Salihiyyah [21], at rest pools in a wadi below the village (Fig. 90), 8 July 2010: net. 1 ma, 3 mj, 1 fa, 6 faL, 3 fj (coll. 1 ma, 4 fa, NMP 92816–92819 [S+A], 92820 [A]), det. & rec. numerous foraging inds. [41 echolocation recordings]; – 2 km E of Ghor Es Safi [= Ghor As Safi] [22], 28 May 1990: net. 1 fa. – M a f r a q: Duqra [23], Az Zarqa' River valley 4 km NW, 23 May 2009: det. calls of several inds. – Z a r q a': Al Azraq Al Janubi [24], Azraq wetland (Fig. 76), 18 April 2008: det. at least 7 foraging inds., wetland, at a dam between ponds, 13 October 2008: net. 6 ma, 1 ms, 1 fa, 2 fs, 2 s.i. (coll. 4 m, 3 f, NMP 92368–92372 [S+A], 92373, 92374 [A]), det. & rec. calls of several inds. [5 echolocation recordings], 9 July 2010: net. 1 mj, 2 faL, 4 fj (coll. 1 fa, NMP 92822 [S+A]); – Al Azraq Al Janubi [25], Shawmari Wildlife Reserve, wildlife watering place, 10 July 2010: net. 1 mj, 1 faL (coll. f, NMP 92823 [S+A]), det. ca. 10 foraging inds.; – Al Azraq Al Shimali [26], Qasr Azraq, fissure in the ceiling of mosque, 13 October 2008: obs. 2 inds., 10 July 2010: obs. 16 inds. (in two groups of 4 and 10 inds., respectively, and two solitary inds.), other two inds. in the Lawrence's room; – Al Halabat Al Sharkiyah [27], Hammam As Sarh, fissures in vaulted ceiling of the ancient bath, 13 October 2008: obs. 8 inds. (coll. 1 ma, NMP 92367 [S+A]); – Al Hazim [28], at the Al Hazim Al Dhahek Well, 29 May 2009: det. calls of several inds. – **Published data**: B a l q a': 3 km W Suwaylih [29], 19 August 1994: 3 m (Qumsiyeh et al. 1998); – near the Dead Sea (between South Shounah and Swymah) [30], 19 April 1997: net. [at least] 1 ind. (Darweesh et al. 1997). – I r b i d: Aqraba [31], 1 ind. (Qumsiyeh et al. 1992, 1998); – Ar-Ramtha [32], 4 November 1992: 1 ind. (Qumsiyeh et al. 1998). – M a' a n: Wadi Musa [33] (ca. 15 km N of Petra [= Al Batra]), Al Bayda Wastewater Treatment Station, 13 June 2006: 2 f (Karatas et al. 2008). – Z a r q a': Al-Hazim [28], deserted brick wall, 28 October 1996: obs. roosting 1 m, 9 f, coll. 1 m, 3 f (Qumsiyeh et al. 1998); – Azraq ed Druz [24], 1 ind. (Qumsiyeh 1985); – Qasr Azraq [26], 1966: a colony, net. 1 fa, 2 inds. (Atallah 1967, 1977, cf. Atallah 1966); Shishan, house, 1966: 3 inds. (Atallah 1967, cf. Atallah 1966); Azraq ash Sheishan, 1 ind. (Qumsiyeh 1985).

Distribution. *Pipistrellus kuhlii* is a very common bat species in Jordan, 33 record sites are available from all geographical parts of the country (the highest number of sites registered – along with the records of *Tadarida teniotis*, see below), i.e. from all four main biogeographical regions (Fig. 74). It is certainly the most common bat species of the Mediterranean arboreal zone of northwestern Jordan and of the steppe/semi-desert zone of northeastern Jordan. Although *P. kuhlii* was previously reported only from a limited number of localities throughout the northern portion of the country (both Mediterranean and semi-desert zones) (Atallah 1966, 1967, 1977, Qumsiyeh et al. 1992, 1998, Darweesh et al. 1997), it also occurs in the southern most arid portion of Jordan. The records there are, however, very limited in comparison with the numbers originating from northern Jordan. In the southern areas, the occurrence of *P. kuhlii* is probably more dependent on availability of anthropically modified habitats than in the northern areas. A very similar distribution pattern is found in *P. kuhlii* in Palestine; Mendelssohn & Yom-Tov (1999: 135) mentioned this species to be: "the most common insectivorous bat in the Mediterranean zone, but is also found in the Northern Negev and Judean Deserts and in the Dead Sea Area", however, south of ca. 30.5' N (central and southern Negev, southern Arava Valley), they did not map any locality.

In the last years, however, some records were made in these areas; Korine & Pinshow (2004) and Razgour et al. (2010) reported a number of records from central Negev around Sede Boqer, and this area probably represents the southern margin of the continuous range of the species in the Holy Land (cf. Benda et al. 2008). Zelenova & Yosef (2003) presented a record of *P. kuhlii* near Eilat, apparently the first record in the southernmost area of Palestine. Similarly in Jordan, this species was recently recorded also in Aqaba, in the southwestern corner of the country. The records from the southernmost Holy Land newly demarcate the southern margin of the species range in the Middle East (cf. Benda et al. 2008).

The records of *P. kuhlii* from Jordan come from a broad altitude range from 305 m b. s. l. to 1093 m a. s. l. (n=32); the mean (435.6 m) represents a medium altitude, suggesting no marked preference of environments along the altitudinal gradient. Findings of bats in their roosts were made at least at six sites; the altitudinal preference of the roost sites (range –223–595 m a. s. l.; mean 409.8 m) are only slightly shifted down against the general preference of altitudes. However, the roost records were made rather randomly in buildings (mostly in historical monuments) and the few roosts probably do not represent general roost preference in *P. kuhlii* in Jordan – at least

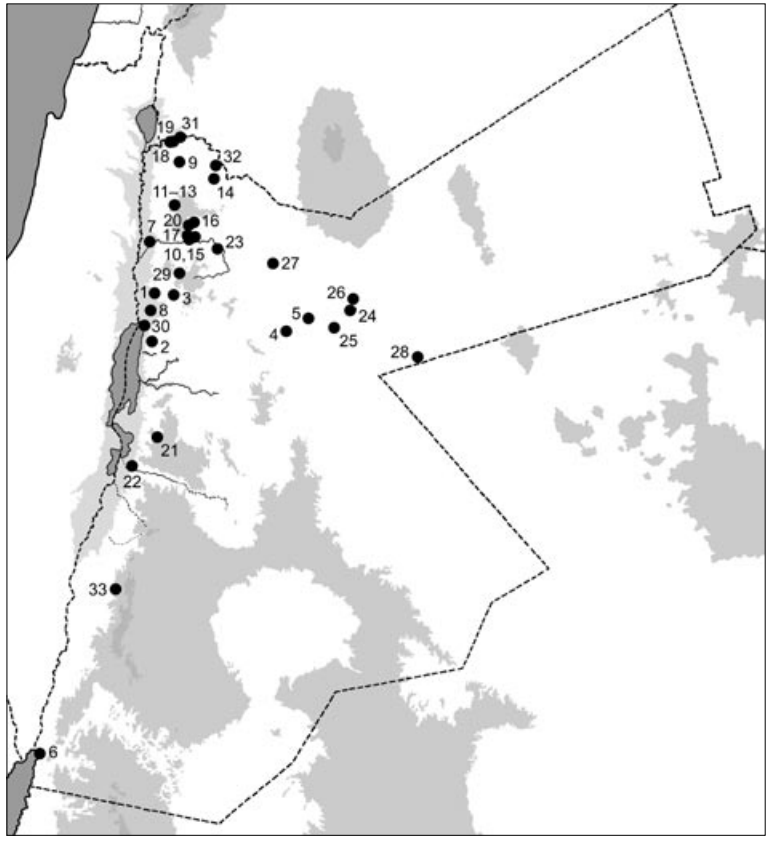


Fig. 74. Records of *Pipistrellus kuhlii* (Kuhl, 1817) in Jordan.

Fig. 75. A roosting group of *Pipistrellus kuhlii* (Kuhl, 1817) perhaps representing a rest of a nursery colony in ceiling fissure of the mosque of Qasr Azraq, Al Azraq Al Shimali (photo by A. Reiter). Note the presence of bugs (most probably *Cacodmus vicinus* Horvath, 1932) around the roost fissure.

on the altitudinal scale. In northern areas of the country, the species perhaps uses also natural shelters, distributed more or less continuously.

Field notes. Roosts of *Pipistrellus kuhlii* were found at least at six sites in Jordan. Atallah (1967: 57) described the first record of the species in Jordan as follows: "A colony was located at the Qasr Azraq [...]. Three more [bats] were obtained from a house at Shishan". Another roost of a colony was also discovered in the eastern part of Jordan, Qumsiyeh et al. (1998: 280) wrote: "Ten individuals [...] were found roosting in a deserted brick wall in the Al-Hazim area." We found a colony of 16 individuals in the mosque of Qasr Azraq in Al Azraq Al Shimali on 10 July (Fig. 75), the bats roosted in fissures among transoms of the ceiling, another two individuals were discovered in the ceiling fissures of the Lawrence's Room above the entrance gate of the Qasr; two individuals were observed in the mosque ceiling fissures on 13 October. Single individuals of *P. kuhlii* were discovered in the wall and ceiling fissures of the ancient caravanserai of Qasr Kharana in the Syrian Desert on three different occasions (May, July, October). A group and a single individual were found to roost in the ruined ancient bath of Hammam As Sarh in Al Halabat Al Sharkiyah on 13 October, one male was discovered in a ceiling fissure of the entrance room and a group of seven individuals was uncovered in a fissure of vaulted ceiling of the inner room (possibly a rest of a former colony). A colony of at least nine individuals was found in a fissure between ceiling bricks in a living house in Majdal on 14 July. Similar roost types of this bat were reported also from other parts of the Middle East (Harrison 1964, Al-Robaae 1966, Qumsiyeh 1996, Benda et al. 2006).

Individuals of *P. kuhlii* were netted at several sites in Jordan. Three bats were netted at a spring below the village of Malka in the Yarmuk Valley in the northernmost Jordan. Two individuals were netted at a water reservoir in Nahla near Jerash in the Ajlun Mts. (Fig. 64). Three individuals were netted above a small fishpond surrounded by tree vegetation near Jufat Al Qafrayn in the Jordan Valley. Eleven bats were netted at rest pools in a wadi below the village of As Salihiyyah near

the Karak Castle (Fig. 90). Twelve and seven individuals were netted on two occasions (October and July) at a dam between ponds (Fig. 76) of the Azraq wetland (within the Azraq Reserve) in Al Azraq Al Janubi; the bats were caught during the sunset foraging activity around the reedbeds between ca. 18.30 and 19.00 (later the activity finished and the bats probably foraged around the street lamps in the city), so the bats probably roosted very close to the wetland. Two bats were netted above a wildlife watering place within the enclosure of the Shawmari Wildlife Reserve some 10 km south of Al Azraq Al Janubi.

At many sites, echolocation calls of foraging individuals of *P. kuhlii* were recorded. Numerous individuals were recorded at a stream in the Wadi Al Kurasi (southern tributary to the Yarmuk Valley) below Malka. At two places in the valley at the village of ʿArjan, at a creek below the village and at a cave near the village, numerous calls of *P. kuhlii* were detected. Foraging individuals were recorded in a garden near Jerash and in the eastern part of the Zarqa' Valley northwest of Duqra. In the Syrian Desert, one bat was recorded passing by the ancient bath of Quseir Amra and one foraging bat at a haunt filled from the Al Hazim Al Dhahek Well in the Hazim area. Numerous foraging individuals of *P. kuhlii* were detected at two sites in valleys leading to the Jordan Valley; at the Iraq Al Amir Caves in the Wadi As Sir (Fig. 3) at three occasions, and also at a stream in the Wadi Shu'ayb above Ash Shunah Al Janubiyya. Calls of foraging *P. kuhlii* were also recorded in Aqaba, around the Ottoman fortress and in gardens along the corniche.

Numerous other bat species were recorded at the *P. kuhlii* sites in Jordan. Only one common roost was found, in Qasr Kharana *Otonycteris hemprichii* was recorded roosting along with *P. kuhlii*. At two places near ʿArjan, *Rhinopoma microphyllum*, *Rhinolophus ferrumequinum*, *Myotis emarginatus*, and *Pipistrellus pipistrellus* were also recorded to forage. *Rousettus aegyptiacus* was netted and calls of *Pipistrellus pipistrellus* detected at Nahla. In the Zarqa' Valley near Duqra, *Tadarida teniotis* was detected together with *P. kuhlii*. *Otonycteris hemprichii* was also detected at Quseir Amra and at the Al Hazim Al Dhahek Well, and netted in the Shawmari

Fig. 76. Western part of the Azraq Wetland Reserve at Al Azraq Al Janubi (western margin of the Syrian Desert) (photo by P. Benda). At this pond, numerous individuals of *Pipistrellus kuhlii* were netted and calls of *Tadarida teniotis* recorded.

Reserve. At Iraq Al Amir, *Rousettus aegyptiacus*, *Rhinopoma cystops*, *Rhinolophus blasii*, *Myotis nattereri*, and *Tadarida teniotis* were also recorded. *Rhinopoma cystops* and *Tadarida teniotis* were recorded in the Wadi Shu'ayb, and *Rousettus aegyptiacus*, *Rhinopoma microphyllum*, *R. cystops*, *Taphozous perforatus*, *T. nudiventris*, and *Eptesicus bottae* at a fishpond near Jufat Al Qafrayn. *Pipistrellus pipistrellus* and *Barbastella leucomelas* were netted (and *Eptesicus bottae* detected) along with *P. kuhlii* at As Salihiyyah.

Reproduction of *P. kuhlii* was both directly and indirectly documented at several sites in Jordan. Atallah (1967: 57) reported on a record of a colony without specification of the date: "A colony was located at the Qasr Azraq where two were mist-netted, one carrying two sucklings." Later, Qumsiyeh (1996: 133) specified: "Lactating females were observed [in the Holy Land] on 24 June." During our research trips, the lactating females were registered in May and in July, no pregnant females were observed. On 27 May, a lactating female was netted at Malka; at As Salihiyyah on 8 July, six bats of the fourteen netted were lactating females, six were volant juveniles; in the Azraq wetland on 9 July, two lactating females and five volant juveniles were netted; a colony of 16 bats was found in Qasr Azraq on 10 July, and a lactating female and a volant juvenile were netted in the Shawmari Wildlife Reserve on the same day; a lactating female was netted at Nahla on 13 July; a colony of at least nine bats was discovered in Majdal on 14 July; and a volant juvenile was netted at Jufat Al Qafrayn on 15 July. These data suggest parturitions to occur as late as in early May. These data correspond with the findings from other parts of the Middle East (Weber 1955, Lewis & Harrison 1962, Harrison 1964, Al-Robaae 1966, DeBlase 1980, Nader & Kock 1983a, Barak & Yom-Tov 1991, Harrison & Bates 1991, Benda et al. 2006).

In the Middle East, remains of *P. kuhlii* were found in the owl diet in Palestine, Syria, Iraq, Turkey, and Iran (Dor 1947, Nader 1969, Benda & Horáček 1998, Shehab et al. 2004, 2007, Obuch & Krištín 2004, Obuch & Benda 2009, Obuch 2010, Obuch unpubl.). In Jordan, rests of one individual were found in a sample of *Athene noctua* pellets collected in the ancient caravanserai of Qasr Kharana. The remains made up 7.6% of mammal items and 0.96% of all prey items, respectively; in the whole analysed little owl diet from Jordan they made up 0.043% of all prey items and 1.01% of mammal items (Table 17).

Morphology. External and cranial dimensions of the Jordanian specimens of *Pipistrellus kuhlii* examined are shown in Table 9. For the material examined see Records.

Feeding ecology. *Pipistrellus kuhlii* is a small aerially hawking insectivorous bat (Norberg & Rayner 1987). According to the studies of its diet composition it seems to be a generalist consuming a wide range of prey categories (Beck 1995, Whitaker et al. 1994, Feldman et al. 2000, Bogdanowicz 2004). In the circum-Mediterranean part of *P. kuhlii* distribution range, the most important diet items found were Diptera, Lepidoptera, Hymenoptera (particularly Formicoidea), and Coleoptera (Rakhmatulina 1983, 2005, Whitaker et al. 1994, Beck 1995, Feldman et al. 2000, Goiti et al. 2003, Whitaker & Karataş 2009).

A considerable regional variation was recorded in Syria (Benda et al. 2006), where Auchenorrhyncha, Coleoptera, Hymenoptera, and Lepidoptera were the most important food items. Besides that, an overwhelming majority of Diptera (Chironomidae) was recorded in the diet around larger water bodies (Lake Asad).

From Jordan, we analysed 178 faecal pellets from 17 individuals originating from six sites (Fig. 77) and contents of two digestive tracts from two sites (Hammam As Sarh, Qasr Kharana). The composition of *P. kuhlii* diet displayed remarkable regional and seasonal variation (Fig. 77). In the pellet sets analysed, the most important prey categories were Heteroptera, Auchenorrhyncha, Hymenoptera, Coleoptera and Lepidoptera. Among Coleoptera, smaller Scarabaeidae were

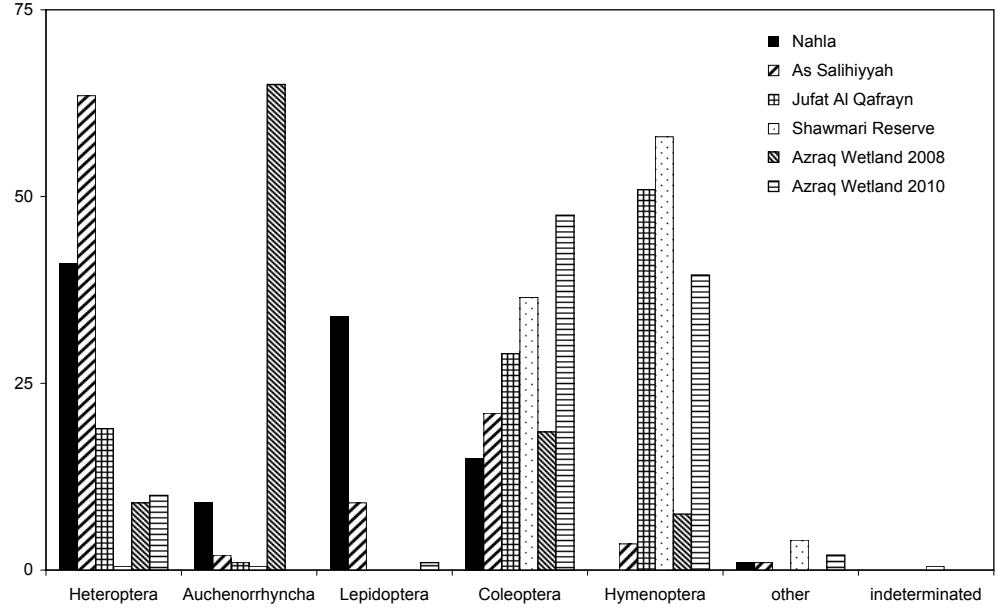


Fig. 77. Volume of particular prey categories in the diet of *Pipistrellus kuhlii* (Kuhl, 1817) from Jordan. Material: Azraq Wetland 2008 – 40 pellets analysed from seven bats; Azraq Wetlend 2010 – 23 pellets analysed from one bat; Shawmari Reserve – 20 pellets analysed from one bat; Nahla – 25 pellets analysed from one bat; Jufat Al Qafrayn – 30 pellets analysed from two bats; As Salihiyyah – 40 pellets analysed from five bats.

the most important. Curculionoidea were also recorded. Formicoidea were the most frequently consumed hymenopterans. In the digestive tracts, Lepidoptera dominated (90–100% of volume), supplemented by Hymenoptera (0–10%). The Lepidoptera found in the diet of *P. kuhlii* were smaller individuals with wingspan of up to ca. 20 mm.

Our results and the available literature data show *P. kuhlii* to be a very flexible aerial hawker. High amounts of one prey category at one site indicate selective foraging and the ability to search and exploit temporary and inconstant diet resources represented by different aggregations of swarming insects.

Echolocation. In total, we obtained 136 recordings of *Pipistrellus kuhlii* calls from nine sites (Figs. 16, 20, 78, 79). Basic echolocation parameters are given in Table 4. It seems that echolocation parameters of *P. kuhlii* are quite uniform throughout its Mediterranean range, comp. Russo & Jones (2002), Benda et al. (2006), Papadatou et al. (2009), similar results are available also from Turkey, Cyprus, Lebanon, and Egypt (own unpubl. data). The data obtained from the Jordanian populations fully conform to this experience.

Records of ectoparasites. **Original data**: A r g a s i d a e: *Argas vespertilionis*: 1 larva (IZB; det. J. Krištofík) from 1 ind., As Salihiyyah, 8 July 2010. – M a c r o n y s s i d a e: *Steatonyssus periblepharus*: 1 protonymph, 1 fa (IZB; det. P. Mašán) from 2 inds., As Salihiyyah, 8 July 2010; – 1 fa (IZB) from 1 fa (NMP 92822), Al Azraq Al Janubi, 9 July 2010; – 1 protonymph (IZB; det. P. Mašán) from 1 fa (NMP 92823), Shawmari Reserve, 10 July 2010. – C i m i c i d a e: *Cacodmus vicinus*: 3 ma, 2 fa (CUP; det. O. Balvín) from 4 ma, 3 fs (NMP 92368–92374), Al Azraq Al Janubi, 13 October 2008; – 4 ma, 5 fa (CUP; det. O. Balvín) from 1 ma, 4 fa (NMP 92816–92820), As Salihiyyah, 8 July 2010.

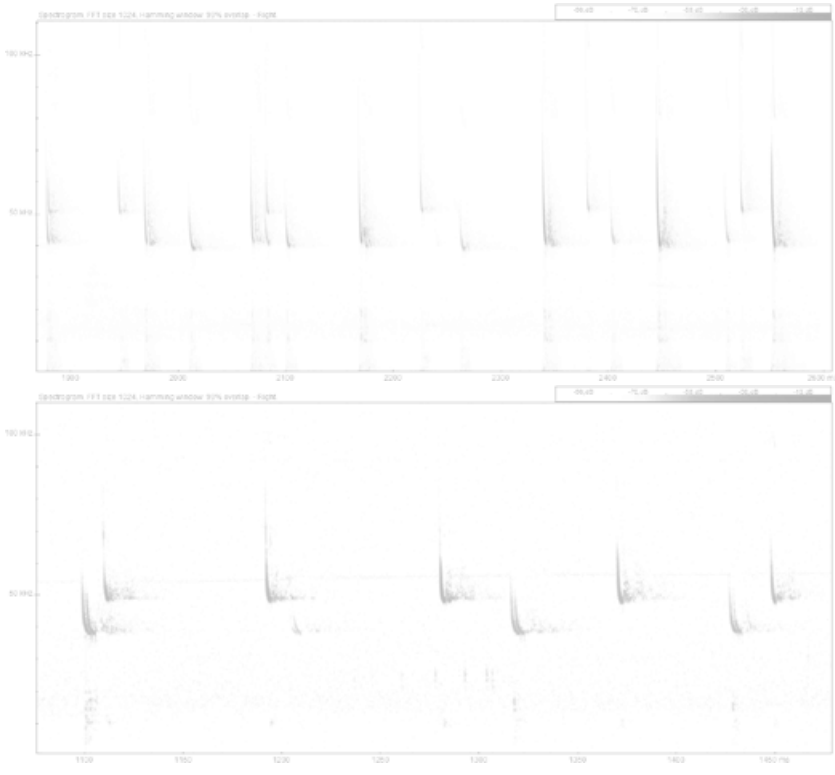


Fig. 78, 79. Spectrograms of echolocation calls of *Pipistrellus pipistrellus* (Schreber, 1774) and *Pipistrellus kuhlii* (Kuhl, 1817). 78 (above) – several individuals foraging simultaneously above a creek below the village of ʿArjan. 79 (below) – several individuals foraging simultaneously at pools in the wadi below the village of As Salihiyyah.

Comments on ectoparasites. Three ectoparasite species were found on *Pipistrellus kuhlii* in Jordan, two acari, *Argas vespertilionis* (Latreille, 1802) and *Steatonyssus periblepharus* Kolenati, 1858, and one bug *Cacodmus vicinus* Horvath, 1932.

P. kuhlii belongs to the principal hosts of *Argas vespertilionis*, similarly as other species of the genus *Pipistrellus* (Dusbábek 1972). The present record represents the first evidence of this tick species from Jordan (found also on *Rousettus aegyptiacus* and *Pipistrellus pipistrellus*). The mite *Steatonyssus periblepharus* is here reported for the first time from Jordan (found also on *Pipistrellus pipistrellus*). According to Theodor & Moscona (1954), *P. kuhlii* is a dominant host species for the bug *Cacodmus vicinus* (see Fig. 75). Our records coming from both western and eastern parts of Jordan confirm such a statement. Individuals of bugs were observed also in the bat roost in the mosque of the Qasr Azraq (Fig. 75).

A variety of other ectoparasites of *P. kuhlii* is known from the Middle East, viz. four bat flies *Nycteribia schmidlii* Schiner, 1853, *N. vexata* Westwood, 1835, and *Penicillidia conspicua* Speiser, 1901 from Turkey (Aktaş & Hasbenli 1994), and *Basilia daganiae* Theodor et Moscona, 1954 from Palestine and Egypt (Theodor 1956, 1967); four bat fleas *Ischnopsyllus octactenus* (Kolenati, 1856) from Turkey (Aktaş 1987, 1990), *I. consimilis* (Wahlgren, 1904) from Turkey, Lebanon, Palestine

and Egypt (Smit 1954, Theodor & Moscona 1954, Hopkins & Rothschild 1956, Lewis 1962, Haas & Tomich 1973), *Xenopsylla cheopis* (Rothschild, 1903) and *Leptopsylla sengis* (Schoenherr, 1911) from Palestine (Theodor & Moscona 1954); and two mite species from Palestine, *Spinturnix acuminatus* (Koch, 1836) and *Steatonyssus periblepharus* Kolenati, 1858 (Anciaux de Faveaux 1976). Most of these species may be also found to parasitise *P. kuhlii* in Jordan.

Otonycteris hemprichii Peters, 1859

Records. **New data**: ´A m m a n: Qasr Kharana [1], ancient caravanserai, 2 April 2008: found rest of 2 inds. (1 skull, 1 rostrum, 2 pairs of mandibles) in *Athene noctua* pellets, 12 October 2008: coll. 1 ma (NMP 92366 [S+A]; cf. Benda & Gvoždík 2010) in a ground floor dark room, 23 May 2009: obs. a colony in ceiling fissure (noted at least 3 inds.) of a ground floor room, 9 July 2010: obs. a colony of at least 8 inds., exam. 1 mj, 3 faL, 2 fj (coll. 1 fa, NMP 92821 [A]); – Quseir Amra [2], at the ancient bath, 12 October 2008: det. & rec. calls of 1 ind. [3 echolocation recordings]; – Wadi Abu Al ´Asal [3], 15 October 2010: found rest of 1 ind. (left mandible) in *Bubo bubo* pellets. – A q a b a: Al Ghal [4], above a camel haunt (Fig. 88), 17 May 2009: net. 2 ma (NMP 92467, 92468 [S+A]; cf. Benda & Gvoždík 2010); – Al Qurayqira [5], Wadi Ghuweir, at Khirbet Feynan, at a rest water pool, 13 May 2009: net. 1 ma (NMP 92428 [S+A]; cf. Benda & Gvoždík 2010); – Wadi Rum [6], at Lawrence's Pool, 27 September 2005: found rests of 1 ind. (rostrum) in *Strix*

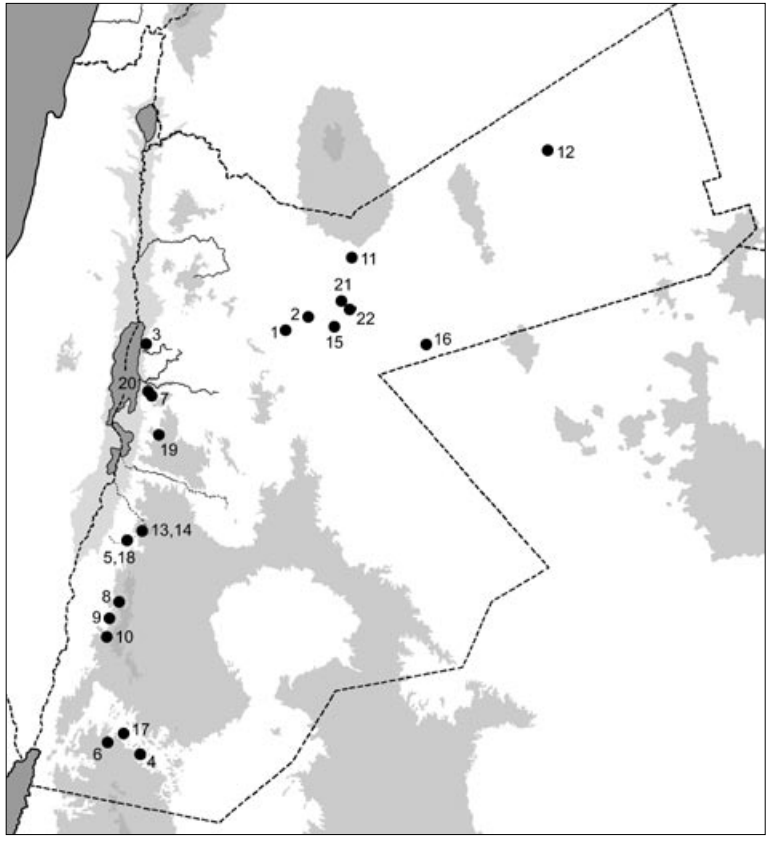


Fig. 80. Records of *Otonycteris hemprichii* Peters, 1859 in Jordan.

butleri pellets. – K a r a k: Wadi Shegaig [7], Mujib Reserve, 19 April 1999: coll. 1 ma (RSCN unnumbered [A]; leg. K. A. Al Omari, F. l. Amerian & R. Heil); – M a' a n: Al Batra [8], Wadi Kharrouba, 18 May 2009: found rests of 1 ind. (left mandible) in *Strix butleri* pellets; – Ar Rajif, Jebel Masuda, Ain Amshit [9] (Fig. 95), 15 May 2009: det. & rec. calls of 1 ind., found rests of 2 inds. (1 left and 2 right mandibles) in *Strix butleri* pellets; – Dilagha [10], Jebel Masuda, at a spring in the easternmost extension of the Wadi Al Abiat (Fig. 83), 22 October 2008: det. & rec. calls of 2–3 inds. – M a f r a q: Al Bishriyya [11], Bir Hamma lava cave, 5 October 2010: net. 2 ma; – Qasr Burqu [12], at the ancient fortress ruins (Fig. 82), 14 October 2008: net. 1 ma, 1 ms, 1 fa (NMP 92376, 92377 [S+A], 92375 [A]; cf. Benda & Gvoždík 2010), det. & rec. calls of several inds. [7 echolocation recordings]. – T a f i l a: Dhana [13], ca. 1 km E of the Rummana Camp (Fig. 44), 19 October 2008: det. & rec. calls of 1 ind. [1 echolocation recording]; – Dhana [14], rocky wall ca. 1 km NW of the Rummana Camp, 19 October 2008: found rest of 1 ind. (left mandible) in *Athene noctua* pellet. – Z a r q a': Al Azraq Al Shimali [15], Shawmari Wildlife Reserve, wildlife watering place, 10 July 2010: net. 1 fa (NMP 92824 [S+A]); – Al Hazim [16], 15 April 2003: coll. 1 ma (JUST unnumbered [S+B]; leg. M. Abu Baker). – **Published data**: A q a b a: Disa [17] (Wadi Rum), 3 inds. [= 31 May 1990: net. 1 ma] (Qumsiyeh et al. 1992); – near Quraiqira [18] (Wadi Fidan), 2 inds. [= 29 May 1990: net. 1 ma, 1 fa] (Qumsiyeh et al. 1992); – [Wadi] Rum [6], Lawrence's Pool, small pool nearby, [October] 1989: net. 1 f (Bates & Harrison 1989). – K a r a k: Ghadir Al-Qatawneh [19] (Karak), 26 June 1992: net. 1 ind. (Qumsiyeh et al. 1998); – vicinity of Ar Raddass [20], south of Wadi Al Mawjib, 1999, net. (Al-Omari et al. 2000). – M a f r a q: Burqa [12], 25 September 1996: net. 1 m, 2 f (Qumsiyeh et al. 1998). – Z a r q a': 4 km north-west of Shishan [21], old deserted hut, interstices between wall stones, 2 May 1966: 3 fG (Atallah 1967, cf. Atallah 1966, 1977); – Azraq ed Druz [22], 2 inds. (Qumsiyeh 1985).

Distribution. *Otonycteris hemprichii* is a rather common bat species in Jordan, 22 record sites were registered in two more or less separated areas – the northeastern and southwestern parts of Jordan (Fig. 80). Thus, the findings come from all three arid biogeographical regions (see above), representing two slightly different vegetation zones, SW desert vs. NE semi-deserts/steppes (cf. Zohary 1973).

In the southwestern portion of Jordan, the records of *O. hemprichii* are available from a rim of habitats adjacent to the Rift Valley and from the Rum Desert. This narrow belt of sites continues from the more widely distributed records on the Palestinian side of the Rift, where this species occurs mainly in the Negev and Judean Deserts, and only scarcely in the Rift Valley (Arava Valley and Dead Sea Basin) (Mendelssohn & Yom-Tov 1999, Zelenova & Yosef 2003, Korine & Pinshow 2004, Razgour et al. 2010). Mendelssohn & Yom-Tov (1999) reported only two records from north of the Dead Sea, from Nabi Musa (at Jericho [Ariha]) and Rosh Ha'Ayin. While the former record probably marks the northern margin of the regular range of *O. hemprichii* in the Rift Valley (as well as in Palestine), the latter one most probably represents evidence of a stray individual (considering the apparent preference of open desert and steppe habitats by this bat).

The range of *O. hemprichii* in northeastern Jordan – area of origin more than a third of the Jordanian records – continues from the range in the Syrian Desert of Syria (Benda et al. 2006) and northern Saudi Arabia (Seddon et al. 1997) as well as from Syrian and Turkish Mesopotamia (Kumerloeve 1975, Benda et al. 2006). As a well adapted dweller of arid habitats (Fenton et al. 1999), *O. hemprichii* is the most frequent bat species in this part of Jordan.

The records of *O. hemprichii* in Jordan come from a broad altitude range from 170 m b. s. l. to 1177 m a. s. l. (n=18) and the mean altitude (617.7 m) suggests a preference of rather elevated sites. Although only four records from northeastern Jordan could be considered as findings of bats in or at their roosts, the altitudinal preference of the respective roost sites (range 520–780 m a. s. l.; mean 651.8 m) is only slightly shifted up against the general preference of altitudes.

Field notes. Observations of *Otonycteris hemprichii* in its roost were made in two sites in Jordan. The first record of this bat in Jordan, in the Azraq area in the Syrian Desert, was described by Atallah (1967: 57) as follows: "Three pregnant females [...], were collected from an old deserted hut, 4 km north-west of [Al Azraq Ash] Shishan. The hut was located on the basalt slope at the edge of the hamada. The walls were constructed of stones with no mud or cement and the roof had wooden joists covered with metal sheets, straw, and mud. The bats were extricated from

Fig. 81. A roosting group of *Otonycteris hemprichii* Peters, 1859 representing a rest of a nursery colony in ceiling cavity of the ancient caravanserai of Qasr Kharana (photo by A. Reiter).

interstices between the stones by forceps." Another roost of *O. hemprichii* was discovered in the partially ruined ancient caravanserai of Qasr Kharana in the Syrian Desert; one individual was found to roost freely on the wall of the dark ground floor room in October, a group of at least three individuals was found in a cavity in the vault of ceiling of another ground floor room in May, while in July, at least eight bats were discovered in a cavity in the vault of ceiling of the first floor (Fig. 81).

O. hemprichii was netted at several sites in Jordan; the first such mention was published by Bates & Harison (1989), who netted an individual over a small pool near Lawrence's Pool in the Rum Desert. Qumsiyeh et al. (1998) reported on the *O. hemprichii* individuals caught by nets set over water pools at Ghadir Al Qatawneh near Karak and at Qasr Burqu in the Syrian Desert. We also netted three bats at Qasr Burqu, however, using a net installed inside the ancient fortress ruins (Fig. 82). In this desert area, another individual was caught into a net placed above a wildlife watering place in the enclosure of the Shawmari Wildlife Reserve near Al Azraq Al Janubi (Fig. 83) and two bats were netted at the Bir Hamma Cave. One individual was netted above a small pool of rest water in a depression of the Wadi Ghuweir near Khirbet Feynan. Two bats were caught into a net installed above a camel haunt in the Al Ghal oasis in the Rum Desert (Fig. 88). At three sites, only the echolocation calls of foraging individuals of *O. hemprichii* were recorded; one bat was recorded passing by the ancient bath of Quseir Amra, one foraging bat at a haunt filled from the Al Hazim Al Dhahek Well in the Hazim area at the Saudi Arabian border, and another one foraging at a spring in the easternmost extension of the Wadi Al Abiat in the Jebel Masuda Mts. (Fig. 84).

Together with *O. hemprichii*, numerous other desert bat species were recorded. During all three visits of Qasr Kharana, single roosting individuals of *Pipistrellus kuhlii* were also found. This species was found along with *O. hemprichii* at many other sites; at Quseir Amra and the Al Hazim Al Dhahek Well its calls were recorded, while in the Shawmari Reserve individuals were

Fig. 82. Qasr Burqu, ruins of ancient fortress and a lake in the Syrian Desert (photo by P. Benda). Within the ruins, individuals of *Otonycteris hemprichii* were netted, while foraging calls of *O. hemprichii* and *Tadarida teniotis* were recorded at the lake and in the surrounding lava desert.

netted. At Qasr Burqu and Quseir Amra, calls of *Tadarida teniotis* were also detected. In the Wadi Ghuweir, a rich bat community was found, besides *O. hemprichii* also *Rhinolophus clivosus*, *R. blasii*, *Eptesicus bottae*, *Pipistrellus pipistrellus*, and *Tadarida teniotis* were recorded. In the Wadi Al Abiat, calls of *Barbastella leucomelas*, *Plecotus christii*, and *Tadarida teniotis* were also detected. *Rhinolophus clivosus*, *Eptesicus bottae*, *Hypsugo ariel*, *Barbastella leucomelas*, and *Plecotus christii* were recorded in the Al Ghal oasis along with *O. hemprichii*.

Reproduction of *O. hemprichii* was documented in two sites in Jordan, both lying in the Syrian Desert. Atallah (1967) reported on a finding of a small nursery colony: "Three pregnant females, each with two embryos, were collected from an old deserted hut [on 2 May], 4 km north-west of Shishan." In Qasr Kharana, a colony of at least eight bats was discovered in a vault cavity on 9 July, at least three of these bats were lactating females and three volant juveniles. These findings are congruent with the data from Syria (Benda et al. 2006), where lactating females with nonvolant juveniles were found on 16 June; it seems that parturitions in the Syrian Desert thus occur in early June (Atallah 1967, 1977). However, from southern Palestine, Mendelssohn & Yom-Tov (1999) reported on a female at the end of lactation netted on 4 July, and Fenton et al. (1999) captured post-lactating females on 19 June. These data suggest an earlier reproduction season in the populations of the southern Holy Land, including southwestern Jordan.

In the Middle East, remains of *O. hemprichii* were found in the owl diet in Palestine, Syria, and Iran (Shehab et al. 2004, Benda et al. 2006, Obuch unpubl.). In Jordan, *O. hemprichii* was the most frequently found bat species in owl diet; remains of altogether eight individuals were found in six samples of the diet of three owl species (Table 17). In the *Strix butleri* diet, its remains made up 0.89–1.9% (mean 1.37%) per sample volume of all prey items (and 0.06–3.52% [mean 0.76%] of mammal items) from the respective samples and 0.35% of all prey items (0.89% of

mammal items) of the whole analysed Hume's owl diet from Jordan. In the *Athene noctua* diet, its remains made up 1.0% and 1.9% per sample volume of all prey items (10.0% and 15.4% of mammal items) from the respective samples and 0.13% of all prey items (3.0% of mammal items) of the whole analysed little owl diet from Jordan. In the very small sample of the *Bubo bubo* diet, remains of *O. hemprichii* made up 12.5% of all prey items (and 20.0% of mammal items) from the respective sample, but 0.089% of all prey items (0.16% of mammal items) of the whole analysed eagle owl diet from Jordan.

Fig. 83. Portrait of a female *Otonycteris hemprichii* Peters, 1859 netted in the Shawmari Reserve at Al Azraq Al Janubi (photo by A. Reiter). Note the extreme parasitation of the bat, altogether 78 individuals of the tick *Argas vespertilionis* (Latreille, 1802) were collected from it.

Fig. 84. A spring in the easternmost extension of the Wadi Al Abiat, Jebel Masuda (photo by P. Benda). Calls of four bat species were recorded there, viz. *Otonycteris hemprichii*, *Barbastella leucomelas*, *Plecotus christii*, and *Tadarida teniotis*.

Morphology. External and cranial dimensions of the Jordanian specimens of *Otonycteris hemprichii* examined are shown in Table 12. For the material examined see Records.

Feeding ecology. Representatives of the genus *Otonycteris* – *O. hemprichii* and *O. leucophaea* (Severcov, 1873) – are large bats applying the gleaning foraging strategy; these species use passive listening of prey on the ground and echolocate only facultatively (Horáček 1991). Results of the studies from different parts of the Middle East and Central Asia showed an important role of large ground arthropods in their diet. The most important prey categories were Scorpionida, Solpugida, Coleoptera (Tenebrionidae, Scarabaeidae, Carabidae), Blattodea, Orthoptera, Heteroptera, and Hymenoptera (Horáček 1991, Whitaker et al. 1994, Arlettaz et al. 1995, Fenton et al. 1999, Benda et al. 1999, 2006, 2008).

From Jordan, we analysed 147 faecal pellets from ten bats originating from five sites (Fig. 85) and contents of two digestive tracts from bats collected at two sites. Solpugida, Coleoptera (larger Scarabaeidae, Tenebrionidae), Orthoptera, Mantodea and Scorpionida were found to prevail in the examined pellet sets (Fig. 85). In the tract content from Qasr Kharana, Mantodea (80% of volume) and Solpugida (20%) were found, while in the other one from Qasr Burqu, only Orthoptera were recorded. The diet composition from different parts of Jordan was quite variable and showed the species to be able to exploit various available taxa of appropriate size. The determining proportion of non flying prey items in the diet indicates ground gleaning to be an important foraging strategy of the species.

Table 12. Basic biometric data on the examined samples of *Otonycteris hemprichii* Peters, 1859, *Barbastella leucomelas* (Cretzschmar, 1830), and *Plecotus christii* Gray, 1838. For abbreviations see p. 192, 193

	Otonycteris hemprichii					*Barbastella leucomelas*					*Plecotus christii*				
	n	**M**	min	max	SD	n	**M**	min	max	SD	n	**M**	min	max	SD
LC	9	**80.3**	75	86	4.330	3	**53.7**	53	54	0.577	29	**52.4**	50	55	1.293
LCd	9	**59.9**	57	64	2.421	3	**52.7**	51	55	2.082	28	**52.1**	46	57	2.394
LAt	11	**62.59**	59.7	65.5	2.109	3	**39.00**	38.3	39.4	0.608	34	**40.31**	38.8	42.4	0.921
LAu	9	**41.71**	39.7	43.4	1.045	3	**19.20**	18.6	19.5	0.520	29	**39.63**	36.8	42.0	1.197
LTr	9	**17.58**	16.9	18.5	0.494	3	**9.03**	9.0	9.1	0.058	29	**18.82**	17.0	20.4	0.797
LPl	–	–	–	–	–	–	–	–	–	–	34	**5.58**	4.9	6.3	0.310
LCr	8	**22.76**	21.93	23.91	0.656	3	**14.17**	13.93	14.32	0.208	25	**16.81**	16.35	17.48	0.267
LCb	8	**21.55**	20.64	22.43	0.573	3	**13.11**	12.97	13.26	0.145	25	**15.70**	15.12	16.38	0.304
LaZ	8	**14.48**	13.92	15.06	0.413	3	**7.31**	7.27	7.38	0.061	24	**8.53**	8.23	9.07	0.173
LaI	7	**4.04**	3.82	4.18	0.115	3	**3.49**	3.47	3.52	0.029	25	**3.18**	2.96	3.49	0.116
LaInf	7	**5.83**	5.43	6.02	0.204	3	**3.87**	3.84	3.92	0.044	25	**3.97**	3.74	4.26	0.148
LaN	8	**10.30**	9.97	10.76	0.269	3	**7.01**	6.97	7.07	0.055	25	**8.09**	7.68	8.58	0.235
LaM	8	**11.47**	11.08	12.14	0.336	3	**8.31**	8.28	8.35	0.038	25	**9.18**	8.89	9.58	0.180
ANc	7	**7.26**	7.06	7.43	0.147	3	**5.19**	5.07	5.30	0.116	25	**5.12**	4.88	5.34	0.110
LBT	8	**5.84**	5.66	6.11	0.146	3	**3.01**	2.97	3.04	0.036	25	**4.71**	4.47	4.94	0.111
CC	7	**6.07**	5.74	6.45	0.271	3	**3.55**	3.43	3.67	0.120	23	**3.55**	3.34	3.71	0.087
M^3M^3	8	**9.72**	9.32	10.08	0.279	3	**5.31**	5.24	5.37	0.065	25	**6.03**	5.69	6.35	0.172
CM^3	8	**8.26**	7.94	8.65	0.204	3	**4.44**	4.41	4.47	0.031	25	**5.69**	5.48	5.95	0.114
LMd	8	**16.18**	15.71	16.79	0.400	3	**8.76**	8.67	8.93	0.147	25	**10.62**	10.28	11.29	0.205
ACo	8	**7.21**	6.86	7.84	0.348	3	**2.42**	2.36	2.47	0.057	25	**3.05**	2.84	3.22	0.090
CM_3	8	**9.32**	8.83	9.74	0.259	3	**4.85**	4.82	4.91	0.049	25	**6.13**	5.91	6.94	0.203

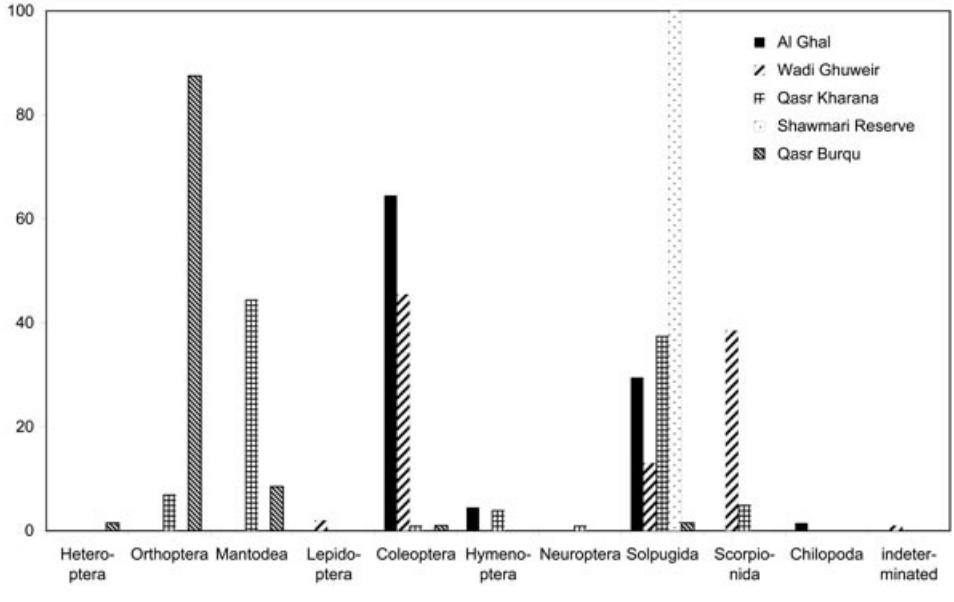


Fig. 85. Volume of particular prey categories in the diet of *Otonycteris hemprichii* Peters, 1859 from Jordan. Material: Al Ghal – 40 pellets analysed from two bats; Wadi Ghuweir – 20 pellets from one bat; Qasr Burqu – 40 pellets from two bats; Shawmari Reserve – seven pellets from one bat; Qasr Kharana – 40 pellets collected from under a colony roost.

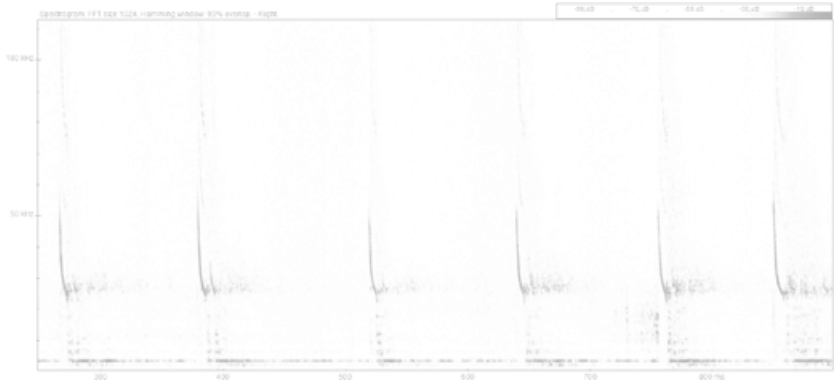


Fig. 86. Spectrogram of echolocation calls of *Otonycteris hemprichii* Peters, 1859; an individual foraging around the fortress ruins of Qasr Burqu.

Echolocation. In total, we obtained 11 recordings of *Otonycteris hemprichii* calls from three localities (Fig. 86). Basic echolocation parameters are given in Table 4. All calls recorded in Jordan showed the maximum energy on the lower harmonic component with FMAXE around 26–27 kHz, on average. Contrastingly, Benda et al. (2008) and Razgour et al. (2010) reported FMAXE around 19–22 kHz in the populations from the Sinai and Palestine, respectively. It seems that *O. hemprichii* displays high plasticity in echolocation parameters; in general, the echolocation calls of *O. hemprichii* resemble those of the genus *Eptesicus*, especially of *E. serotinus* (Schreber, 1774) from Europe (Russo & Jones 2002), however, with a markedly weaker loudness.

Records of ectoparasites. **Original data**: A r g a s i d a e: *Argas vespertilionis*: 78 larvae (UCPN) from 1 fa (NMP 92824), Shawmari Wildlife Reserve, 10 July 2010.

Comments on ectoparasites. Only one ectoparasite species was recorded from *Otonycteris hemprichii* in Jordan; an extremely high number of larvae of the tick *Argas vespertilionis* (Latreille, 1802) was found on a single host individual netted in the Shawmari Reserve (Fig. 83). This finding represents the first record of this parasite from this host species. From the Middle East, only two ectoparasite species were found to parasitise *O. hemprichii*; the tick *Argas hermanni* Audouin, 1827 was recorded in Egypt (Anciaux de Faveaux 1976) and the flea *Araeopsylla wassifi* Traub, 1954 in Turkey (Haas & Tomich 1973).

Barbastella leucomelas (Cretzschmar, 1830)

Records. **New data**: A q a b a: Al Ghal [1], above a camel haunt (Fig. 88), 17 May 2009: net. 1 faL (NMP 92466 [S+A]). – K a r a k: As Salihiyyah [2], at rest pools in a wadi below the village (Fig. 90), 8 July 2010: net. 1 ma (NMP 92812 [S+A]), det. & rec. 1–2 inds. [2 echolocation recordings]. – M a' a n: Dilagha [3], Jebel Masuda, at a spring in the easternmost extension of the Wadi Al Abiat (Fig. 83), 22 October 2008: det. & rec. calls of 1 ind. [4 echolocation recordings]. – T a f i l a: Dhana [4], at an artificial watering place for birds at the Rummana Camp (Fig. 44), 4 July 2010: det. & rec. 1 ind.; – Dhana [5], at an artificial watering place for birds ca. 1 km E of the Rummana Camp, 4 July 2010: net. 1 ma (NMP 92800 [S+A]), det. & rec. call. of 1 foraging ind. [1 echolocation recording]; – Dhana, village [6], 22 April 2008: det. 2 foraging inds.

Distribution. *Barbastella leucomelas* is a bat species reported here from Jordan for the first time, although its occurrence in the country is not surprising, considering its presence in Palestine. It

was recorded from six sites in Jordan, in three of them it was documented by a capture of an individual (Fig. 87). However, the recordings of echolocation calls are fully plausible for evidence of this species as the calls of barbastelle bats are very characteristic and incommutable, although fine and indistinctive (cf. Benda et al. 2008). *B. leucomelas* ranks among rather rare bats in Jordan, however, it is not the rarest one – it is even the twelfth rarest bat of Jordan (or fifteenth most common), concerning the numbers of bat records (Table 1). The records come from the southwestern part of the country, from sites of high altitudes in the Southern Highlands, adjacent to the Rift Valley; one record comes from the Rum Desert. This occurrence pattern is parallel to the distribution in Palestine, where four record sites are available from the whole extent of the Arava Valley (Mendelssohn & Yom-Tov 1999).

The records of *B. leucomelas* in Jordan come from a very narrow altitude range of 815–1224 m a. s. l. (n=6); the mean altitude (1031.7 m) suggests a preference of extremely elevated sites. The mean altitude of the records is the highest one among those of Jordanian bats, *B. leucomelas* thus represents the 'most montane' species of the bat fauna. Since all records represent evidences of foraging bats (see Records), roost preferences cannot be evaluated in this species. However,

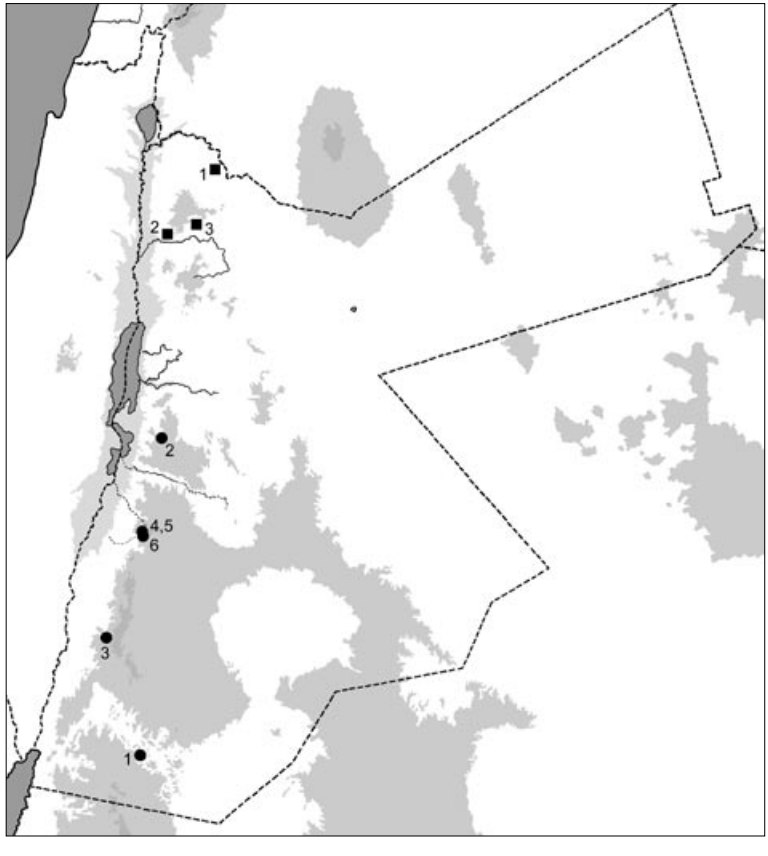


Fig. 87. Records of *Barbastella leucomelas* (Cretzschmar, 1830) (circles) and *Miniopterus pallidus* Thomas, 1905 (squares) in Jordan.

considering the narrow altitudinal range and the high elevation of the record sites, the roosts of *B. leucomelas* could be found only in the elevated areas of the southern deserts of Jordan.

B. leucomelas is a bat species endemic to desert regions surrounding the northern edge of the Red Sea, in all these areas it belongs to very uncommon bats (Benda et al. 2008). Until now, only six individuals have been reported from southern Palestine (Makin 1976, 1977, Harrison & Makin 1988, Mendelssohn & Yom-Tov 1999, Zelenova & Yosef 2003), seven bats from the Sinai (Rüppell 1842, Benda et al. 2008), two individuals were collected from Eritrea (von Heuglin 1977, Hayman & Hill 1971) and one from a 'Coast of Arabia' (Harrison 1964). However, the evidence of *B. leucomelas* in Jordan has augmented not only the available scarce material of this species in museum collections, the newly established Jordanian range has also significantly extended the known area of distribution of this species in the southern Levant. The locality at As Salihiyyah in the valley under the Karak Castle represents the northernmost and also easternmost site of finding of this bat within its whole range. Until now, both these primacies have belonged to Ne'ot HaKikar at the southwestern edge of the Dead Sea. The new record shifted the margin of the range 30 km to the east and ca. 26 km to the north, i.e. ca. 40 km to NE.

Field notes. No roosts of *Barbastella leucomelas* were found in Jordan. However, single individuals of this bat were netted at three sites and its characteristic echolocation calls were recorded at three others. An individual was netted above a camel haunt in the small oasis of Al Ghal surrounded by sand plains of the Rum Desert (Fig. 88). One bat was netted above an artificial watering place for birds ca. 1 km east of the Rummana Camp in the hilly country of the upper eastern part of the

Fig. 88. Part of the oasis of Al Ghal with the surrounding Rum Desert (photo by A. Reiter). Above the camel haunt in the right part of the picture, *Eptesicus bottae*, *Hypsugo ariel*, *Otonycteris hemprichii*, *Barbastella leucomelas*, and *Plecotus christii* were netted and echolocation calls of *Rhinolophus clivosus* were recorded.

Fig. 89. Portrait of a male *Barbastella leucomelas* (Cretzschmar, 1830) from near of the Rummana Camp, Dhana Reserve (photo by A. Reiter).

Dhana Reserve (Fig. 88, 44). One individual was netted at rest pools in a wadi below the village of As Salihiyyah near the Karak Castle (Fig. 90). Calls of one foraging individual were recorded at a spring in the easternmost extension of the Wadi Al Abiat in the Jebel Masuda Mts. (Fig. 83). Calls of *B. leucomelas* were recorded twice in the Dhana Reserve; one foraging bat was recorded at an artificial watering place close to the Rummana Camp and other two bats were recorded between gardens in the old Dhana village.

In the Al Ghal oasis, *Rhinolophus clivosus*, *Eptesicus bottae*, *Hypsugo ariel*, *Otonycteris hemprichii*, and *Plecotus christii* were recorded along with *B. leucomelas*. *Pipistrellus pipistrellus* and *P. kuhlii* were also netted and calls of *Eptesicus bottae* recorded at As Salihiyyah, while calls of *Otonycteris hemprichii*, *Plecotus christii*, and *Tadarida teniotis* were detected in the Wadi Al Abiat. In the Dhana Reserve, *Rhinolophus clivosus*, *Myotis nattereri*, *Eptesicus bottae*, *Hypsugo ariel*, *Pipistrellus pipistrellus*, *Plecotus christii*, and *Tadarida teniotis* were recorded at places where individuals or calls of *B. leucomelas* were documented.

One indirect observation of reproduction of *B. leucomelas* was recorded in Jordan; a lactating female was netted in the Al Ghal oasis on 17 May. From the Arava Valley of Palestine, Harrison & Makin (1988) and Mendelssohn & Yom-Tov (1999) reported a pregnant female collected on 4 April and a lactating female caught in July. These findings suggest that parturitions in *B. leucomelas* in the Holy Land occur in April and early May.

B. leucomelas has not been evidenced in the analysed samples of owl pellets from Jordan.

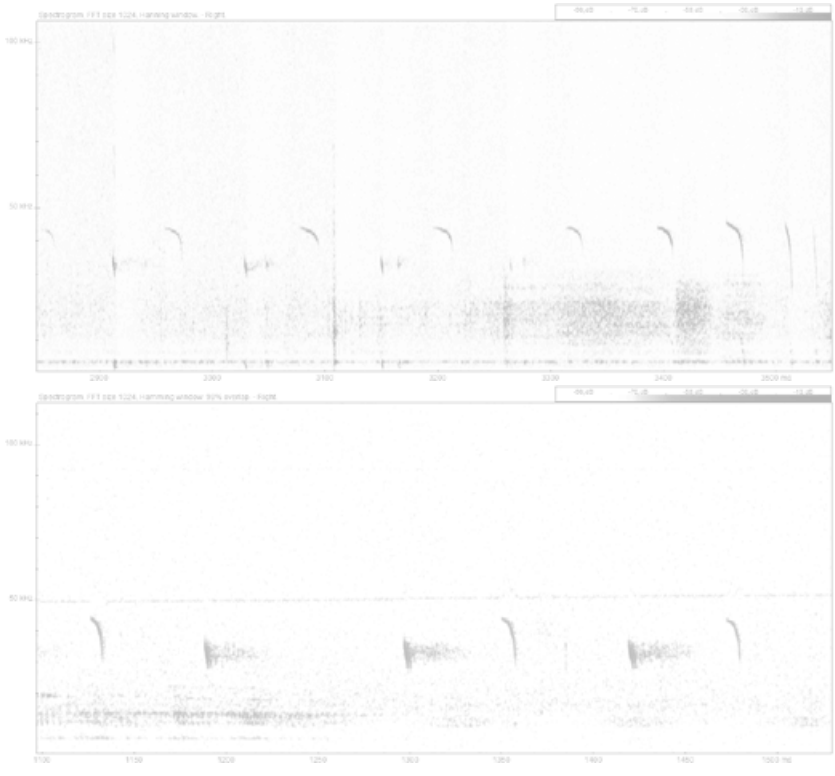
Morphology. External and cranial dimensions of the Jordanian specimens of *Barbastella leucomelas* examined are shown in Table 12. For the material examined see Records.

Feeding ecology. Representatives of the genus *Barbastella* are extremely specialised bats feeding predominantly on Lepidoptera (Beck 1995, Rydell et al. 1996, Sierro & Arlettaz 1997, Andreas et al. in press). While the previous authors analysed the diet of the European *B. barbastellus* (Schreber, 1774) (Beck 1995, Rydell et al. 1996, Sierro & Arlettaz 1997, Andreas et al. in press) and Central Asian *B. darjelingensis* (Hodgson, 1855) (Sierro & Arlettaz 1997), the diet of *B. leucomelas* was for the first time reported by Benda et al. (2008) from the bats collected in the Sinai. They found small Lepidoptera to prevail in samples from four bats with a small proportion of small winged ants (Hymenoptera) in the diet of one individual.

From Jordan, we analysed 10 faecal pellets from one bat collected in the Dhana Reserve and 20 droppings from one bat netted at As Salihiyyah. The diet sample from the Dhana Reserve was composed of small Lepidoptera (89% of volume) and Neuroptera, cf. Chrysopidae (11%), while the sample from As Salihiyyah comprised only small Lepidoptera (100%).

The high proportion of Lepidoptera observed in the samples from Jordan corresponds well with the results available from the Sinai. The published data and our new results concerning the whole genus *Barbastella* indicate a unique foraging specialisation of all the studied species. This fact becomes even more apparent if we take into account the vast geographic range and diversity of habitats where the diet of these bats was studied. The diet of *B. barbastellus* was studied in mixed mountain forests and deciduous forests of Central and Western Europe, the diet of *B. darjelingensis* was collected in xeric steppes and semi-deserts of Central Asia and the diet of *B. leucomelas* in deserts of the Middle East. The only notable difference among these species seems to be size of the prey; an apparently high proportion of larger moths was observed in the diet of

Fig. 90. Wadi below As Salihiyyah, Southern Highlands (photo by A. Reiter). Above pools in the wadi, *Pipistrellus pipistrellus*, *P. kuhlii*, and *Barbastella leucomelas* were netted and echolocation calls of *Eptesicus bottae* were recorded.



Figs. 91, 92. Spectrograms of echolocation calls of *Barbastella leucomelas* (Cretzschmar, 1830). 91 (above) – an individual foraging at a spring in the Wadi Al Abiat. 92 (below) – an individual foraging at pools in the wadi below the village of As Salihiyyah.

B. barbastellus (Andreas et al. in press) as compared to *B. leucomelas* that probably feeds almost entirely on smaller insect individuals.

Echolocation. In total, we obtained seven recordings of *Barbastella leucomelas* calls from three localities (Figs. 91, 92). Basic echolocation parameters are given in Table 4. Echolocation in this species was described in details by Benda et al. (2008) from the Sinai; the echolocation parameters of the Jordanian populations fully conform to the data available from the Sinaitic bats.

Plecotus christii Gray, 1838

Records. **New data**: ʻA m m a n: Mukawir [1], caves near the Palace of Machaerus ruins, 21 May 2009: found 1 ma (NMP 92501 [S+A]); – A q a b a: Al Ghal [2], above a camel haunt (Fig. 88), 17 May 2009: net. 1 fa, 6 faL (NMP 92470–92474 [S+A], 92469, 92475 [A]); – Wadi Rum, small watering place at a bedouin camp 1 km east of the village [3], 24–25 October 2004: net. 2 ma (NMP 92096, 92097 [S+A]; cf. Benda et al. 2006, 2008), obs., det. & rec. several inds. [3 echolocation recordings]; – Wadi Rum [4], east side, 11 June 1999: coll. 1 ind. ad. (RSCN unnumbered [B]). – M a' a n: Ar Rajif, Jebel Masuda, Ain Amshit [5] (Fig. 95), 15 May 2009: net. 5 ma, 4 fa, 1 fs (NMP 92448–92451, 92454–92457 [S+A], 92452, 92453 [A]), det. calls of several inds.; – Ash Shawbak [6], Ash Shawbak Castle, undeground corridor, 20 October 2008: obs. 5 inds. torpid (coll. 3 fa, NMP 92392, 92393 [S+A], 92394 [A]), 19 May 2009: obs. 2 inds., coll. 1 ma (NMP 92497 [S+A]), 7 July 2010: obs. 4 torpid inds. (exam. 1 faL); – Dilagha [7], Jebel Masuda, at a spring in the easternmost exten-

sion of the Wadi Al Abiat (Fig. 83), 22 October 2008: det. & rec. calls of 1 ind. [1 echolocation recordings]; – Jabal Al Bayda [8], small cave in sandstone rocks ca. 2 km to S, 10 October 2010: net. 1 ma, 1 fa (coll. 1 ma; NMP 93838 [S+A]). – T a f i l a: Al Qurayqira [9], Khirbet Feynan, ca. 2 km W of the Feynan Ecolodge, mine, 5 July 2010: obs. two clusters of ca. 40 and 10 inds. ca. 100–150 m deep in the mine (exam 13 inds. from the larger cluster: 1 ma, 1 ms, 7 faL, 4 fa, 3 fs; coll. 1 m, 2 f, NMP 92801, 92803 [S+A], 92802 [A]); – Al Qurayqira [10], Wadi Khalid, Wadi Araba, 18 June 2000: coll. 1 ind. ad. s.i. (RSCN unnumbered [S+B]; leg. M. Abu Baker & RSCN); – Dhana [11], at an artificial watering place for birds at the Rummana Camp (Fig. 44), 19 May 2009: net. 1 fs (NMP 92499 [A]); – Dhana [12], artificial sandstone caves ca. 2 km E of the Rummana Camp, 18 October 2008: net. 1 ma, 1 fa (NMP 92384, 92385 [S+A]); – Dhana [13], small sandstone cave in the Rummana hill, 19 May 2009: net. 1 ma (NMP 92498 [S+A]); – Dhana [14], village, at a stream in the village gardens, 6 July 2010: det. & rec. 1 ind.; – Dhana [15], Wadi Dhana (Fig. 5), Mahjub Cave, 25 July 2000: coll. 1 ma, 1 ind. ad. s.i. (RSCN unnumbered [A], unnumbered [S+B]; leg. Mayas & M. Faqir) by hand inside the cave. – **Published data** (all records were published under *P. austriacus*): A q a b a: Disa [16] (Wadi Rum), [= 31 May 1990: net.] 8 inds. [2 ma, 1 fa (JUST unnumbered)] (Qumsiyeh et al. 1992); – near Gharandal [17] (Wadi Araba), 4 inds. [= 30 May 1990: net. 2 ma, 2 fa] (Qumsiyeh et al. 1992). – M a' a n: Petra [= Al Batra] [18], a cave in the ruins (Disi & Hatough-Bouran 1999); – Ras' an Naqb [19], 4 November 1992: 1 ind. (Qumsiyeh 1996, Qumsiyeh et al. 1998).

Distribution. *Plecotus christii* is a rather common species in Jordan, 18 record sites are known from the southwestern portion of the country (Fig. 93). *P. christii* was previously reported from

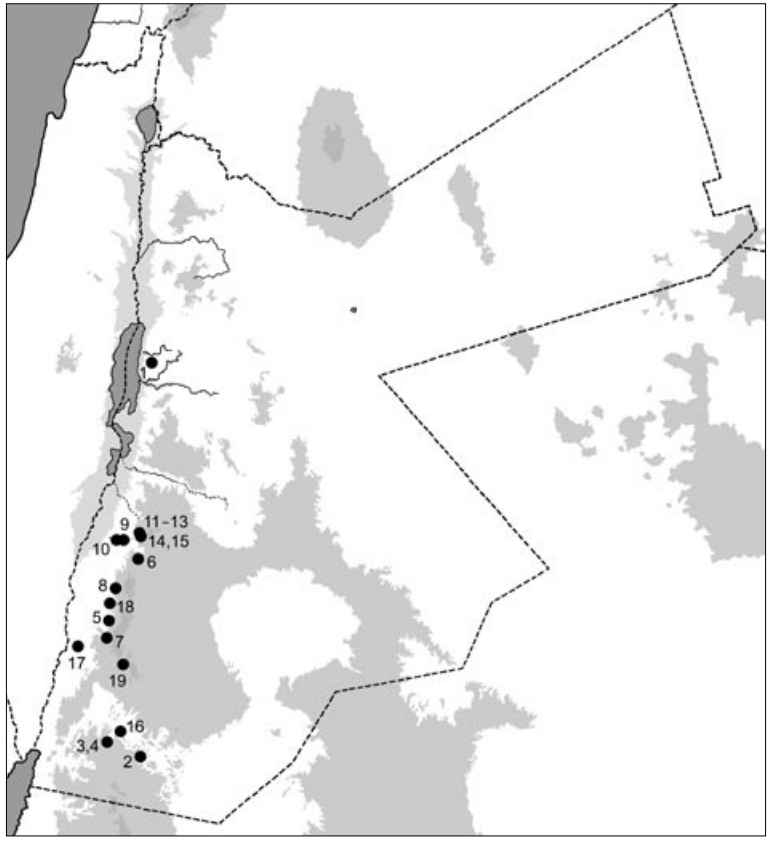


Fig. 93. Records of *Plecotus christii* Gray, 1838 in Jordan.

Jordan under the name *Plecotus austriacus* (Fischer, 1829), nowadays considered a European form which occurs neither in Asia nor in Africa (Benda et al. 2004c, 2008, Spitzenberger et al. 2006). *P. christii* is a species distributed at the Afro-Asian transition, in a rather limited area stretching from eastern Libya and northern Sudan to central Palestine and western Jordan (Benda et al. 2008). In Jordan, the published records were known from the southernmost corner of the country, from and south of Al Batra (Petra) (Qumsiyeh et al. 1992, 1998, Qumsiyeh 1996, Disi & Hatough-Bouran 1999). New records evidenced occurrence of *P. christii* along the Rift Valley as northwards as to 31° 30' N in Jordan, which well corresponds with the range in Palestine as described by Mendelssohn & Yom-Tov (1999). The northernmost known record within the species range was made nearby Jerusalem, some 40 km WNW of Mukawir, the northernmost record site in Jordan.

In Palestine, *P. christii* occurs in Judea, Negev Desert, and in the Arava Valley (Mendelssohn & Yom-Tov 1999), i.e. both in lowland and mountainous areas. An identical pattern of occurrence is shown by this species in Jordan, where it lives in low areas adjacent to the Wadi Araba and in high areas of the Southern Highlands and the Rum Desert. In both area types *P. christii* prefers arid environments. The records of *P. christii* in Jordan come from a rather broad altitude range of 240–1546 m a. s. l. (n=18) and the mean altitude (913.2 m) suggests a preference of very elevated sites. Although only a third of the records represents findings of bats in or at their roosts (n=6), the altitudinal preference of the roost sites (range 278–1340 m a. s. l.; mean 960.8 m) is even shifted up against the general preference of altitudes. After *Barbastella leucomelas*, *P. christii* is the second 'most montane' bat of Jordan.

In southwestern Syria (Mount Hermon, Anti-Lebanon Mts.) and probably also in northern Palestine ('by the Sea of Galilee'), records of another species of the genus were made, *Plecotus macrobullaris* Kuzjakin, 1965 (Benda et al. 2006, cf. Mendelssohn & Yom-Tov 1999). However, this species is an inhabitant of high mountain environments in the Middle East (see Benda et al. 2004c, 2006) and its occurrence in Jordan seems unlikely.

Field notes. *Plecotus christii* was discovered to roost at four sites in Jordan; all of these sites were artificial underground spaces. The most interesting finding was made in a long mine at Khirbet Feynan, situated some 2 km west of the Feynan Ecolodge; ca. 100–150 m deep in the mine, two clusters of about 40 and 10 torpid individuals (including lactating females) were found to hang on the roof ca. 1.5 m high (Fig. 94). One torpid male was found to roost on a side wall in the artificial caves next to the Palace of Machaerus at Mukawir, high above the Dead Sea bank. In the deep underground corridor of the Ash Shawbak Castle, single roosting individuals of *P. christii* were observed during three visits, five individuals in October, two torpid bats in May, and four torpid individuals in July. In the upper part of the Dhana Reserve, two bats were netted when leaving their roost in fissures in artificial sandstone caves in a rocky slope some 2 km east of the Rummana Camp (Fig. 44). In this area, *P. christii* was also netted at an artificial watering place for birds at the Rummana Camp and at a small sandstone cave in a hill opposite to the Camp. Two individuals were caught into a net putted up at a small sandstone cave at Jabal Al Bayda and ten bats into several nets installed in the area around the spring of the Ain Amshit oasis in the Jebel Masuda Mts. (Fig. 95). In the Rum Desert, *P. christii* individuals were netted at three sites; seven bats were caught into a net installed above a camel haunt in the small oasis of Al Ghal (Fig. 88), two bats were netted at the Lawrence's Pool in the Wadi Rum, and eight bats in Disa (Qumsiyeh et al. 1992).

Various other bat species were recorded in the sites of *P. christii* occurrence in Jordan. In the underground corridor of the Ash Shawbak Castle, *Rhinolophus blasii* and *Myotis nattereri* were also observed, while in the mine at Khirbet Feynan an individual of *Rhinopoma cystops* was found. In the Ain Amshit oasis, *Rhinolophus clivosus* and *Pipistrellus pipistrellus* were also netted.

Fig. 94. A group of *Plecotus christii* Gray, 1838 roosting in a mine at Khirbet Feynan near Al Qurayqira, Dhana Reserve (photo by A. Reiter).

Fig. 95. Ain Amshit oasis, Jebel Masuda Mts. (photo by A. Reiter). In various places of the oasis, five bat species were recorded; *Rhinolophus clivosus*, *Pipistrellus pipistrellus* and *Plecotus christii* were netted, calls of *Eptesicus bottae* and *Otonycteris hemprichii* were detected, and remains of *O. hemprichii* were found in owl pellets.

Rhinolophus clivosus, *Eptesicus bottae*, *Hypsugo ariel*, *Otonycteris hemprichii*, and *Barbastella leucomelas* were recorded along with *P. christii* in Al Ghal, and *Eptesicus bottae*, *Hypsugo ariel*, and *Tadarida teniotis* in the Wadi Rum. *Rhinolophus clivosus*, *Myotis nattereri*, *Eptesicus bottae*, *Barbastella barbastellus*, and *Tadarida teniotis* were documented from the upper part of the Dhana Reserve. Calls of *Otonycteris hemprichii*, *Barbastella leucomelas*, and *Tadarida teniotis* were detected along with those of *P. christii* in the Wadi Al Abiat (Fig. 83).

Indirect evidence of *P. christii* reproduction is available from three sites in Jordan. Seven of thirteen bats examined from the mine at Khirbet Feynan on 5 July were lactating females and three were full grown juveniles. On 7 July, one lactating female was found in the underground of the Ash Shawbak Castle. Six of the seven females netted at Al Ghal on 17 May were lactating. However, none of four adult females netted at Ain Amshit on 15 May was lactating nor pregnant. These data suggest that parturitions in Jordan might occur in late April and/or early May. Mendelssohn & Yom-Tov (1999) reported lactating females caught in southern Palestine on 25 April, 1 and 2 May, and 14 June, and suggested parturitions to take place there in April. This is roughly in accordance with the available data from Jordan.

P. christii has not been evidenced in the analysed samples of owl pellets from Jordan.

Morphology and variation. External and cranial dimensions of the Jordanian specimens of *Plecotus christii* examined are shown in Table 12. For the material examined see Records.

The populations of *P. christii* of the southern Holy Land, i.e. of the northernmost and easternmost parts of the species distribution range, were defined as a separate form, *P. c. petraeus* Benda, 2008, based on the bats from the Sinai (Benda et al. 2008). Individuals of this subspecies were found to be larger than the individuals of the nominotypical form, inhabiting the desert areas of

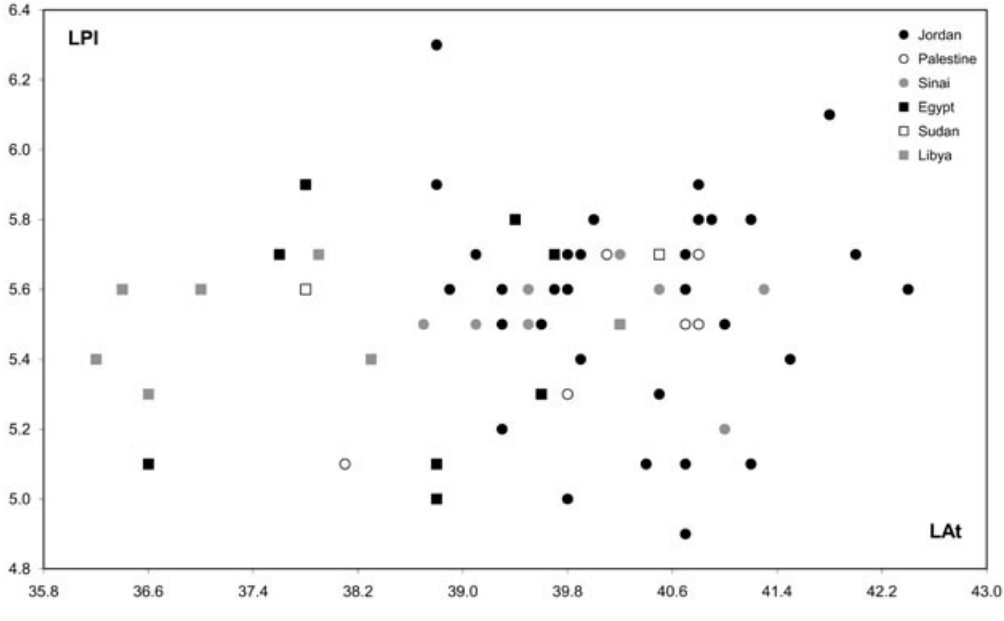


Fig. 96. Bivariate plot of the examined Jordanian and comparative samples of *Plecotus christii* Gray, 1838: forearm length (LAt) against the thumb length (LPl). Egypt = continental part of Egypt.

Table 13. Comparison of biometric data on six *Plecotus christii* Gray, 1838 population sample sets. Egypt = continental part of Egypt. For abbreviations see p. 192, 193

	Jordan				Palestine				Sinai			
	n	**M**	min	max	n	**M**	min	max	n	**M**	min	max
LAt	34	**40.31**	38.8	42.4	7	**40.01**	38.1	40.8	8	**39.98**	38.7	41.3
LPl	34	**5.58**	4.9	6.3	7	**5.40**	5.0	5.7	8	**5.53**	5.2	5.7
LCr	25	**16.81**	16.35	17.48	7	**17.02**	16.70	17.42	8	**16.87**	16.57	17.18
LCb	25	**15.70**	15.12	16.38	7	**15.90**	15.48	16.37	8	**15.76**	15.57	16.12
LaZ	24	**8.53**	8.23	9.07	7	**8.57**	8.35	8.78	7	**8.57**	8.41	8.76
LaN	25	**5.12**	4.88	5.34	8	**5.25**	5.12	5.40	8	**5.18**	5.07	5.33
LBT	25	**4.71**	4.47	4.94	8	**4.73**	4.48	4.90	8	**4.68**	4.53	4.78
CM^3	25	**5.69**	5.48	5.95	8	**5.72**	5.58	6.07	8	**5.67**	5.54	5.84
LMd	25	**10.62**	10.28	11.29	8	**10.70**	10.32	11.13	8	**10.56**	10.36	10.77
CM_3	25	**6.13**	5.91	6.94	8	**6.19**	5.90	6.85	8	**6.09**	5.93	6.37
CM^3/LCb	25	**0.362**	0.345	0.373	7	**0.360**	0.351	0.373	8	**0.360**	0.355	0.369
CC/CM^3	23	**0.623**	0.590	0.652	8	**0.612**	0.568	0.636	8	**0.639**	0.623	0.655
M^3M^3/CM^3	25	**1.059**	1.005	1.102	8	**1.044**	1.020	1.075	8	**1.078**	1.049	1.126
LaN/LCr	25	**0.481**	0.443	0.510	7	**0.472**	0.460	0.485	8	**0.479**	0.462	0.496
ACo/LMd	25	**0.287**	0.269	0.302	8	**0.282**	0.267	0.296	8	**0.290**	0.285	0.301

	Egypt				Libya				Sudan	
	n	**M**	min	max	n	**M**	min	max	BMNH 49.2.8.35.	NMP 93679
LAt	9	**38.63**	36.6	39.7	7	**37.51**	36.2	40.2	37.8	40.5
LPl	8	**5.45**	5.0	5.9	7	**5.50**	5.3	5.7	5.6	5.7
LCr	8	**16.37**	16.12	16.69	5	**16.34**	15.92	16.75	–	16.64
LCb	8	**15.20**	14.93	15.42	4	**15.22**	14.97	15.57	–	15.57
LaZ	7	**8.45**	8.07	8.86	5	**8.50**	8.22	8.74	–	8.27
LaN	8	**7.96**	7.49	8.23	4	**5.47**	5.42	5.52	–	5.16
LBT	9	**4.47**	4.32	4.55	5	**4.43**	4.31	4.55	–	4.59
CM^3	9	**5.35**	5.15	5.58	7	**5.30**	5.08	5.47	–	5.37
LMd	9	**10.22**	9.98	10.52	7	**10.18**	9.78	10.52	–	10.23
CM_3	9	**5.74**	5.48	5.95	7	**5.41**	3.51	5.86	–	5.69
CM^3/LCb	8	**0.352**	0.344	0.370	4	**0.351**	0.344	0.356	–	0.345
CC/CM3	8	**0.650**	0.619	0.674	6	**0.644**	0.632	0.657	–	0.641
M^3M^3/CM^3	8	**1.096**	1.021	1.135	6	**1.109**	1.084	1.137	–	1.073
LaN/LCr	8	**0.486**	0.454	0.508	5	**0.496**	0.486	0.508	–	0.480
ACo/LMd	9	**0.283**	0.265	0.293	6	**0.289**	0.279	0.298	–	0.291

continental Egypt, eastern Libya and northern Sudan (Benda et al. 2004c, 2008). The comparison of the Jordanian samples of *P. christii* with the samples of other populations from Palestine and the Sinai (*P. c. petraeus*), and from Egypt, Sudan and desert Libya (*P. c. christii*) showed two basic size groups within the examined samples, corresponding with the two subspecies (Figs. 96, 97); the most numerous samples from Jordan closely corresponded in their absolute and relative dimensions with the dimension ranges of the series from the Sinai and Palestine (see Table 13). Although the two groups of *P. christii* populations, the African (*christii*) and Asian (*petraeus*) ones, partly overlapped in several dimension ranges (Figs. 96, 97), no cline but a step shift in size characters between two basic geographical ranges was observed. The delimitation of two taxa within *P. christii*, differing in geographical ranges (i.e. of two subspecies), seems to be well supported on morphological grounds.

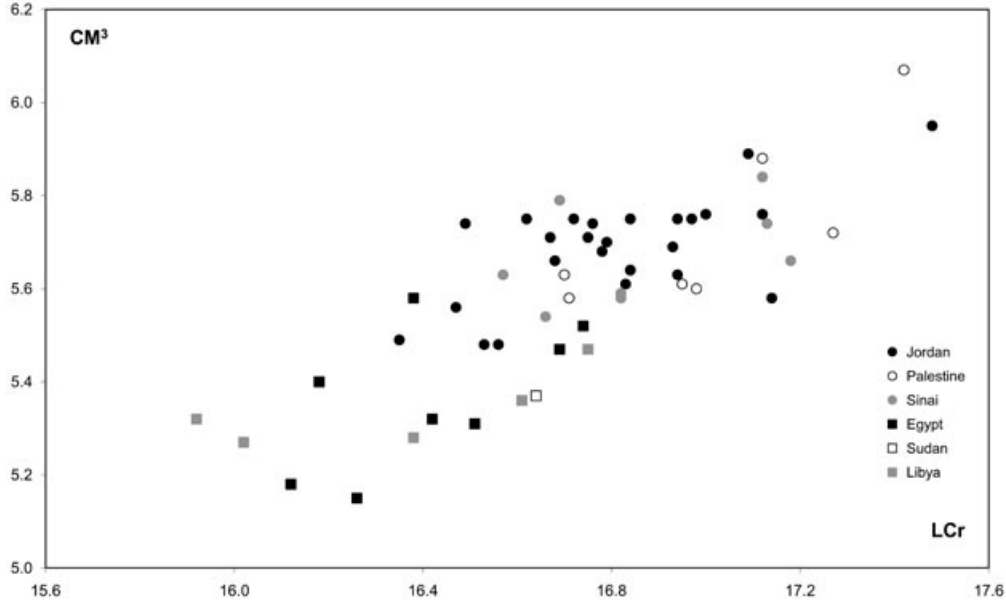


Fig. 97. Bivariate plot of the examined Jordanian and comparative samples of *Plecotus christii* Gray, 1838: greatest length of skull (LCr) against the length of upper tooth-row (CM^3). Egypt = continental part of Egypt.

The relatively rich museum material of *P. christii* from Jordan enabled us to describe baculum of *P. christii petraeus*, a character traditionally considered as of valuable taxonomic relevance in this genus (cf. Lanza 1960, Benda et al. 2004c, Spitzenberger et al. 2006). Based on four Jordanian preparations (Fig. 98), the baculum in *P. c. petraeus* is a flattened bone with pointed distal epiphysis and broadened proximal epiphysis, maximum length 0.775–0.958 mm (mean 0.859 mm) and maximum width at proximal epiphysis 0.451–0.577 mm (mean 0.518 mm). In shape, it closely

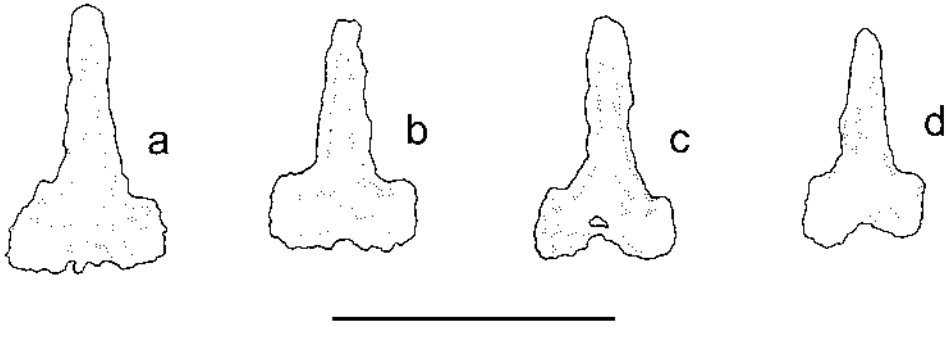


Fig. 98. Baculum preparations from *Plecotus christii* Gray, 1838 from Jordan. a – NMP 92501, Mukawir; b – NMP 92384, Dhana Reserve, cave at the Rummana Camp; c – NMP 93838, Jabal Al Bayda; d – NMP 92450, Ain Amshit, Jebel Masuda. Scale bar = 1 mm.

resembles that of *P. c. christii* from Egypt and Libya (Lanza 1960, Qumsiyeh 1985, Benda et al. 2004c), which is slightly shorter but relatively broader in its proximal part (maximum length 0.707–0.800 mm, mean 0.753 mm; maximum width 0.460–0.559 mm, mean 0.518 mm).

Feeding ecology. *Plecotus christii* is a medium-sized gleaning bat (Whitaker et al. 1994, Benda et al. 2008). The diet of *P. christii* was analysed in Palestine (Whitaker et al. 1994, Feldman et al. 2000) and the Sinai (Benda et al. 2008); Lepidoptera were by far the most important prey category complemented by small proportions of Trichoptera, Coleoptera and Diptera (Feldman et al. 2000) or Blattodea (Benda et al. 2008).

From Jordan, we analysed 58 faecal pellets from 13 bats originating from three sites (Fig. 99) and seven contents of digestive tracts from bats coming from five sites. The diet composition of bats collected in the Ash Shawbak Castle and in the Khirbet Feinan mine was dominated by Lepidoptera and corresponded well with the published data. The diet of bats collected at Al Ghal was surprisingly diversified and dominated by Coleoptera (smaller and medium-sized Scarabaeidae). These data are even more interesting if we take into account the relatively large size of the respective analysed sample (Fig. 99). Similarly, in two digestive tracts of *P. christii* collected in the Wadi Rum, Lepidoptera were nearly absent (only 10% of volume in one stomach) and the diet contained Orthoptera (20–60% of volume), Coleoptera (0–30%), small Solpugida (0–30%), and smaller proportions (0–20%) of Chilopoda, Brachycera, and Neuroptera. In five other tracts coming from the more northward localities (Dhana Reserve, Mukawir, Jabal al Bayda, Ash Shawbak Castle), Lepidoptera dominated (80–100%), complemented in the particular tracts by small proportions (10%) of Coleoptera, Orthoptera and Neuroptera.

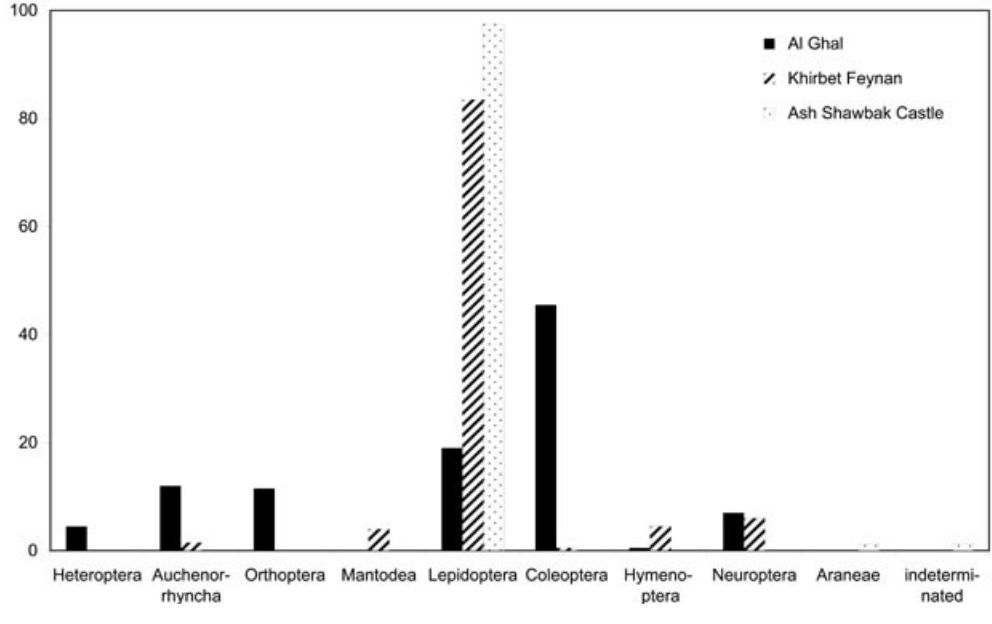


Fig. 99. Volume of particular prey categories in the diet of *Plecotus christii* Gray, 1838 from Jordan. Material: Al Ghal – 30 pellets analysed from seven bats; Ash Shawbak Castle – eight pellets analysed from three bats; Khirbet Feynan – 20 pellets analysed from three bats.

The Ash Shawbak Castle and Khirbet Feinan mine are localities situated in or close to the Mediterranean zone, whereas the oases of Wadi Rum and Al Ghal are found in the sand Rum Desert. The results from the latter desert localities suggest that *P. christii* may not be a moth eating specialist and indicate possible shifts in the trophic niche of the species on the extreme margin of its suitable environment.

Echolocation. In total, we obtained four recordings of *Plecotus christii* calls from two sites. Basic echolocation parameters are given in Table 4. Echolocation of this species was described in details by Benda et al. (2008) based on the recordings made in the Sinai. Jordanian populations show almost identical parameters as the Sinaitic bats, except for a slightly lower FMAXE and shorter PDUR.

Miniopterus pallidus Thomas, 1905

Records. **New data**: I r b i d: Ar Ramtha [1], June 2004: 1 ind. (JUST unnumbered); – Khashibah [2], 'Al Wardeh Cave' mine (Fig. 39), 26 May 2009: obs. a mixed colony of *Miniopterus* and four other bat species of ca. 350 inds., coll. 1 fa, 1 faG (NMP 92532, 92533 [S+A]), 14 July 2010: net. 1 ms, 1 mj, 1 fa, 1 fs, 6 fj (coll. 1 m, 2 f, NMP 92839 [S+A], 92837, 92838 [A]). – **Published data** (all records were published under *M. schreibersii*): I r b i d: Jarash [3], Roman ruins, hole in the hillside below the Temple of Zeus, 19 October 1953: coll. 1 m (Harrison 1956, 1959a, 1964); – near the Dibbine Forest, Mugharet el Wardeh [2], 4 inds. (Harrison & Bates 1991).

Distribution. The taxonomic affiliation of Jordanian as well as Levantine populations of the genus *Miniopterus* Bonaparte, 1837 is not fully understood, therefore the status of these populations could be evaluated only tentatively in this paper. In short, Bilgin et al. (2006) and Furman et al. (2009) suggested the occurrence of two forms of *Miniopterus schreibersii* (Kuhl, 1817) to exist in a clear parapatry in the northern part of the Middle East, *M. s. schreibersii* in coastal areas of the eastern Mediterranean and *M. s. pallidus* in continental areas of central Turkey and in Iran. Furman et al. (2010) and Maraci et al. (2010) further suggested that these two forms represent separate species, based on genetic and biogeographical characters. Šrámek (2010) analysed the available material of *Miniopterus* from the Levant, where he also found two forms; the examined specimens from Syria and Lebanon belonged solely to the *schreibersii* lineage, while the only analysed samples from Jordan (originating from the Al Wardeh Cave) were shown to pertain to the *pallidus* lineage. However, the Syrian sample from the Yarmuk Valley (Talsh'hab) on the Syrian-Jordanian border (some 57 km north of the Al Wardeh Cave) belonged to the *schreibersii* lineage (Šrámek 2010). Therefore, both forms, *M. pallidus* and *M. schreibersii*, may well occur in Jordan, although only *M. pallidus* remains evidenced from the country. We thus tentatively assign the Jordanian populations to the latter taxon.

M. pallidus is a rare bat species in Jordan, only three record sites are available from the Mediterranean biogeographical region (Fig. 87). According to the data by Mendelssohn & Yom-Tov (1999), the Jordanian range represents the southernmost spot of the *Miniopterus* occurrence in the Levant, since in Palestine this bat currently occurs only in a cave on Mount Meron (Upper Galilee). The colony of *M. pallidus* occupying the 'Al Wardeh Cave' mine above the Zarqa' Valley in Jordan lives about 90 km SSW of this sole Palestinian occurrence spot being notified. The historical occurrence in Palestine reached as southwards as the southern part of West Bank, however, from Judea, Samaria, Lower Galilee and the Rift Valley this bat was reported to become extinct during the second half of the 20th century (Makin 1989, Mendelssohn & Yom-Tov 1999). Nevertheless, in SW Syria, *Miniopterus* bats were found at Talsh'hab (Benda et al. 2006) and on Mount Hermon (Mendelssohn & Yom-Tov 1999). Northwards, the range continues in the Levant (western Syria and Lebanon; Benda et al. 2006, Horáček et al. 2008) and Turkey (Karataş & Sözen

2004), where the bats of the genus *Miniopterus* are not rare (however, taxonomic affiliations of these populations are various, see above).

The limited records of *M. pallidus* from Jordan come from a very narrow altitude range of 515–665 m a. s. l. (n=3), this range as well as the mean altitude (586.7 m) suggest a preference of rather elevated sites. At least two of these sites represent findings of bats in or at their roosts; altitudes of the roost sites (580 and 665 m a. s. l.; mean 622.5 m) are only slightly shifted up against the general altitudinal preference.

Field notes. We recorded *Miniopterus pallidus* in a roost of a large mixed colony in the extensive ancient mine named Al Wardeh Cave near Khashibah in the southern slope of the Ajlun Mts. above the Zarqa' Valley (Fig. 39). The colony was composed of five bat species, besides *M. pallidus* also of *Rhinolophus euryale*, *R. blasii*, *Myotis blythii*, and *M. emarginatus*. In May 2009, it counted ca. 350 individuals, while in July ca. 1000 individuals; however, the percentage of *M. pallidus* cannot be estimated. The presence of *Miniopterus* in this mine was first published by Harrison & Bates (1991), our records confirmed the persistence of the colony in this underground space.

One female of the two collected on 26 May (Fig. 100) was pregnant, it contained one foetus of the crown-rump length 20.0 mm. This finding concurs with the data from other parts of the

Fig. 100. Portrait of a female *Miniopterus pallidus* Thomas, 1905 from the 'Al Wardeh Cave' mine at Khashibah (photo by A. Reiter).

Table 14. Basic biometric data on the examined samples of *Miniopterus pallidus* Thomas, 1905 and *Tadarida teniotis* (Rafinesque, 1814). For abbreviations see p. 192, 193

	Miniopterus pallidus					*Tadarida teniotis*				
	n	**M**	min	max	SD	n	**M**	min	max	SD
LC	5	**62.2**	58	67	3.701	1	90			
LCd	5	**61.8**	56	66	3.701	1	48			
LAt	5	**46.12**	43.4	47.9	1.780	5	**61.08**	59.6	63.6	1.684
LAu	5	**14.06**	13.2	15.2	0.767	1	34.6			
LTr	5	**6.00**	5.2	6.9	0.682	1	7.4			
LCr	3	**15.33**	14.84	15.83	0.495	3	**24.02**	23.57	24.27	0.393
LCb	3	**14.97**	14.34	15.49	0.583	3	**23.27**	22.74	23.61	0.467
LaZ	3	**8.65**	8.52	8.82	0.154	3	**13.83**	13.53	14.08	0.278
LaI	3	**3.47**	3.44	3.49	0.025	3	**4.65**	4.59	4.71	0.060
LaInf	3	**4.03**	3.93	4.11	0.092	3	**4.87**	4.82	4.93	0.055
LaN	3	**8.03**	7.93	8.09	0.090	3	**11.53**	11.48	11.64	0.092
LaM	3	**8.83**	8.58	8.97	0.215	3	**12.51**	12.34	12.75	0.215
ANc	3	**6.34**	6.27	6.42	0.076	3	**7.29**	7.26	7.33	0.038
LBT	3	**2.92**	2.79	3.03	0.121	3	**5.33**	5.22	5.39	0.098
CC	3	**4.59**	4.53	4.66	0.066	3	**5.52**	5.39	5.63	0.122
M^3M^3	3	**6.39**	6.27	6.53	0.132	3	**9.31**	9.05	9.49	0.229
CM^3	3	**6.02**	5.88	6.17	0.145	3	**8.99**	8.88	9.08	0.101
LMd	3	**11.00**	10.58	11.33	0.382	3	**16.83**	16.52	17.04	0.276
ACo	3	**2.55**	2.47	2.66	0.100	3	**3.95**	3.77	4.19	0.218
CM_3	3	**6.39**	6.29	6.51	0.112	3	**9.62**	9.44	9.74	0.157

Middle East (Mendelssohn & Yom-Tov 1999, Aşan Baydemir & Albayrak 2006, Benda et al. 2006), suggesting parturitions to occur from late April to June.

Although in the Middle East *Miniopterus* bats were found to be a part of owl diet in Palestine, Turkey, and Iran (Dor 1947, Obuch 1994, 2010, Obuch unpubl.), no similar data are available from Jordan.

Morphology. External and cranial dimensions of the Jordanian specimens of *Miniopterus pallidus* examined are shown in Table 14. For the material examined see Records.

Feeding ecology. Bats of the *Miniopterus schreibersii* complex are medium-sized bats which were formerly supposed to fly fast almost exclusively in open areas (cf. Boye 2004). However, such a claim was deduced from casual estimates based on wing morphology without thorough observations of bats in the field, with most probability. Other authors described the foraging behaviour differently, as they observed bats to hunt manoeuvrably around street lamps, below the forest canopy, above water bodies as well as close to vegetation (Lugon & Roue 1999, Presetnik 2002).

The diet composition of *M. schreibersii* s.str., a species morphologically almost identical with *M. pallidus*, was studied in Europe and the Middle East. Lugon & Roue (1999), Presetnik (2002) and Benda et al. (2006) showed *M. schreibersii* s.str. to feed predominantly on Lepidoptera, much less on Neuroptera, Diptera or other taxa. Whitaker & Karataş (2009) discovered important proportions of Coleoptera and Orthoptera in the diet samples of *M. schreibersii* s.l. from Turkey (perhaps including also *M. pallidus*). The diet of *Miniopterus natalensis* (Smith, 1834) – a species belonging also to the *M. schreibersii* morpho-group – was studied in southern Africa (Fenton et al. 1977); the bats fed especially on aquatic Diptera. A subsequent study by Fenton & Thomas

Fig. 101. A female *Nycteribia s. schmidlii* Schiner, 1853 collected from its primary host, *Miniopterus pallidus* Thomas, 1905, at the 'Al Wardeh Cave' mine near Khashibah (photo by O. Balvín). The record represents the first evidence of this parasite from Jordan.

(1980) showed important proportions of Coleoptera within the dry season and Diptera in the wet season in the diet of *M. natalensis*.

The diet of *M. pallidus* s.str. was studied only in Iran (Benda et al. 1999) and it seems this species also feeds predominantly on Lepidoptera. Only one content of digestive tract of *M. pallidus* was analysed from Jordan (Al Wardeh Cave); it contained solely remnants of Lepidoptera.

The diet composition of bats of the *M. schreibersii* complex, studied across the Mediterranean from Western Europe to Iran (Lugon & Roue 1999, Benda et al. 1999, Presetnik 2002, Benda et al. 2006), always contained an overwhelming majority of Lepidoptera. Also Vestjens & Hall (1977) found that *Miniopterus* spp. in Australia feed mainly on moths. It may seem that due to specific foraging strategy and/or echolocation mode, the bats of this complex/morpho-group are moth--eating specialists. However, the findings by Fenton et al. (1977), Fenton & Thomas (1980) and Whitaker & Karataş (2009) indicate that these bats have a wider trophic niche and more flexible foraging strategy, as they are able to feed also on Coleoptera and Diptera.

Records of ectoparasites. **Original data**: S p i n t u r n i c i d a e: *Spinturnix psi*: 2 ma, 1 f (IZB; det. J. Krištofík) from 1 ma, 2 fa (NMP 92837–92839), Khashibah, 'Al Wardeh Cave' mine, 14 July 2010. – N y c t e r i b i i d a e: *Penicillidia conspicua*: 2 ma, 3 fa (UCPN) from 1 ma, 1 fa, 1 fa (NMP 92837–92839), Khashibah, 'Al Wardeh Cave' mine, 14 July 2010. – *Nycteribia schmidlii schmidlii*: 1 ma, 2 fa (UCPN) from from 1 ma, 1 fa, 1 fa (NMP 92837–92839), Khashibah, 'Al Wardeh Cave' mine, 14 July 2010.

Comments on ectoparasites. Although only three individuals of *Miniopterus pallidus* from only one site in Jordan (Al Wardeh Cave) were examined for parasites, three parasite species were

collected, one mite *Spinturnix psi* Kolenati, 1856 and two bat flies *Nycteribia schmidlii* Schiner, 1853 (Fig. 101) and *Penicillidia conspicua* Speiser, 1901. All three parasites represent new species for the fauna of Jordan.

Spinturnix psi is a host-specific species adapted to *Miniopterus schreibersii* s.l. (Estrada-Peña et al. 1991). It is widespread in southern Europe, southern Asia to Japan, in Madagascar, New Guinea and Australia (Domrow 1962, Dusbábek 1962, Baker & Delfinado 1964, Deunff 1977, Estrada-Peña & Serra-Cobo 1991).

Miniopterus schreibersii s.l. (including *M. pallidus*) has been reported as a principal host for both species of bat flies *Nycteribia schmidlii* and *Penicillidia conspicua* in southwestern Asia (Hůrka 1964; Afghanistan and Turkmenia). These parasites are cave-dwelling species occurring in the southwestern Palaearctic (Theodor 1975, Hůrka 1964, 1980), their closest records to Jordan originate from Palestine (Theodor 1967; *Miniopterus* sp.).

No flea species (Ischnopsyllidae) was found on *Miniopterus* in Jordan. In Afghanistan, Smit (1960) reported *Rhinolophopsylla unipectinata* (Taschenberg, 1880) from *M. pallidus*, a flea that was recorded in Jordan from *Rhinolophus clivosus* (see above). Parasitation of *M. pallidus* by this flea is probable also in Jordan.

Tadarida teniotis (Rafinesque, 1814)

Records. **New data**: ʻA m m a n: ʻAmman (Мертвое море, Палестина, Равва-Аммон [Mertvoe more, Palestina, Ravva-Ammon] = Dead Sea, Palestine, ʻAmman) [1], 5 May 1897: 1 ind. (ZIN 6162 [A], leg. Davidov); – Quseir Amra [2], at the ancient bath, 12 October 2008: det. & rec. calls of 1 ind. [1 echolocation recording]; – Ash Shunah Al Janubiyya [3], Wadi Shu'ayb ca. 5 km NE, at a stream, 22 May 2009: det. & rec. calls of several inds.; – Az Zara Springs [4] (Fig. 19), 22 October 2004: det. calls of 1 ind., 11 May 2009: det. calls of 2 inds.; – An Nuzha [5], Wadi Al Wala, above a river (Fig. 103), 11 July 2010: net. 1 faL (NMP 92826 [S+A]), det. & rec. calls of 1 foraging ind. [3 echolocation recordings]; – Iraq Al Amir [6], at artificial caves (Fig. 3), 10 May 2009: det. calls of 1 ind.; – Wadi Mujib [7], siq estuary (Fig. 18), 16 October 2008: det. calls of 1 ind.; – Wadi Zarqa Ma'in [8], 5 April 1999: coll. 1 fa (RSCN unnumbered [S+A]; leg. K. A. Al Omari & M. A. Abu Baker). – A q a b a: Aqaba [9], Red Sea shore ca. 10 km S, 26 October 2004: repeatedly det. calls of an ind.; – Al Qurayqira [10], Wadi Ghuweir, in the wadi between Khirbet Feynan and rest water pool 2 km to E, 13 May 2009: det. calls of several inds.; – Wadi Rum [11], at the Lawrence's Pool, 24–25 October 2004: repeatedly det. calls of several inds., 27 September 2005: found rests of 3 inds. (2 left and 3 right mandibles) in *Strix butleri* pellets, 18 May 2009: found rests of 2 inds. (rostrum, 1 left and 2 right mandibles) in *Strix butleri* pellets. – I r b i d: Al Mustaba [12], Az Zarqa' River valley, 12 April 2008: det. 1 foraging ind.; – Umm Qais [13], at hotel, 13 April 2008: det. calls of 3 foraging inds. – K a r a k: Rashah, Mujib Reserve [14], 20 April 1999: coll. 1 ma (RSCN unnumbered [S+A]; leg. K. A. Al Omari, F. l. Amerian & R. Heil); – Tall Numiera [15], at water pools (Fig. 59), 17 October 2008: det. & rec. calls of at least 1 ind.; – Wadi Weida'a [16], water pool at the wadi estuary, 12 May 2009: det. calls of several foraging inds. – M a' a n: Dilagha [17], Jebel Masuda, at a spring in the easternmost extension of the Wadi Al Abiat (Fig. 83), 22 October 2008: repeatedly det. & rec. calls of 1 ind. [3 echolocation recordings]; – Ma'an [18], May 2005: 1 ma; – Al Batra [19], May 2005: obs. 2 inds. – M a f r a q: Duqra [20], Az Zarqa' River valley 4 km NW, 23 May 2009: det. & rec. calls of several inds.; – Qasr Burqu [21], at the ancient fortress ruins (Fig. 82), 14 October 2008: det. & rec. repeatedly calls of 1 ind. – T a f i l a: Dhana [22], at an artificial watering place for birds at the Rummana Camp (Fig. 44), 4 July 2010: det. & rec. 1 ind.; – Dhana [23], ca. 1 km E of the Rummana Camp, 19 October 2008: det. calls of 1 ind., 19 May 2009: det. calls of 1 ind.; – Dhana [24], village and gardens at the village, 21 and 22 April 2008: det. calls of several inds., 20 May 2009: det. calls of several inds.; – Dhana [25], Wadi Dhana ca. 5 km NE of Feynan Ecolodge (Fig. 5), 14 May 2009: det. calls of several inds.; – Wadi Al Hasa [26] (Fig. 23), above a river ca. 1 km E of Hammamat Borbatah, 5 July 2010: det. a foraging ind. – Z a r q a': Al Azraq Al Janubi [27], Azraq wetland (Fig. 76), March 2000: coll. 2 ma (JUST unnumbered [B]; leg. Mujdi & M. Abu Baker), 18 April 2008: det. calls of 2 inds. – **Published data**: ʻA m m a n: Amman [1], May 1992: 1 ind. (Qumsiyeh 1996, Qumsiyeh et al. 1998); – Jbeiha [28], Jordan University Campus, a room, 19 October 1976: coll. 1 m (Qumsiyeh 1980, 1985). – A q a b a: Disa [29] (Wadi Rum), [31 May 1990:] 11 inds. [1 ma, 1 fa (JUST unnumbered)] (Qumsiyeh et al. 1992). – I r b i d: Jerash [30], 1 ind. (Qumsiyeh et al. 1992, 1998). – K a r a k: 2 km E Ghor es-Safi [= Ghor As Safi] [31], 1 ind. [= 28 May 1990: 1 ma] (Qumsiyeh et al. 1992); – vicinity of Ar Raddass [32], south of Wadi Al Mawjib, 1999, net. (Al-Omari et al. 2000). – M a' a n: Petra [= Al Batra] [19] (Amr 2000, most probably based on the vague mention by Disi & Hatough-Bouran 1999). – Z a r q a': Faidhat edh Dhahikiya [33], north end of Wadi Sirhan, 1966: shot 4 f (Atallah 1967, cf. Atallah 1966), 2 inds. (Qumsiyeh 1985).

Distribution. *Tadarida teniotis* is a very common species in Jordan, it represents the most widespread bat of the country, its localities are scattered equally in all four main biogeographical regions (Fig. 102). Altogether 33 record sites are available throughout the Jordanian territory, the highest number of sites registered – along with the records of *Pipistrellus kuhlii* (see above). However, the latter species has a centre of its occurrence in northern Jordan, while *T. teniotis* rather in the western part of the country, if anywhere. The published records have been known from two separate regions of Jordan, the western / southwestern and eastern parts of the country (Atallah 1966, 1967, Qumsiyeh 1980, 1996, Qumsiyeh et al. 1992, 1998, Al-Omari et al. 2000). New findings of *T. teniotis* interconnect these regions; however, most of the records (two thirds) are represented by noting and/or recordings of echolocation calls, individuals were examined only in ten sites, from one site we report osteological remains from owl pellets. Since the loud and low frequence voice of echolocation calls of *T. teniotis* is much better detectable (even by a naked ear) than the calls of other bats, the abundance of records is incomparable with that of other species. On the other hand, this fact enabled a very detailed survey of this species, in this way we recorded it twice more frequently than by other methods of evidence.

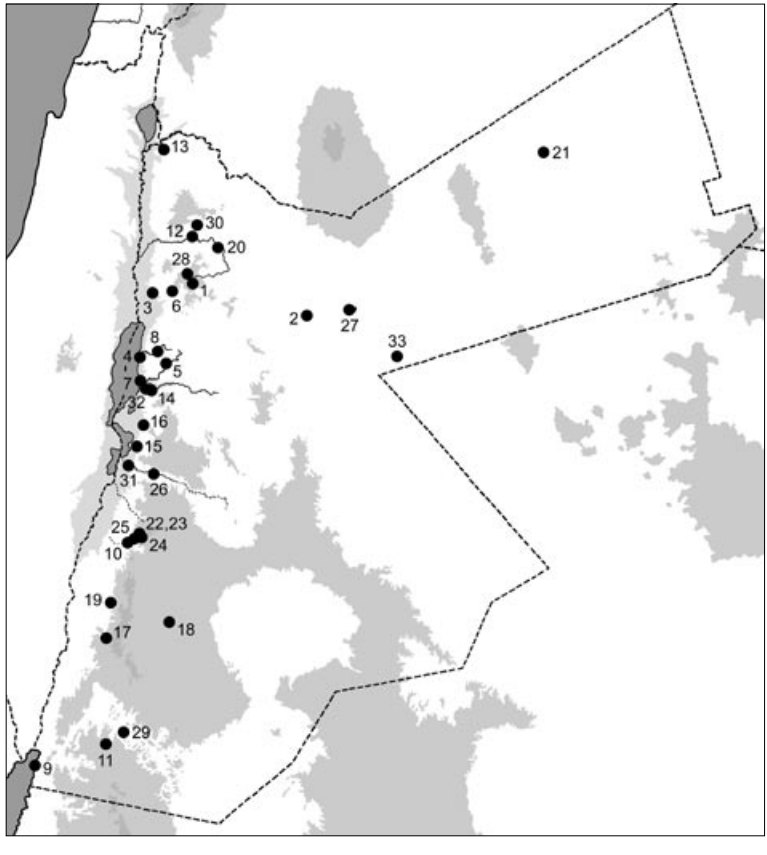


Fig. 102. Records of *Tadarida teniotis* (Rafinesque, 1814) in Jordan.

The distribution pattern in Jordan well resembles that described for Palestine by Mendelssohn & Yom-Tov (1999: 103), these authors mapped numerous records throughout the country: "from the Rift Valley from the Hula to Elat, Jerusalem, Tel Aviv, Karmi'el, Herzliyya, Lod, Sede Boqer, the Galilee, the Golan and other localities" (see also Yom-Tov & Kadmon 1998). Mendelssohn & Yom-Tov (1999: 103) concluded: "together with Kuhl's pipistrelle it is one of the two most common insectivorous bats". Thus, the densities of records and general pictures of occurrence of *T. teniotis* are almost identical on both sides of the Rift Valley.

The records of *T. teniotis* in Jordan come from a very broad altitude range from 385 m b. s. l. to 1224 m a. s. l. (n=33); the mean altitude (443.6 m) represents a medium altitude, suggesting no marked preference of environments along the altitudinal gradient. Since almost all records represent evidences of foraging bats (see Records), roost preferences cannot be evaluated. However, considering the extreme altitudinal range of the records, the roosts of *T. teniotis* may be found in all altitude categories of the Jordanian landscape.

Field notes. Only few field data are available on *Tadarida teniotis* from Jordan, besides the plentiful records of its echolocation calls. Only two observations from roost were published; Atallah (1967: 57) reported on the finding from the Syrian Desert: "Four females were shot at Faidhat edh Dhahikiya, the north end of Wadi Shirhan. These bats were common in this locality, inhabiting narrow crevices in the chalk cliffs." Another record from a possible roost was mentioned by Qumsiyeh (1980), who collected an adult individual from a room at the Jordan University Campus at Jbeiha in western ʿAmman. Netting of an individual was made only once, a lactating female was caught above a river in the Wadi Al Wala (Fig. 103) leading to the Wadi Al Mujib in the Dead Sea Basin on 11 July, and this record remains the only indirect evidence of reproduction of *T. teniotis* from Jordan (the timing is in accordance with other data from the Middle East by Lewis & Harrison 1962 and Mendelssohn & Yom-Tov 1999). At this site, *Rousettus aegyptiacus* and *Pipistrellus pipistrellus* were also netted, and echolocation calls of *Rhinopoma cystops* and *Eptesicus bottae* recorded.

At many sites, the typical echolocation calls of the foraging individuals were detected and/or recorded. Three individuals were detected in the village of Umm Qais; at artificial caves of Iraq Al Amir in the Wadi As Sir (Fig. 3), a call of one individual was detected, simultaneously also *Rousettus aegyptiacus*, *Rhinopoma cystops*, *Rhinolophus blasii*, *Myotis nattereri* and *Pipistrellus kuhlii* were recorded. Calls of passing individuals of *T. teniotis* were recorded in the Zarqa' Valley near Duqra, calls of *P. kuhlii* were also detected there.

Calls of *T. teniotis* were detected in many sites in the Rift Valley and the valleys leading to it; calls of passing bats were detected in the Wadi Shu'ayb near Ash Shunah Al Janubiyya, where calls of *P. kuhlii* were also recorded. At the Az Zara Springs (Fig. 19), foraging individuals of *T. teniotis* were recorded above the bank of the Dead Sea and surrounding habitats, at this site *Rousettus aegyptiacus* and *Taphozous perforatus* were also netted and calls of *Rhinopoma cystops* and *Taphozous nudiventris* recorded. In the estuary of the deep canyon-like terminal part (siq) of the Wadi Mujib into the Dead Sea (Fig. 18), *T. teniotis* foraging was recorded simultaneously with *Taphozous perforatus*. At a creek and water reservoir near Tall Numiera in the estuary of the Wadi Numiera (Fig. 59), calls of foraging *T. teniotis* were detected, while *Pipistrellus pipistrellus* and *Hypsugo ariel* were netted at this site. At a water reservoir in estuary of the Wadi Weida'a, individuals of *T. teniotis* were recorded to forage and drink at water surface according to their searching calls; at this site *Rhinopoma cystops*, *Eptesicus bottae*, and *Hypsugo ariel* were also recorded. Searching calls of *T. teniotis* were also registered in the Wadi Ghuweir at Khirbet Feynan, in this wadi *Rhinolophus clivosus*, *R. blasii*, *Eptesicus bottae*, *Pipistrellus pipistrellus*, and *Otonycteris hemprichii* were collected. In the Wadi Al Hasa (Fig. 23), at a river above the

Hammamat Borbatah resort, calls of one foraging individual of *T. teniotis* were detected, along with this species also *Rhinopoma cystops*, *Taphozous perforatus*, *T. nudiventris*, *Nycteris thebaica*, *Eptesicus bottae*, and *Hypsugo ariel* were recorded. In the Wadi Dhana (Fig. 5), above the Feynan Ecolodge, *T. teniotis* was registered to forage above the sandstone rocks; *Rousettus aegyptiacus* and *Rhinopoma cystops* were collected at this site.

In the Southern Highlands, *T. teniotis* was registered mainly in the Dhana Reserve; an exception represents the record made at a spring in the easternmost extension of the Wadi Al Abiat in the Jbel Masuda Mts. (Fig. 83), where *T. teniotis* was recorded together with *Otonycteris hemprichii*, *Barbastella leucomelas*, and *Plecotus christii*. In the hilly country of the upper part of the Dhana Reserve, *T. teniotis* was recorded to forage above the fertile old Dhana village as well as the areas surrounding the Rummana Camp (Fig. 44); in these habitats *Rhinolophus clivosus*, *Myotis nattereri*, *Eptesicus bottae*, *Hypsugo ariel*, *Pipistrellus pipistrellus*, *Barbastella leucomelas*, and *Plecotus christii* were also documented. In the Rum Desert, *T. teniotis* was recorded only occasionally (cf. Qumsiyeh et al. 1992); we registered this bat there only once (besides the records in owl pellets, see below), in October 2004, when several individuals were detected to forage above the Wadi Rum during a netting session at the Lawrence's Pool, when *Eptesicus bottae* was also netted. *T. teniotis* was also recorded to forage above the shore of the Gulf of Aqaba in the southernmost part of Jordan.

Calls of *T. teniotis* were also several times registered in the Syrian Desert of Jordan. One bat was recorded passing by the ancient bath of Quseir Amra, there were also recorded *Pipistrellus kuhlii* and *Otonycteris hemprichii* at this site. Above the ponds and wetlands of the Azraq

Fig. 103. Wadi Al Wala above the Dead Sea, Southern Highlands (photo by A. Reiter). Above a stream in the wadi, individuals of *Rousettus aegyptiacus*, *Pipistrellus pipistrellus*, and *Tadarida teniotis* were netted and echolocation calls of *Rhinopoma cystops* and *Eptesicus bottae* were recorded.

Reserve (Fig. 76) at Al Azraq Al Janubi, calls of two *T. teniotis* individuals were detected along with *P. kuhlii*. Foraging calls of at least one foraging individual of *T. teniotis* were recorded at Qasr Burqu within the dark lava desert in northeasternmost Jordan (Fig. 82); *O. hemprichii* was also netted and detected there.

T. teniotis was detected to be an exceptional item in owl diet in Turkey, Syria, and Palestine (Obuch 1994, 2010, Benda et al. 2006, Obuch & Benda 2009, Obuch unpubl.), and similarly also in Jordan. Rests of five individuals were found in two small samples of *Strix butleri* pellets collected in the Wadi Rum at two occasions. In the respective samples, the remains made up 7.5% and 11.1% of mammal and 2.7% and 8.0% of all prey items, respectively; in the whole analysed Hume's owl diet from Jordan they made up 0.44% of all prey items and 1.1% of mammal items (Table 17).

Morphology. External and cranial dimensions of the Jordanian specimens of *Tadarida teniotis* examined are shown in Table 14. For the material examined see Records.

Feeding ecology. *Tadarida teniotis* is a large bat hunting in direct flight in open spaces (Norberg & Rayner 1987, Feldman et al. 2000). The species was found to feed particularly on Lepidoptera in France and Kirghizstan (Rydell & Arlettaz 1994), in Palestine (Whitaker et al. 1994), in Syria (Benda et al. 2006) and in the Sinai (Benda et al. 2008). Only Whitaker & Karataş (2009) found another prey category (Orthoptera) to prevail over the moths in the diet of this bat in Turkey.

From Jordan, we analysed 25 faecal pellets collected from one bat netted in the Wadi Al Wala and two contents of digestive tracts from bats collected in the Mujib Reserve. The diet composition revealed from the pellet samples was dominated by Lepidoptera (89.0% of volume), complemented only by small proportions of Orthoptera (5.5%), Heteroptera (4.0%), Neuroptera (1.0%), and Hymenoptera (0.5%). One digestive tract contained only Lepidoptera, the other one Lepidoptera (60% of volume) and Orthoptera (40%). These data are well in accordance with the results of previous studies.

Echolocation. In total, we obtained four recordings of *Tadarida teniotis* calls from two localities. Basic echolocation parameters are given in Table 4. Most of the echolocation parameters of the Jordanian populations of *T. teniotis* fall within the range described by previous authors for the Mediterranean populations of the species (Russo & Jones 2002, Obrist et al. 2004, Benda et al. 2006, 2008) except for FMAXE, which was, on average, lower by 1–2 kHz than in the European bats. However, such difference may be due to the small sample size.

Records of ectoparasites. **Original data**: M a c r o n y s s i d a e: *Parasteatonyssus hoogstraali*: 1 protonymph (IZB; det. P. Mašán) from 1 fa (NMP 92826), Wadi Al Wala, 11 July 2010.

Comments on ectoparasites. Only one parasite was found on *Tadarida teniotis* in Jordan, a mite *Parasteatonyssus hoogstraali* Keegan, 1956. This is the first record of this parasite from Jordan (found also on *Pipistrellus pipistrellus*) and from the Arabian Peninsula as well. Records of this mite from *T. teniotis* were published also from Egypt and Kirghizstan (Radovsky 1967) and from the Canary Islands (Estrada-Peña & Sánchez 1988).

Other arthropod ectoparasites were reported to parasitise *T. teniotis* in the Middle East, which could be expected also in Jordan. A bat fly *Nycteribia pedicularia* Latreille, 1805 was found in Palestine (Theodor & Moscona 1954), bat fleas *Araeopsylla wassifi* Traub, 1954 in Turkey and Egypt (Hopkins & Rothschild 1956, Haas & Tomich 1973) and *A. gestroi* (Rotschild, 1906) in Lebanon (Lewis 1964), and a tick *Argas vespertilionis* (Latreille, 1802) in Egypt (Anciaux de Faveaux 1976).

Fauna

The present review summarises 289 records of 26 bat species from the contemporary territory of the Hashemite Kingdom of Jordan (Tables 1, 15). Such numbers are well comparable with the knowledge of bat fauna of Syria (Benda et al. 2006, Shehab et al. 2007) but significantly smaller than the numbers reported from Palestine (Mendelssohn & Yom-Tov 1999). The last published summaries of Jordanian bat fauna (Qumsiyeh et al. 1998) brought 60 records of 21 species. The number of records has thus increased almost five times (more than eleven record sites per species), the number of species has increased of five newly confirmed members of the Jordanian bat fauna. While new records of two species were already published, viz. *Taphozous nudiventris* and *Nycteris thebaica* (Darweesh et al. 1997, Al-Omari et al. 2000), three other species are reported here for the first time; viz. *Myotis blythii*, *Pipistrellus pipistrellus* and *Barbastella leucomelas*, however, most of these species were expected to occur in Jordan previously (Qumsiyeh et al. 1992, 1998). Notable findings of some other species were also made that markedly specified their distribution ranges (both in Jordan and as a whole), e.g. *Rousettus aegyptiacus*, *Rhinopoma cystops*, *Taphozous perforatus*, *T. nudiventris*, *Rhinolophus clivosus*, *R. blasii*, *Myotis nattereri*, *M. emarginatus*, *Eptesicus bottae*, *Hypsugo ariel*, *Pipistrellus kuhlii*, *Otonycteris hemprichii*, *Plecotus christii*, or *Tadarida teniotis*. All these species were formerly reported from a very limited number of records or from only one site in Jordan (Table 1), and the presented survey evidenced their occurrence range as well as their ecological delimitation more accurately.

The reviewed number of 26 species represents 74.3% of the bat fauna of the Levant (35 species; Table 15). One bat species, *Miniopterus pallidus*, has not been confirmed from other Levantine countries than from Jordan, its nearest records are known from southern and southeastern Asia Minor (Furman et al. 2010). The closest confirmed finding of this form was reported from Delikli at Mersin (Furman et al. 2010), some 520 km from the confirmed Jordanian record site.

However, the present faunal list of Jordanian bats may still be incomplete, as several other species can be expected to occur in the country; at least nine bat species that are known to be present in the surrounding Levantine countries (Palestine, Lebanon, Syria) have not yet been confirmed from Jordan. The potential members of the Jordanian fauna can be divided into two groups; (1) the northern, Mediterranean elements, inhabiting western Syria, Lebanon and northern Palestine (some of them also Cyprus), and (2) southern, desert elements, occurring in the desert and semi-desert habitats of Palestine, Egypt and adjacent areas of Africa and Arabia.

Concerning the group (1) of the 'northern' species, the hottest candidate to enrich the bat fauna of Jordan is *Miniopterus schreibersii* (Kuhl, 1817); results of molecular genetic analysis confirmed this species to occur in Syria, Lebanon and Cyprus (Šrámek 2010), besides of its known range in Europe and Asia Minor (Bilgin et al. 2006, Furman et al. 2010, Šrámek 2010). Moreover, the Syrian locality of *M. schreibersii* at Talsh'hab, Yarmuk Valley (see Benda et al. 2006, Šrámek 2010), lies very close to the northern border of Jordan (ca. 1600 m), and foraging or even roosting of these bats on the Jordanian side of the valley is very likely. Four other bat species, ranking among the Mediterranean faunal elements, occur in the Mediterranean arboreal zone of the Levant (see the distribution reviews by Benda et al. 2006): *Myotis myotis* (Borkhausen, 1797), *Eptesicus serotinus* (Schreber, 1774), *Hypsugo savii* (Bonaparte, 1837), and *Nyctalus noctula* (Schreber, 1774). The patterns of distribution of these bats in the Levant are similar to those of other Mediterranean bats within the Jordanian fauna (*Rhinolophus euryale*, *Myotis blythii*, *M. emarginatus*, *M. capaccinii*). Their occurrence is more or less continuous from southern Turkey, western Syria and Lebanon to northern Palestine and the Golan Heights. The southern margin of their continuous ranges probably lies in this zone, approximately at 33° N, but isolated records were documented also from central

Table 15. List of bat species per individual regions of the transition between North Africa and Southwest Asia, showing the faunal status (+ = occurrence confirmed and published; × = occurrence unconfirmed, but possible according to published data; – = occurrence unconfirmed). Based mainly on the data summarised by Qumsiyeh (1985), Harrison & Bates (1991), Gaucher (1992, 1993, 1995), Gaucher & Harrison (1995), Mendelssohn & Yom-Tov (1999), Benda et al. (2006, 2008), and by the present review. Explanation of geographical terms: Lower Egypt = territory of continental Egypt north of 27° N; Hijaz = western part of Saudi Arabia north of 18° N and west to 43° W ; Syria = Syria s.str., territory of the contemporary Syrian Arab Republic incl. the Golan Heights (i.e. sensu Benda et al. 2006)

	Jordan	Palestine	Sinai	Lower Egypt	Hijaz	Iraq	Syria	Lebanon
Rousettus aegyptiacus	+	+	+	+	+	–	+	+
Epomophorus labiatus	–	–	–	–	+	–	–	–
Rhinopoma microphyllum	+	+	–	+	+	+	+	+
Rhinopoma cystops	+	+	+	+	+	–	+	–
Rhinopoma hardwickii	–	–	–	–	–	+	–	–
Taphozous perforatus	+	+	+	+	+	–	–	–
Taphozous nudiventris	+	+	–	+	+	+	+	–
Nycteris thebaica	+	+	+	+	+	–	–	–
Rhinolophus ferrumequinum	+	+	–	–	–	+	+	+
Rhinolophus clivosus	+	+	+	+	+	–	–	–
Rhinolophus hipposideros	+	+	+	–	+	+	+	+
Rhinolophus euryale	+	+	–	–	–	–	+	+
Rhinolophus mehelyi	+	+	×	+	–	+	+	–
Rhinolophus blasii	+	+	–	–	–	–	+	+
Hipposideros tephrus	–	–	–	–	+	–	–	–
Asellia tridens	+	+	+	+	+	+	+	–
Myotis myotis	–	+	–	–	–	–	+	+
Myotis blythii	+	+	–	–	–	+	+	+
Myotis nattereri	+	+	–	–	–	–	+	+
Myotis tschuliensis	–	–	–	–	–	+	–	–
Myotis emarginatus	+	+	–	–	+	×	+	+
Myotis aurascens	–	–	–	–	–	–	+	+
Myotis capaccinii	+	+	–	–	–	+	+	+
Eptesicus serotinus	–	+	–	–	–	–	+	+
Eptesicus bottae	+	+	+	+	+	+	+	–
Eptesicus anatolicus	–	–	–	–	–	+	+	+
Rhyneptesicus nasutus	–	–	–	–	+	+	–	–
Hypsugo savii	–	+	–	–	–	–	+	+
Hypsugo ariel	+	+	+	–	+	–	–	–
Pipistrellus pipistrellus	+	+	–	–	–	–	+	+
Pipistrellus kuhlii	+	+	+	+	+	+	+	+
Pipistrellus rueppellii	–	+	–	+	–	+	–	–
Nyctalus noctula	–	+	–	–	–	–	+	+
Nycticeinops schlieffenii	–	–	–	+	+	–	–	–
Scotophilus dinganii	–	–	–	–	+	–	–	–
Otonycteris hemprichii	+	+	+	+	+	+	+	–
Barbastella leucomelas	+	+	+	–	×*	–	–	–
Plecotus macrobullaris	–	×	–	–	–	–	+	–
Plecotus christii	+	+	+	+	–	–	–	–
Plecotus cf. *balensis***	–	–	–	–	+	–	–	–
Miniopterus sp.	+	+	–	–	–	+	+	+
Tadarida teniotis	+	+	+	+	+	+	+	+
Tadarida aegyptiaca	–	–	–	+	+	–	–	–
Chaerephon nigeriae	–	–	–	–	+	–	–	–
suma per region	26	31	14–15	17	23–24	18	27	21

* according to the (rather) unsubstantial interpretation by Qumsiyeh (1985) only (see Benda et al. 2008)
** for details concerning the identification see Benda et al. (in press)

parts of Palestine (Mendelssohn & Yom-Tov 1999). Findings of these four species in Jordan are well probable, namely in the Mediterranean arboreal zone of the Northern Highlands, similarly as recorded e.g. in *Myotis blythii*, a species awaited to occur in Jordan for a long time (Qumsiyeh et al. 1992) and evidenced only recently (see above). Another two species were documented from Lebanon and western Syria, incl. the Golan Heights (but not from Palestine): *Myotis aurascens* Kusjakin, 1935 and *Plecotus macrobullaris* Kuzjakin, 1965. These species could theoretically be found also in the northernmost areas of Jordan, however, they are, according to their distribution pattern in the Middle East, rather high mountain inhabitants which perhaps do not find appropriate habitats in Jordan. Another species, *Eptesicus anatolicus* Felten, 1971 is a bat occurring in southern Turkey and Iran, northern Iraq, northwestern Syria, Cyprus and Lebanon (Benda et al. 2006, 2007, Horáček et al. 2008), i.e. an endemic of the Mediterranean parts of the Middle East. Its southernmost records in the Levant are known from Lebanon (at ca. 33.5° N), it has been found neither in Palestine nor in the Golan Heights, therefore its occurrence in the Mediterranean habitats of Jordan seems to be less probable than in the other above noted species.

The only bat species of the group (2), i.e. of the 'southern' elements missing in the faunal list of bats of Jordan, is *Pipistrellus rueppellii* (Fischer, 1829). This bat was repeatedly evidenced from Palestine, Mendelssohn & Yom-Tov (1999: 138) mentioned: "it was found several times in the Dead Sea Area, once near Elat and once near Haifa". Korine & Pinshow (2004) and Razgour et al. (2010) reported its rather frequent occurrence in the central Negev Desert. According to the map by Mendelssohn & Yom-Tov (1999: 139, Fig. 64), the closest record site of *P. rueppellii* in Palestine lies less than 4 km from the Jordanian border. The occurrence of this species in Jordan is thus very probable (see also Qumsiyeh et al. 1998).

Zoogeography

Concerning the general distribution of bat fauna, the territory of Jordan comprises three main bioregions; (1) a region of relatively humid woodlands and steppes situated in the Mediterranean northwestern part of the country, covering mountain habitats of the Northern Highlands; (2) a region of deserts and semi-deserts in the southwestern parts of Jordan, covering mainly western slopes of the Southern Highlands, Wadi Araba and adjacent deserts (incl. the Rum Desert); and (3) semi-deserts and steppes situated in the eastern and northeastern portions of the country. This geographical division corresponds with the geobotanical subdivision of the Middle East by Zohary (1973). The northwestern bioregion can be co-identified with Zohary's zones of the Mediterranean woodland climax and the Mediterranean steppe-maquis, respectively, the southwestern bioregion with the Sudanian and sub-Sudanian desert and savanna vegetation, and the northeastern arid bioregion with the Mesopotamian steppes and semi-deserts, a part of the Irano-Turanian zone.

In relation to these bioregions, there are five types of bat occurrence in Jordan (see the distribution maps of the particular species above); two types are represented by species occurring mainly in one of the two main bioregions, [1] true Mediterranean bats (occurring in bioregion (1) of NW Jordan) and [2] desert bats (SW Jordan, 2), while species of the other three faunal types inhabit more bioregions than only one: [3] western bats (NW and SW Jordan, 1+2), [4] steppe-desert bats (SW and NE Jordan, 2+3), and [5] ubiquitous bats living in all three parts of the country (NW, NE and SW Jordan, 1+2+3). In a more crude view, a similar pattern was already observed by Harrison (1964), who found two basic subregions in a large portion of the northern part of Arabia, and their border passing through the territory of Jordan; he named them a zone of 'Boreal Eurasiatic Mammals' (= here defined as the Mediterranean bioregion) and a zone of 'Saharo-Sindian Desert Mammals' (here defined as desert and steppe-desert regions), respectively. The faunal type [1], the group of the true Mediterranean bat species, is in Jordan represented by *Rhinopoma microphyllum*, *Rhinolophus ferrumequinum*, *R. hipposideros*, *R. euryale*, *Myotis blythii*, *M. emar-*

ginatus, *M. capaccinii*, and *Miniopterus pallidus*. This group makes up 30.7% of the species, but only 12.4% of the records. Type [2], the group of the desert species inhabiting solely SW Jordan, comprises *Taphozous perforatus*, *T. nudiventris*, *Nycteris thebaica*, *Rhinolophus clivosus*, *R. mehelyi*, *Asellia tridens*, *Eptesicus bottae*, *Hypsugo ariel*, *Barbastella leucomelas*, and *Plecotus christii*. This group makes up 38.5% of the species, but only 29.7% of the records. Type [3], the group of bats occurring in western Jordan, i.e. both in the Mediterranean and desert bioregions, includes *Rousettus aegyptiacus*, *Rhinopoma cystops*, *Rhinolophus blasii*, *Myotis nattereri*, and *Pipistrellus pipistrellus*. This group makes up only 19.2% of the species, but even 26.9% of the records. Type [4], the group of bats distributed in southwestern desert and northeastern steppe Jordan, is represented by only one species, *Otonycteris hemprichii*; this group makes up 3.8% of the species and 7.8% of the records. The last type [5], the group of ubiquitous bats, comprises two species, *Pipistrellus kuhlii* and *Tadarida teniotis*. This group makes up only 7.7% of the species, but even 23.3% of the records.

The Jordanian bats can be also classified based on their affinities to altitudinal categories. The fauna can be divided into several groups, according to the altitude preferences (expressed as a mean value of the particular site altitudes; Fig. 104) and altitude ranges (expressed as altitude difference between the lowest and highest occurrence sites recorded; Fig. 105); (1) bats confined to lower altitudes (*Taphozous perforatus*, *T. nudiventris*, *Nycteris thebaica*, *Rhinolophus mehelyi*, *Myotis capaccinii*), (2) bats confined to upper altitudes (*Rhinolophus clivosus*, *R. hipposideros*, *R. euryale*, *Myotis blythii*, *M. nattereri*, *M. emarginatus*, *Barbastella leucomelas*), (3) bats confined to medium altitudes (*Rhinopoma microphyllum*, *Rhinolophus ferrumequinum*, *Miniopterus pallidus*), (4) widespread bats (*Rousettus aegyptiacus*, *Rhinopoma cystops*, *Rhinolophus blasii*, *Asellia tridens*, *Eptesicus bottae*, *Hypsugo ariel*, *Pipistrellus pipistrellus*, *P. kuhlii*, *Otonycteris hemprichii*, *Plecotus christii*, *Tadarida teniotis*). As it could be expected, most of the widespread species as well as the species confined to lower altitudes belong to the category of desert bats, since deserts and semi-deserts are available in all altitudinal categories, namely in the southern part of Jordan, and in the lower altitudes of the country they are almost the only habitat types present. On the other hand, most of the species confined to upper and medium altitudes belong to the Mediterranean bats, since the Mediterranean habitats are limited to elevated areas of highland ranges of western Jordan. From this point of view, some species showed a rather surprising assignment; *Rhinolophus mehelyi* and *Myotis capaccinii* belong to the Mediterranean species in most of their distribution ranges, their assignment to the bats confined to the lower altitudes is caused by the extreme scarcity of their records, originating accidentally only from very low areas. On the other hand, *Barbastella leucomelas* and *Rhinolophus clivosus* belong to the "montane" bats although in Palestine they pertained to the species inhabiting mainly the Arava Valley, i.e., very low sites (Mendelssohn & Yom-Tov 1999). Records of both of these species were not rare in Jordan (see above) and their preference for more elevated sites represents rather an unaffected natural trend.

However, the two above mentioned subdivisions of the Jordanian bat fauna seem to be slightly arbitrary in some species, being based solely on the comparison of the recorded site characteristics. At least two species affiliations should be considered artificial as their Jordanian records do not characterise their distribution ranges adequately, with most probability. *Rhinopoma microphyllum* is a form dwelling mainly arid habitats, generally considered to be the Saharo-Sindian faunal element in the Middle East (Atallah 1978). Its occurrence area in Jordan is only an edge of the species distribution range, which reaches the Mediterranean only marginally via the Rift Valley, and it certainly could not be considered a true Mediterranean species (see Benda et al. 2006: 20). On the other hand, *Rhinolophus mehelyi* could be regarded a rather Mediterranean species considering the pattern of its distribution from Iberia and Maghreb through southern Europe to the Middle East, which (perhaps only accidentally) has not been recorded in the Mediterranean part of Jordan, but

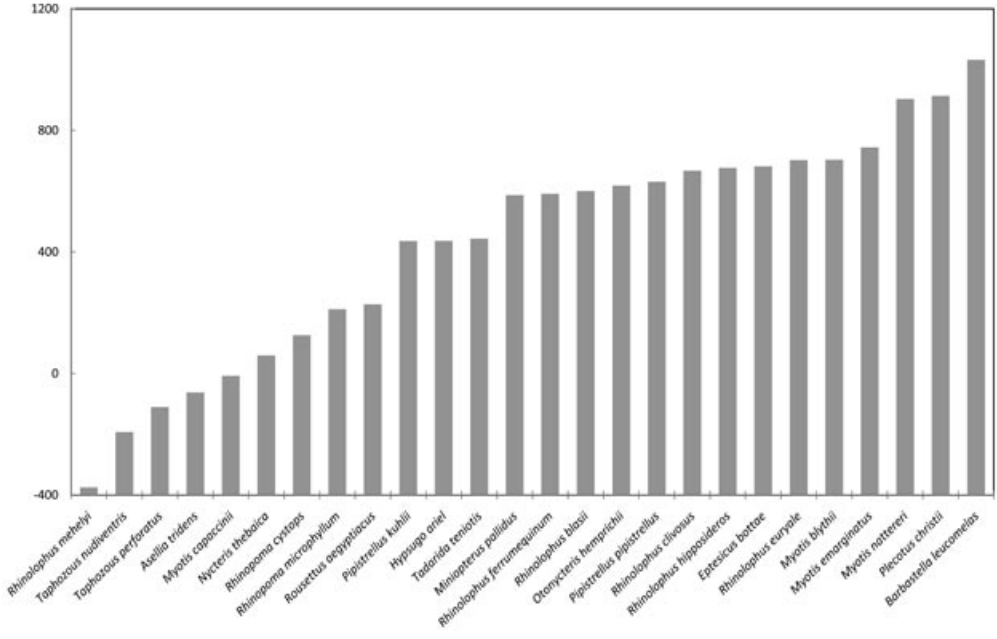


Fig. 104. Mean altitudes of distribution of particular bat species in Jordan, arranged from the lowest to the highest.

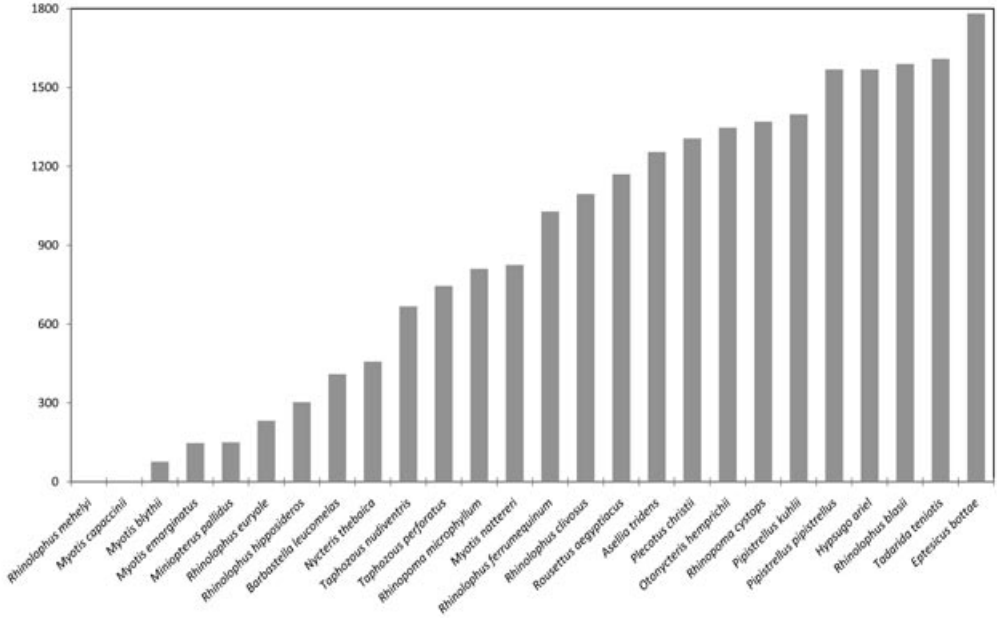


Fig. 105. Altitude ranges of distribution of particular bat species in Jordan, arranged from the smallest to the largest.

it inhabits such habitats in Turkey, Syria, Lebanon and Palestine (see Benda et al. 2006: 76); this species is thus actually a typical representative of the third group. The group assignments of other species seem to be convenient as they more or less correspond with the knowledge available from other countries of the Levant (see the particular species chapters).

As we emphasised in Introduction, and also as it clearly arises from the above defined and characterised faunal types, the territory of Jordan (along with Syria and Palestine) lies on the transition of two main biomes of the southwestern Palaearctic, the Mediterranean arboreal and the Saharo-Sindian eremial. In Jordan, the border between these bioregions stretches along the eastern extents of uplands fringing the Rift Valley from the east, i.e. the Northern Highlands and Southern Highlands ("Ajlun Mts. and the Hills of Amman and Noab" by Atallah 1977). Jordan thus comprises margins of distribution ranges of bat species both of northern and southern affiliations. Most of the above categorised Mediterranean elements have their southern distribution limit either in northwestern Jordan or in the adjacent regions of central Palestine. The southernmost Levantine contemporary records of *Rhinolophus euryale*, *Myotis blythii*, *M. emarginatus*, *M. capaccinii*, *Pipistrellus pipistrellus*, and *Miniopterus pallidus* come from this area. On the other hand, four eremial elements, *Eptesicus bottae*, *Hypsugo ariel*, *Barbastella leucomelas*, and *Plecotus christii* have a northern limit of their distribution ranges on the northwestern margins of semi-deserts in western areas of Jordan.

A multivariate analysis of the faunal data gathered in the present review showed two main biogeographical regions concerning the fauna of bats, similarly as the above described empirical observation. The cluster (UPGMA) analysis grouped the bat communities (represented by 36 localities with known occurrence of at least three bat species; Table 16) into two main clusters (Figs. 106, 107), (1) those occuppying Mediterranean sites, and (2) those occupying desert and semi-desert sites. The cluster (1) represents a group of core Mediterranean communities composed mainly of *Rhinolophus hipposideros*, *R. euryale*, *R. blasii*, *Myotis blythii*, *M. nattereri*, *M. emarginatus*, and *Miniopterus pallidus*, from sites lying in the Mediterranean arboreal zone (Zubiya and Iraq Al Wahaj Caves, Dibbin subterranean complex, 'Al Wardeh Cave' mine, and the Ash Shawbak Castle).

More structured affinities among the communities were shown within the cluster (2), however, no intrinsic difference was found between the sites from the Syrian Desert of northeastern Jordan and the desert sites of southwestern Jordan. Within the cluster (2), two main sets were found; (2a) a set of true desert communities from southern and southwestern parts of Jordan, and (2b) a set of mixed communities from western Jordan and from the Syrian Desert. Within the set (2a), another division to two subsets could be observed; (2a-a) a subset of core desert bat communities of continental desert habitats in the Rum Desert (Wadi Rum, Disa, Al Ghal) and in elevated arid sites of the Southern Highlands (Rummana area of the Dhana Reserve, Jabal Al Bayda, Wadi Al Abiat, Ain Amshit); and (2a-b) a subset of desert bat communities living in the Rift Valley more to north (Ar Raddas, Wadi Al Hasa, Khirbet Feinan). The whole set (2a) is particularly characterised by the presence of *Rhinolophus clivosus*, *Eptesicus bottae*, *Hypsugo ariel*, *Otonycteris hemprichii*, *Barbastella leucomelas*, and *Plecotus christii*. The set (2b) is composed of three main subsets of bat communities, characterised by presence of arid habitats dwelling species plus also *Pipistrellus kuhlii*, and frequently also *Rousettus aegyptiacus*; (2b-a), the pair of sites situated in the northern part of the Rift in Jordan (Jordan Valley), Jufat Al Qafrayn and Tabaqat Fahl, inhabited mainly by *Rousettus aegyptiacus* and both *Rhinopoma* species; (2b-b) a group of communities composed of the Mediterranean and arid elements from the Highlands (Jerash, Malka, ʿArjan, As Salihiyyah, Nahla), typical mostly by presence of *Rhinolophus ferrumequinum* and *Pipistrellus pipistrellus*; and (2b-c) a group of sites lying in or adjacent to the Rift and in the Syrian Desert, together with two elevated sites, Dhana Village and the Wadi As Sir. All the set of communities (2b) can be

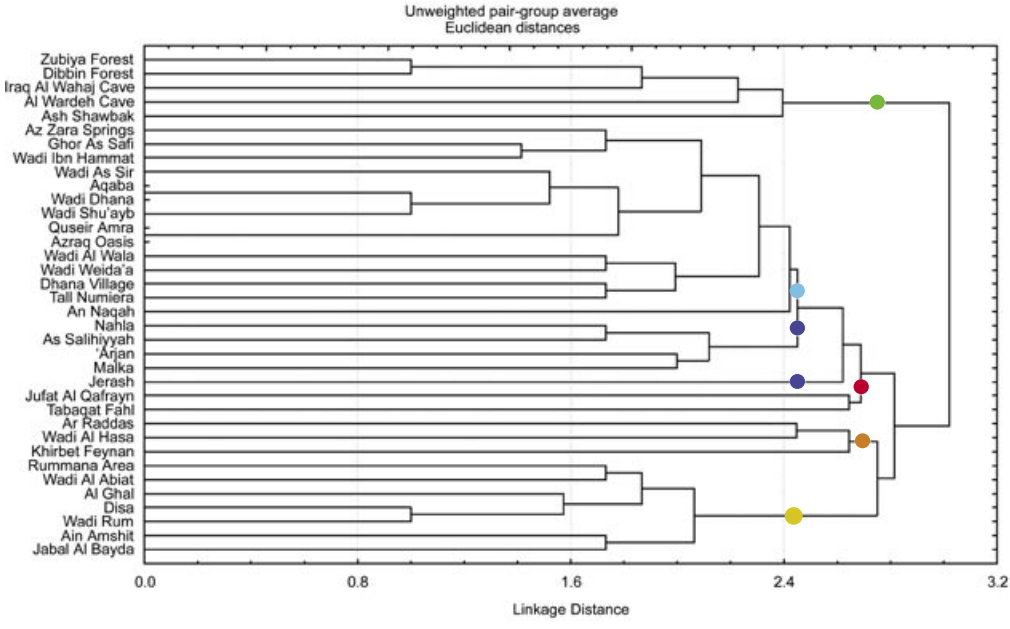


Fig. 106. Results of the cluster analysis (UPGMA) of bat communities recorded from Jordan: similarities among particular occurrence sites (for the data see Table 16).

considered as transient type between the continental desert and the Mediterranean arboreal community types, as the set is represented by communities composed of desert and Mediterranean as well as the widespread faunal elements. From this point of view, most variable is the fauna of the Dhana Reserve and broader surrounding in the Southern Highlands, where a combination of the true Mediterranean and continental desert communities coexists (Fig. 107) and certainly deserves conservation attention.

The cluster (WPGMA) analysis of the same data set (Table 16) defined two basic faunal types within the Jordanian bat fauna considering the species distribution and their mutual occurrence (Fig. 108); (1) widespread species, and (2) locally distributed species. Within the group (1) of the widespread species, two categories can be observed; (1a) bats occurring throughout Jordan (*Pipistrellus kuhlii*, *Tadarida teniotis*), and (1b) bats occurring along the whole Rift Valley of Jordan (*Rousettus aegyptiacus*, *Rhinopoma cystops*). Within the group (2) of the locally distributed species, three categories are present; (2a) Mediterranean species (*Rhinopoma microphyllum*, *Rhinolophus ferrumequinum*, *R. hipposideros*, *R. euryale*, *R. mehelyi*, *R. blasii*, *Asellia tridens*, *Myotis blythii*, *M. nattereri*, *M. emarginatus*, *M. capaccinii*, *Miniopterus pallidus*); (2b) desert species whose occurrence is centered to southern deserts (*Rhinolophus clivosus*, *Eptesicus bottae*, *Otonycteris hemprichii*, *Plecotus christii*); and (2c) desert species whose occurrence is centered to the Rift Valley (*Taphozous* spp., *Nycteris thebaica*, *Hypsugo ariel*, *Pipistrellus pipistrellus*, *Barbastella leucomelas*). Such division well corresponds with and/or complements the empirical division of bat fauna as delineated above as well as with the results of the more sophisticated analysis of the Palestinian bat fauna by Yom-Tov & Kadmon (1998), based on environmental characteristics and more numerous distributional data.

Amr et al. (2006) summarised zoogeographical affinities of the Jordanian bat fauna. They founded four groups of species according to geographical positions of their whole distribution ranges (under the contemporary taxonomy): (1) Mediterranean species (*Rhinopoma microphyllum*, *Rhinolophus ferrumequinum*, *R. clivosus*, *R. hipposideros*, *R. euryale*, *R. blasii*, *Myotis nattereri*, *M. emarginatus*, *M. capaccinii*, *Miniopterus* sp.), (2) Afrotropical (Sudanian) species (*Rousettus aegyptiacus*, *Taphozous* spp., *Nycteris thebaica*, *Rhinolophus mehelyi*, *Asellia tridens*, *Hypsugo ariel* s.str.), (3) Saharo-Arabian species (*Eptesicus bottae*, *Hypsugo bodenheimeri*, *Plecotus christii*), and (4) widespread species (*Pipistrellus kuhlii*, *Tadarida teniotis*). Based on the above summary of the Jordanian records as well as the whole distribution of the respective taxa, we can apply a similar concept, however, the composition and also definition of the particular groups should be somewhat different; (1) North-Mediterranean species (*Rhinolophus ferrumequinum*, *R. euryale*, *Myotis blythii*, *M. nattereri*, *M. capaccinii*, *Miniopterus pallidus*), (2) Circum-Mediterranean species (*Rhinolophus mehelyi*, *Pipistrellus kuhlii*, *Tadarida teniotis*), (3) Mediterraneo-Arabian

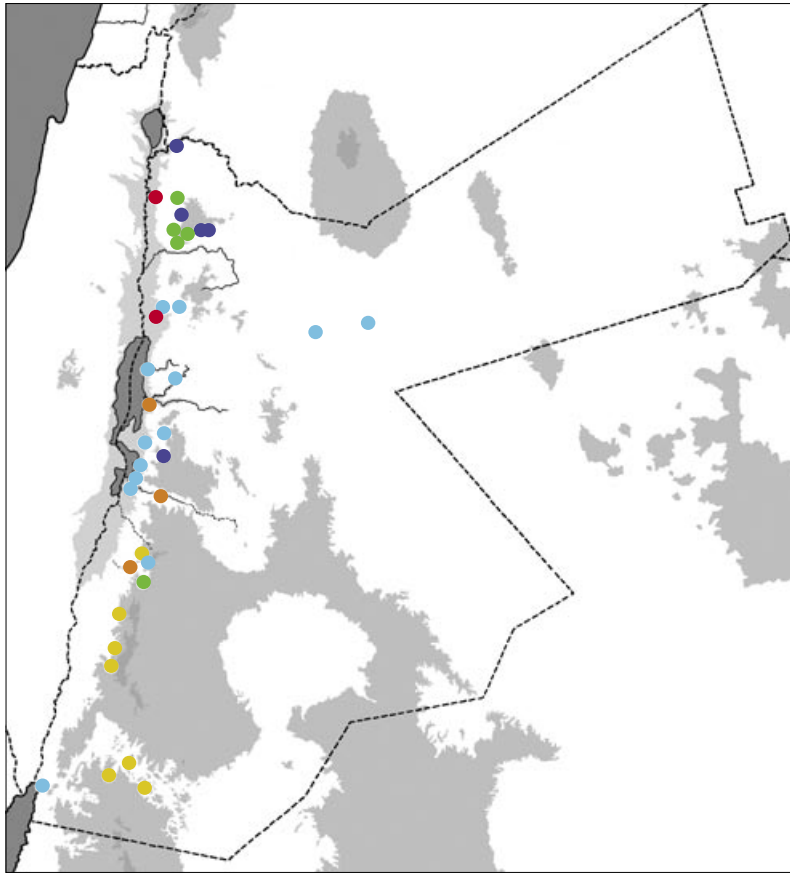


Fig. 107. Distribution of particular types of bat communities in Jordan. For colour definition see the results of the UPGMA cluster analysis (Fig. 106).

Table 16. List of localities in Jordan with known occurrence of at least three bat species. Explanations: 1 = occurrence confirmed, 0 = occurrence unconfirmed; species acronyms: *Ra* = *Rousettus aegyptiacus*, *Rmi* = *Rhinopoma microphyllum*, *Rcy* = *Rhinopoma cystops*, *Tp* = *Taphozous perforatus*, *Tn* = *Taphozous nudiventris*, *Nt* = *Nycteris thebaica*, *Rf* = *Rhinolophus ferrumequinum*, *Rcl* = *Rhinolophus clivosus*, *Rh* = *Rhinolophus hipposideros*, *Re* = *Rhinolophus euryale*, *Rme* = *Rhinolophus mehelyi*, *Rb* = *Rhinolophus blasii*, *At* = *Asellia tridens*, *Mb* = *Myotis blythii*, *Mn* = *Myotis nattereri*, *Me* = *Myotis emarginatus*, *Mc* = *Myotis capaccinii*, *Eb* = *Eptesicus bottae*, *Ha* = *Hypsugo ariel*, *Pp* = *Pipistrellus pipistrellus*, *Pk* = *Pipistrellus kuhlii*, *Oh* = *Otonycteris hemprichii*, *Bl* = *Barbastella leucomeas*, *Pc* = *Plecotus christii*, *Mp* = *Miniopterus pallidus*, *Tt* = *Tadarida teniotis*

site \ species	*Ra*	*Rmi*	*Rcy*	*Tp*	*Tn*	*Nt*	*Rf*	*Rcl*	*Rh*	*Re*	*Rme*	*Rb*	*At*	*Mb*	*Mn*	*Me*	*Mc*	*Eb*	*Ha*	*Pp*	*Pk*	*Oh*	*Bl*	*Pc*	*Mp*	*Tt*	Σ
Zubiya Forest	0	0	0	0	0	0	1	0	1	1	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	6
Dibbin Forest	0	0	0	0	0	0	1	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	5
Iraq Al Wahaj Cave	1	0	0	0	0	0	1	0	0	1	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	7
Al Wardeh Cave	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0	0	0	0	0	0	0	0	1	0	5
Ash Shawbak	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	3
Az Zara Springs	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	5
Ghor As Safi	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	1	6
Wadi Ibn Hammat	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	4
Wadi As Sir	1	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	1	6
Aqaba	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	4
Wadi Dhana	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	4
Wadi Shu'ayb	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	3
Quseir Amra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	3
Azraq Oasis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	3
Wadi Al Wala	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	5
Wadi Weida'a	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	4
Dhana Village	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	1	0	0	1	6
Tall Numiera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	3
An Naqah	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Nahla	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	3
As Salihiyyah	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	0	0	0	4
ʻArjan	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	5
Malka	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	3
Jerash	0	0	1	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1	1	7
Jufat Al Qafrayn	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	7
Tabaqat Fahl	1	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	6
Ar Raddas	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	6
Wadi Al Hasa	0	0	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	8
Khirbet Feynan	0	0	1	0	0	1	0	1	0	0	0	1	1	0	0	0	0	1	0	1	0	1	0	0	0	1	9
Rummana Area	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	1	1	1	0	1	7
Wadi Al Abiat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	4
Al Ghal	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	1	0	0	6
Disa	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0	1	6
Wadi Rum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	1	0	1	5
Ain Amshit	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	1	0	0	5
Jabal Al Bayda	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	1	0	0	4

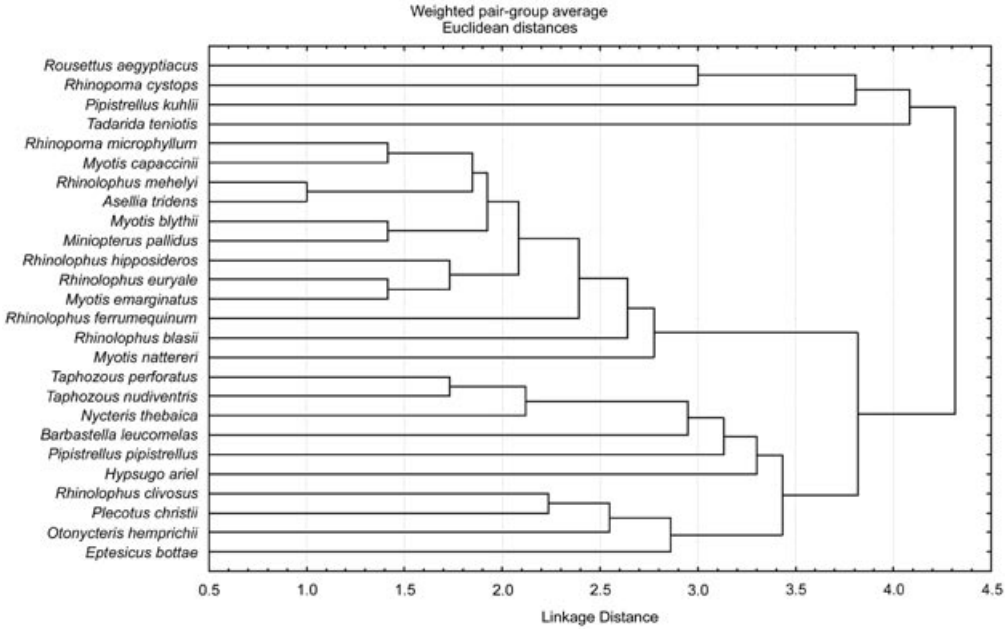


Fig. 108. Results of the cluster analysis (WPGMA) of bat communities recorded from Jordan: similarities among particular species (for the data see Table 16).

species (*Rhinolophus hipposideros*, *Myotis emarginatus*), (4) Afrotropical species (*Rousettus aegyptiacus*, *Taphozous perforatus*, *Nycteris thebaica*, *Rhinolophus clivosus*), (5) Saharo-Arabian species (*Rhinopoma microphyllum*, *R. cystops*, *Taphozous nudiventris*, *Asellia tridens*, *Eptesicus bottae*, *Hypsugo ariel*, *Plecotus christii*), and (6) widespread species (*Rhinolophus blasii*).

Ectoparasites

Along with the review of records and ecology of bats of Jordan, we also present all available records of arthropod parasites of bats from this country. They belong to 17 species of seven families; viz. Argasidae, Spinturnicidae, Macronyssidae, Cimicidae, Nycteribiidae, Streblidae, and Ischnopsyllidae. Most of them are here reported from Jordan for the first time, since only the records of argasid, nycteribiid and streblid bat parasites were published from Jordan previously (Kock & Nader 1979, Saliba et al. 1990, Amr & Qumsiyeh 1993).

Five species of ticks (Argasidae) are known from bats of the Middle East (Hoogstraal 1955, 1956, Theodor & Costa 1960, 1967, own data), *Argas vespertilionis* (Latreille, 1802), *A. transgariepinus* (White, 1846), *A. boueti* Roubaud et Colas-Belcour, 1933, *A. confusus* Hoogstraal, 1955, and *Ornithodoros salahi* Hoogstraal, 1953. Until now, only records of *Argas* sp. ex *vespertilionis* group and *O. salahi* have been available from Jordan (Saliba et al. 1990). Here we report the first Jordanian records of *Argas vespertilionis*, and *A. confusus*. *A. vespertilionis* is a widespread tick species, occurring in Europe, North Africa, and Asia to Australia (Filippova 1966). The distribution range of *A. confusus* has been confined to the Levant and northeastern Africa (Hoogstraal 1955, 1956, Theodor & Costa 1967). *A. boueti* and *A. transgariepinus* are known to occur in

Africa and Palestine, *A. transgariepinus* also in Europe (Hoogstraal 1955, Starkoff & Cagnolati 1962, Theodor & Costa 1967, Beaucournu 1966, Aeschlimann & Büttiker 1975). Regarding their Palestinian distribution, both species might be found also in Jordan.

Two mites of the family Spinturnicidae were found in Jordan, *Spinturnix psi* Kolenati, 1856 and *S. myoti* (Kolenati, 1856), both for the first time in the country. *S. psi* is a species of Palaeotropical and -subtropical distribution and its range corresponds to that of its main host, bats of the genus *Miniopterus* (Baker & Delfinado 1964). The record from Jordan, made from *M. pallidus*, thus does not represent an irregularity from the geographical and ecological points of view. *S. myoti* parasitises on many vespertilionid species (Deunff 1977), its main hosts are bats of the genus *Myotis*, particularly of the *M. myotis* group (Bruyndonckx et al. 2009). The Jordanian record from *Myotis blythii* therefore represents the most typical host affinity in this mite.

Two mites of the family Macronyssidae were found in Jordan, *Steatonyssus periblepharus* Kolenati, 1858 and *Parasteatonyssus hoogstraali* Keegan, 1956, both for the first time in the country. *S. periblepharus* is a mite that parasitises mainly the members of the genus *Pipistrellus*, but it was also found on species of the genera *Myotis*, *Plecotus* and *Eptesicus* (Kolenati 1859, Till & Evans 1964, Lanza 1999). We collected this parasite from two host species, belonging to the main host genus *Pipistrellus*. *P. hoogstraali* has been so far registered only as a parasite of *Tadarida teniotis* (Radovsky 1967, Estrada-Peña & Sánchez 1988). We collected this mite from this bat too, however, also from *Pipistrellus pipistrellus*. The latter bat species represents a new host of the parasite and extends its host range.

A record of the bug *Cacodmus vicinus* Horvath, 1932 (Cimicidae) is here published from Jordan for the first time. We found this bug to parasitise two bat species, *Pipistrellus pipistrellus* and *P. kuhlii*, the latter species has been referred as the most frequent host species of this parasite (Péricart 1996). This bug has a south-Mediterranean distribution, its known records originate from North Africa (Algeria, Tunisia, Libya, Egypt; Hůrka 1982) and the Middle East (Palestine, Jordan, Lebanon, Turkey; Usinger 1966, Aktaş & Kiyak 1990, Péricart 1996). This bug is the only cimicid species known from Jordan.

Seventeen bat fly species of the family Nycteribiidae are known from the western Palaearctic (Theodor 1967, Hůrka & Soós 1986). Of them, three species (*Penicillidia monoceros* Speiser, 1900, *Basilia nattereri* (Kolenati, 1857), *Nycteribia kolenati* Theodor et Moscona, 1954) occur only in their limited ranges of Europe. From the territory of Jordan, eight nycteribiid species are known; *Penicillidia conspicua* Speiser, 1901, *P. d. dufourii* Westwood, 1835, *Nycteribia s. schmidlii* Schiner, 1853, and *Basilia daganiae* Theodor et Moscona, 1954 are here reported for the first time, *Phthiridium biarticulatum* Hermann, 1804, *P. integrum* (Theodor et Moscona, 1954), *Basilia nana* Theodor, 1954, and *Eucampsipoda aegyptia* (Macquart, 1851) were already known from Jordan and we added some new records. The occurrence of the species newly recorded in Jordan is not surprising, all these bat flies were reported to occur in the neighbouring Palestine (Theodor & Moscona 1954) and also in other countries of the Middle East and Central Asia (Hůrka 1964, 1980). From the territory of Palestine, records of twelve nycteribiid species are available (Theodor & Moscona 1954); besides the eight species known from Jordan, additionally also *Nycteribia latreillii* (Leach, 1817), *N. vexata* Westwood, 1835, *N. pedicularia* Latreille, 1805, *Phthiridium bilobum* (Theodor et Moscona, 1954). All these bat flies could be naturally expected to occur in Jordan. The Nycteribidae fauna of the Middle East is composed mainly of the Palaearctic elements, only *Eucampsipoda aegyptia* belongs to the Afrotropical fauna. Although accidentally found also in other bat species (Theodor & Moscona 1954), it is a host-specific parasite of *Rousettus aegyptiacus*, a bat with mostly Afrotropical distribution (Kock & Nader 1979). *Basilia nana* is a typical parasite of *Myotis nattereri* and was recorded in Jordan only from this host bat (Amr & Qumsiyeh 1993, own data). It belongs to the species parasitising on arboreal and petrophilous bats, respectively;

probably due to that its records are known mainly from Europe and the arboreal Mediterranean, including Palestine and Turkey (Theodor & Moscona 1954, Theodor 1967, Aktaş & Hasbenli 1994, Hasbenli 1997). *Penicillidia d. dufourii* was collected only from *Myotis blythii*, however, it can also be expected from other species of this genus or from the genus *Rhinolophus* (Hůrka 1964, Theodor 1967). *Nycteribia s. schmidlii* and *Penicillidia conspicua* were found to parasitise only *Miniopterus pallidus* in Jordan, but it can be expected also from *Rousettus aegyptiacus* or some species of the genera *Myotis* and/or *Rhinolophus* (Theodor & Moscona 1954). *Myotis blythii*, *M. emarginatus*, *Rhinolophus euryale*, and *R. blasii* were found to share the same roost with *M. pallidus* (Al Wardeh Cave) and the parasite transfer among these potential hosts is likely to occur there. Species of the genus *Rhinolophus* are typical hosts of *Phthiridium biarticulatum*. In Jordan, this parasite was collected from *Rhinolophus ferrumequinum*, *R. euryale* and *R. blasii* (Amr & Qumsiyeh 1993, own data). It has a relatively limited distribution range stretching from Egypt to Palestine, Jordan, Saudi Arabia, and Yemen (Theodor 1967, 1975, Kock & Nader 1979, Amr & Qumsiyeh 1993). Kock & Nader (1979) rank the bat fly *Phthiridium integrum* among the Saharo-Sindian faunal elements; in Jordan it was found on *Rhinolophus clivosus* and *R. hipposideros* (Amr & Qumsiyeh 1993, own data). Both documented host species have extensive Arabian ranges, which corresponds with the faunal assignment of this bat fly.

The bat flies of the family Streblidae are mainly inhabitants of the tropics, only few species occur in the southern Palaearctic (Theodor 1975); two species of the streblid genus *Brachytarsina* Macquart, 1851 occur in the Mediterannean (Maa 1968, Theodor 1975), *B. flavipennis* Macquart, 1851 (southern Europe; Hůrka 1972) and *B. alluaudi minor* Theodor, 1968 (Egypt, Palestine; Theodor & Moscona 1954, Theodor 1975). Only the former species was collected from Jordan. Other three streblid species, belonging to the mainly Afrotropical genera *Raymondia* Frauenfeld, 1855 and *Ascodipteron* Adensamer, 1896 are known from the Middle East, viz. *R. huberi* Frauenfeld, 1855, *A. rhinopomatos* Jobling, 1952 and *A. namrui* Maa, 1965. All these species are known from Palestine (Theodor 1975), their occurrence in Jordan is thus awaited.

Only one flea species (Ischnopsyllidae) was confirmed to occur on bats of Jordan, *Rhinolophopsylla u. unipectinata* (Taschenberg, 1880). Although this flea is here reported from Jordan for the first time, this record is obviously not exceptional as the flea has a broad circum-Mediterranean range from Spain and Belgium to Turkmenia and Yemen (Sanborn & Hoogstraal 1953, Hopkins & Rothschild 1956, Rosický 1957, Aellen 1960, Smit 1960, Lewis 1964, 1973, etc.). This flea species is a cave-dwelling parasite, mainly hosted by bats of the genus *Rhinolophus*; however, it can be rarely found also on other cave inhabitants in Jordan – *Rhinopoma cystops*, *Asellia tridens*, *Myotis blythii*, *M. capaccinii*, *Miniopterus pallidus*, and the *Pipistrellus* species. The record presented here extends the host range of this flea with a new bat host, *Rhinolophus clivosus*.

Most of the parasites collected were found on the species of the genus *Rhinolophus*; this can be caused by their cave-dwelling roost habits, which seem to represent an extensive opportunity mainly for parasitation by cave-dwelling bat flies (*Nycteribia pedicularia*, *Penicillidia conspicua*, *P. d. dufourii*, *Phthiridium biarticulatum*, and/or *P. integrum*). *Pipistrellus pipistrellus* possesses a specialised parasite fauna, in Jordan represented by *Cacodmus vicinus* (Cimicidae) and *Basilia daganiae* (Nycteribiidae). Similar records were published from *Pipistrellus kuhlii* from Palestine (Theodor & Moscona 1954) and *Pipistrellus hanaki* from Libya (Hůrka 1982).

Bats in owl diet

We collected owl pellets in Jordan during the field trips in 2005, 2006, 2008, 2009, and 2010 (Table 17). Bats were found in the owl diet in this country for the first time, see Al-Melhim et al. (1997), Amr et al. (1997) and Rifai et al. (1998). We detected remains of bats in the diet of five owl species; *Bubo bubo* (Linnaeus, 1758), *Athene noctua* (Scopoli, 1769), *Asio otus* (Linnaeus,

Table 17. Presence of bat remains in the owl pellets from Jordan. Explanations: year = year of the sample collection (for exact date see Records), B = bat items, M = mammalian items, P = whole prey items; for the ptey species acronyms see Table 16

sample \ item	year	*Ra*	*Rf*	*Rh*	*At*	*Mb*	*Ha*	*Pk*	*Oh*	*Tt*	Σ B	Σ M	Σ P	% M	% P
Bubo bubo															
Wadi Abu Al Asal	2010	–	–	–	–	–	–	–	1	–	1	5	8	20.00	12.50
total *Bubo bubo*		–	–	–	–	–	–	–	1	–	1	623	1126	0.16	0.09
Athene noctua															
Qasr Kharana	2008	–	–	–	–	–	–	1	2	–	3	13	104	23.08	2.88
Dana, Rummana Camp	2008	–	–	–	–	–	–	–	1	–	1	10	98	10.00	1.02
total *Athene noctua*		–	–	–	–	–	–	1	3	–	4	99	2332	4.04	0.17
Asio otus															
Marj al Hamman	2006	–	–	1	–	–	–	–	–	–	1	15	100	6.67	1.00
total *Asio otus*		–	–	1	–	–	–	–	–	–	1	181	1092	0.55	0.09
Strix aluco															
Iraq Al Wahaj	2008	20	–	–	–	1	–	–	–	–	21	68	156	30.88	13.46
Iraq Al Wahaj	2009	6	1	–	–	–	–	–	–	–	7	19	103	36.84	6.80
Iraq Al Wahaj	2010	2	–	–	–	–	–	–	–	–	2	19	53	10.53	3.77
total *Strix aluco*		28	1	–	–	1	–	–	–	–	30	106	312	28.30	9.62
Strix butleri															
Wadi Rum	2005	–	–	–	–	–	–	–	1	3	4	40	112	10.00	3.57
Wadi Rum	2009	–	–	–	–	–	–	–	–	2	2	18	25	11.11	8.00
Al Batra	2005	–	–	–	1	–	–	–	–	–	1	107	394	0.93	0.25
Al Batra	2009	–	–	–	–	–	–	–	1	–	1	15	54	6.67	1.85
Ain Amshit	2009	–	–	–	–	–	–	–	2	–	2	69	125	2.90	1.60
Wadi Abu Al Asal	2010	–	–	–	–	–	1	–	–	–	1	23	70	4.35	1.43
total *Strix butleri*		–	–	–	1	–	1	–	4	5	11	449	1148	2.45	0.96
[*Tyto alba*]		–	–	–	–	–	–	–	–	–	0	2207	2593	0.00	0.00
total owls		28	1	1	1	1	1	1	8	5	47	3665	8902	1.28	0.53

1758), *Strix aluco* Linnaeus, 1758, and *S. butleri* (Hume, 1878). Surprisingly, no bats were found in the diet of *Tyto alba* (Scopoli, 1769), of which 2,593 prey items were found in Jordan. Altogether 8,902 prey items were found in the diet of these six owl species (Table 17), however, the proportion of bats was extremely low, 47 individuals (0.53%). Such a proportion is quite different from that observed in Syria, where bats made up almost 8% of the whole owl diet, and the highest proporotion of bats was found in the *Tyto alba* diet (Benda et al. 2006).

The highest proportion of bats in the diet among the Jordanian owls was found in the pellets of *Strix aluco*, where bats made up 9.62% of the whole diet and 28.3% of the mammal items. However, the limited sample of the diet examined (312 prey items as a whole) came from only one site, Iraq Al Wahaj Cave near Kufranja, a cave where colonies of six bat species are presumed to roost (see above), including a large colony of *Rousettus aegyptiacus*. The individual/s of *S. aluco* roosting near the entrance inside this cave were undoubtedly specialised to catch bats emerging from the inner parts of the cave. Such behaviour was reported also from other parts of the distribution range of this owl species (Obuch 1992, 1998).

In the diet of the other owl species, the proportion of bats did not exceed 1% of the whole diet examined per owl species (*B. bubo* 0.089%, *A. noctua* 0.172%, *A. otus* 0.092%, and *S. butleri* 0.958%), although the samples were much more extensive than that from *S. aluco*; the samples exceeded 1000 items in each owl species (Table 17).

A c k n o w l e d g e m e n t s

We wish to thank to all the RSCN staff who took part in field trips and/or helped with the data collecting and the research organisation, namely Enas Sakijha, Thabit Al Share, and Omar Abed (RSCN HQ ʿAmman), Amer Al Rfoo, Ibrahim Al Khsabah and Malek Al Owaji (Dhana Nature Reserve), Ashraf Al Halah and Yahya Bakeer (Azraq and Shawmari Nature Reserves), and Yaseen Ananbeh (Ajlun Natural Reserve). For their help in the field works, we thank Zdeňka Bendová, Magdalena Kubešová, and Lenka Reiterová. We are obliged to the Sipösz family (ʿAmman) for their broad help in the trips organisation and for the background for the trips in ʿAmman.

We thank Ján Krištofík & Peter Mašán (IZB) and Ondřej Balvín (CUP) for their kind help with the ectoparasites determination. We also thank all who kindly allowed to examine museum material under their care: Riyad Sadek (AUB), Paulina Jenkins, Daphne Hill & Louise Tomsett (BMNH), Petr Koubek & Jiří Chamr (IVB), Giuliano Doria (MSNG), Paolo Agnelli (MZUF), Dieter Kock, Gerhard Storch, Julia Altmann & Katrin Krohmann (SMF), Yoram Yom-Tov (TAU), †Willi Issel (WIC), Rainer Hutterer (ZFMK), and Petr P. Strelkov & Galina I. Baranova (ZIN).

Field works and the preparation of this review were supported by grants of the Czech Science Foundation (# 206/09/0888), Grant Agency of the Academy of Sciences of the Czech Republic (# IAA601110905), Ministry of Culture of the CR (# DE06P04OMG008, MK00002327201), Ministry of Environment of the CR (# MSM 6293359101), and the Grant Agency of the Matej Bel University (# UGA I-09-00-23).

REFERENCES

Advani R. 1982: Seasonal fluctuations in the diet composition of Rhinopoma hardwickei in the Rajasthan Desert. *Proceedings of the Indian Academy of Sciences*, *Animal Sciences* **91**(6): 563–568.

Aellen V. 1960: Notes sur les puces des chauves-souris principalement de la Suisse (Siphonaptera, Ischnopsyllidae). *Bulletin de la Société Neuchâteloise des Sciences* **83**: 41–61.

Aeschlimann A. & Büttiker W. 1975: Importations de tiques en Suisse (Acarina: Ixodoidea). *Mitteilungen der Schweizerische Entomologische Gesellschaft* **48**: 69–75.

Aktaş M. 1987: Bat fleas of Eastern Turkey (the east of Samsun–İskenderun Line)]. *Doğa – Turkish Journal of Zoology* **11**: 111–118.

Aktaş M. 1990: Bati Türkiye (Samsun-İskendenderun hattinin batisi) yarasalarinin pireleri [Bat fleas of western Turkey (west of the line between Samsun and İskenderun). *Doğa – Turkish Journal of Zoology* **14**: 107–112 (in Turkish, with an abstract in English).

Aktaş M. & Hasbenli A. 1994: Bat flies of eastern Turkey (the east of Samsun–İskenderun line) (Diptera: Nycteribiidae). *Gazi Üniversitesi Fen Bilimleri Enstitüsü Dergisi* **7**: 48–51.

Aktas M. & Kiyak S. 1990: A new record of Cacodmus vicinus Horvath to the fauna of Turkey (Hemiptera, Cimicidae). *Miscellaneous Papers of the Centre for Entomological Studies*, *Ankara* **7**: 1–2.

Al-Melhim W. N., Amr Z. S. Disi A. M. & Katbeh-Bader A. 1997: On the diet of the little owl, Athene noctua, in the Safawi area, eastern Jordan. *Zoology in the Middle East* **15**: 19–28.
Al-Robaae K. 1966: Untersuchungen der Lebensweise irakischer Fledermäuse. *Säugetierkundliche Mitteilungen* **14**: 177–211.
Al-Eisawi D. 1985: Vegetation of Jordan. Pp.: 45–57. In: Hadidi A. (ed.): *Studies in the History and Archeology of Jordan*. *Volume 1*. Amman: Department of Antiquities.
Al-Omari K. A., Abu Baker M. A. & Amr Z. S. 2000: First record of the Egyptian slit-faced bat, Nycteris thebaica, from Jordan. *Zoology in the Middle East* **21**: 5–7.
Aldridge H. D. J. N., Obrist M. K., Merriam H. G. & Fenton M. B. 1990: Roosting, vocalizations, and foraging by the African bat Nycteris thebaica. *Journal of Mammalogy* **71**: 242–246.
Amr Z. S. 2000: *Mammals of Jordan*. *Jordan Country Study on Biological Diversity*. Amman: United Nations Environment Programme, 100 pp.
Amr Z. S. & Disi A. M. 1988: *Jordanian Mammals Acquired by the Jordan University Natural History Museum*. Amman: University of Jordan, 32 pp.
Amr Z. S. & Qumsiyeh M. B. 1993: Records of bats flies from Jordan, Libya and Algeria. *Entomological News* **104**: 43–46.
Amr Z. S., Woodbury S. C. & Disi A. M. 1987: On a collection of mammals from Jordan. *Dirasat*, *Series B* **14**: 131–136.
Amr Z. S., Al-Melhim W. N. & Yousef M. A. 1997: Mammal remains from pellets of the eagle owl, Bubo bubo, from Azraq Nature Reserve, Jordan. *Zoology in the Middle East* **14**: 5–10.
Amr Z., Abu Baker M. & Rifai L. 2004: Mammals of Jordan. Pp.: 437–465. In: Waitzbauer W., Albert R., Petutschnig B. & Aubrecht G. (eds.): *Denisia 14*. *Reise durch die Natur Jordaniens*. Linz: Biologiezentrum/Oberösterreichische Landesmuseen, 508 pp.
Amr Z. S., Abu Baker M. A. & Qumsiyeh M. B. 2006: Bat diversity and conservation in Jordan. *Turkish Journal of Zoology* **30**: 235–244.
Anciaux de Faveaux M. 1976: Catalogue des acariens parasites et commensaux des chiroptères. Septiéme partie. Mise à jour des troisième et quatrième parties. Addendum. *Institut Royal des Sciences Belgiques*, *Documents de Travail* **7**: 547–637.
Anciaux de Faveaux M. 1983: Les cycles annuels de reproduction chez les Chiroptères phytophiles au Shaba (S.E. Zaïre) et au Rwanda. *Annales du Musée Royal de l'Afrique Centrale*, *Tervuren*, *Science Zoologique* **237**: 27–34.
Anciaux de Faveaux M. 1987: Catalogue des acariens parasites et commensaux des chiroptères. Neuviéme partie. Mise à jour des troisième et quatrième parties. *Institut Royal des Sciences Belgiques*, *Documents de Travail* **7**: 872–1027.
Anderson J. 1902: *Zoology of Egypt: Mammalia*. *Revised and completed by W. E. de Winton*, *F. S. Z.* London: Hugh Rees, Ltd., 374 pp.
Andreas M., Reiter A. & Benda P. in press: Diet composition, prey selection and diet seasonal changes in the western barbastelle bat. *Acta Chiropterologica*.
Arlettaz R. 1996: Feeding behaviour and foraging strategy of free-living mouse eared bats, Myotis myotis and Myotis blythii. *Animal Behaviour* **51**: 1–11.
Arlettaz R., Dändliker G., Kasybekov E., Pillet J.-M., Rybin S. & Zima J. 1995: Feeding habits of the long-eared desert bat, Otonycteris hemprichi (Chiroptera: Vespertilionidae). *Journal of Mammalogy* **76**: 873–876.
Arlettaz R., Perrin N. & Hausser J. 1997: Trophic resource partitioning and competition between the two bat sibling species Myotis myotis and Myotis blythii. *Journal of Animal Ecology* **66**: 897–911.
Aşan Baydemir N. & Albayrak İ. 2006: A study on the breeding biology of some bat species in Turkey (Mammalia: Chiroptera). *Turkish Journal of Zoology* **30**: 103–110.
Atallah S. I. 1966: Mammalogy. P.: 664. In: Boyd J. M. (ed.): International Jordan Expedition 1966. *Nature* **212**: 663–665.
Atallah S. I. 1967: Mammalogy (with a list of reptiles and amphibians). Pp.: 56–63. In: Boyd J. E. (ed.): *International Jordan Expedition 1966*. Unpublished report. London: International Biological Programme, Conservation of Terrestrial Communities Section, 84 pp.
Atallah S. I. 1977: Mammals of the Eastern Mediterranean Region; their Ecology, Systematics and Zoogeographical Relationships. *Säugetierkundliche Mitteilungen* **25**: 241–319.
Atallah S. I. 1978: Mammals of the Eastern Mediterranean Region; their Ecology, Systematics and Zoogeographical Relationships. *Säugetierkundliche Mitteilungen* **26**: 1–50.
Baker E. W. & Delfinado M. D. 1964: Spinturnicidae of South East Asia and the Pacific Region. *Pacific Insects* **6**: 571–591.
Barak Y. & Yom-Tov Y. 1991: The mating sestem of Pipistrellus kuhli (Microchiroptera) in Israel. *Mammalia* **55**: 285–292.
Barlow K. E. 1997: The diets of two phonic types of the bat Pipistrellus pipistrellus in Britain. *Journal of Zoology*, *London* **243**: 597–609.

Bartonička T., Řehák Z. & Andreas M. 2008: Diet composition and foraging activity of Pipistrellus pygmaeus in a floodplain forest. *Biologia*, *Bratislava* **63**: 1–7.
Bates P. J. J. & Harrison D. L. 1989: New records of small mammals from Jordan. *Bonner Zoologische Beiträge* **40**: 223–226.
Bates P. J. J. & Harrison D. L. 1997: *Bats of the Indian Subcontinent*. Sevenoaks: Harrison Zoological Museum, 258 pp.
Bauerová Z. 1986: Contribution to the trophic bionomics of Myotis emarginatus. *Folia Zoologica* **35**: 305–310.
Bauerová Z. & Červený J. 1986: Towards an understanding of the trophic ecology of Myotis nattereri. *Folia Zoologica* **35**: 55–61.
Beaucournu J. C. 1966: Sur quelques Ixodoidea (Acarina) paléarctiques inféodés aux micro-Chiroptères. *Annales de Parasitologie Humaine et Comparee* **41**: 495–502.
Beck A. 1991: Nahrungsuntersuchungen bei der Fransenfledermaus, Myotis nattereri (Kuhl, 1818). *Myotis* **29**: 67–70.
Beck A. 1995: Fecal analyses of European bat species. *Myotis* **32–33**: 109–119.
Beck A., Stutz H.-P. B. & Ziswiler V. 1989: Das Beutespektum der Kleinen Hufeisennase Rhinolophus hipposideros (Bechstein, 1800) (Mammalia: Chiroptera). *Revue Suisse de Zoologie* **96**: 643–650.
Benda P. & Gvoždík V. 2010: Taxonomy of the genus Otonycteris (Chiroptera: Vespertilionidae: Plecotini) as inferred from morphological and mtDNA data. *Acta Chiropterologica* **12**: 83–102.
Benda P. & Horáček I. 1998: Bats (Mammalia: Chiroptera) of the Eastern Mediterranean. Part 1. Review of distribution and taxonomy of bats in Turkey. *Acta Societatis Zoologicae Bohemicae* **62**: 255–313.
Benda P. & Sádlová J. 1999: New records of small mammals (Insectivora, Chiroptera, Rodentia, Hyracoidea) from Jordan. *Časopis Národního Muzea*, *Řada Přírodovědná* **168**: 25–36.
Benda P. & Vallo P. 2009: Taxonomic revision of the genus Triaenops (Chiroptera: Hipposideridae) with description of a new species from southern Arabia and definitions of a new genus and tribe. *Folia Zoologica* **53**(Monograph 1): 1–45.
Benda P., Obuch J., Andreas M., Reiter A. & Uhrin M. 1999: New records of bats from Iran. P.: 6. In: Cruz M. & Kozakiewicz K. (eds.): *VIIIth European Bat Research Symposium*. *Abstracts*. Kraków: Chiropterological Information Center, Institute of animal Systematics and Evolution PAS, 86 pp.
Benda P., Hulva P., Andreas M. & Uhrin M. 2003: Notes on the distribution of Pipistrellus pipistrellus complex in the Eastern Meiterranean: First records of P. pipistrellus for Syria and of P. pygmaeus for Turkey. *Vespertilio* **7**: 87–95.
Benda P., Hanák V., Andreas M., Reiter A. & Uhrin M. 2004a: Two new species of bats (Chiroptera) for the fauna of Libya: Rhinopoma hardwickii and Pipistrellus rueppellii. *Myotis* **41–42**: 109–124.
Benda P., Hulva P. & Gaisler J. 2004b: Systematic status of African populations of Pipistrellus pipistrellus complex (Chiroptera: Vespertilionidae), with a description of a new species from Cyrenaica, Libya. *Acta Chiropterologica* **6**: 193–217.
Benda P., Kiefer A., Hanák V. & Veith M. 2004c: Systematic status of African populations of long-eared bats, genus Plecotus (Mammalia: Chiroptera). *Folia Zoologica* **53** (Monograph 1): 1–47.
Benda P., Andreas M., Kock D., Lučan R. K., Munclinger P., Nová P., Obuch J., Ochman K., Reiter A., Uhrin M. & Weinfurtová D. 2006: Bats (Mammalia: Chiroptera) of the Eastern Mediterranean. Part 4. Bat fauna of Syria: distribution, systematics, ecology. *Acta Societatis Zoologicae Bohemicae* **70**: 1–329.
Benda P., Hanák V., Horáček I., Hulva P., Lučan R. & Ruedi M. 2007: Bats (Mammalia: Chiroptera) of the Eastern Mediterranean. Part 5. Bat fauna of Cyprus: review of records with confirmation of six species new for the island and description of a new subspecies. *Acta Societatis Zoologicae Bohemicae* **71**: 71–130.
Benda P., Dietz C., Andreas M., Hotový J., Lučan R. K., Maltby A., Meakin K., Truscott J. & Vallo P. 2008: Bats (Mammalia: Chiroptera) of the Eastern Mediterranean and Middle East. Part 6. Bats of Sinai (Egypt) with some taxonomic, ecological and echolocation data on that fauna. *Acta Societatis Zoologicae Bohemicae* **72**: 1–103.
Benda P., Reiter A., Al-Jumaily M., Nasher A. K. & Hulva P. 2009: A new species of mouse-tailed bat (Chiroptera: Rhinopomatidae: Rhinopoma) from Yemen. *Journal of the National Museum* (*Prague*), *Natural History Series* **177**: 53–68.
Benda P., Al-Jumaily M. M., Reiter A. & Nasher A. K. in press: Noteworthy records of bats from Yemen with description of a new species from Socotra. *Hystrix*, *n. s*. **22**.
Bergmans W. 1994: Taxonomy and biogeography of African fruit bats (Mammalia, Megachiroptera). 4. The genus Rousettus Gray, 1821. *Beaufortia* **44**(4): 79–126.
Bilgin R., Karataş A., Çoraman E., Pandurski I., Papadatou E. & Morales J. C. 2006: Molecular taxonomy and phylogeogaphy of Miniopterus schreibersii (Kuhl, 1817) (Chiroptera: Vespertilionidae), in the Eurasian transition. *Biological Journal of the Linnean Society* **87**: 577–582.
Blondel J., Aronson J., Bodiou J.-Y. & Boeuf G. 2010: *The Mediterranean Region*. *Biological Diversity in Space and Time*. *Second Edition*. Oxford: Oxford University Press, xv+376 pp.
Bodeheimer F. S. 1958: The present taxonomic status of the terrestrial mammals of Palestine. *Bulletin of the Research Council of Israel*, *Section B*: *Zoology* **7**: 165–190.

Bogdanowicz W. 2004: Pipistrellus kuhlii (Kuhl, 1817) – Weißrandfledermaus. Pp.: 875–908. In: Krapp F. (ed.): *Handbuch der Säugetiere Europas*. *Band 4: Fledertiere*. *Teil II*: *Chiroptera II*. *Vespertilionidae 2*, *Molossidae*, *Nycteridae*. Wiebelsheim: Aula-Verlag, x+605–1186 pp.
Bonhote J. L. 1909: On a small collection of mammals from Egypt. *Proceedings of the Zoological Society of London* **1909**: 788–798.
Bowie R. C. K., Jacobs D. S. & Taylor P. J. 1999: Resource use by two morphologically similar insectivorous bats (Nycteris thebaica and Hipposideros caffer). *South African Journal of Zoology* **34**: 27–33.
Boye P. 1983: *German Ornithological Research Trip 1983 to the Hashemite Kingdom of Jordan*. Unpublished Report. (non vidi; ex many sources.)
Boye P. 2004: Miniopterus schreibersii Natterer in Kuhl, 1819 – Langflügelfledermaus. Pp.: 1093–1122. In: Krapp F. (ed.): *Handbuch der Säugetiere Europas*. *Band 4: Fledertiere*. *Teil II: Chiroptera II*. *Vespertilionidae 2*, *Molossidae*, *Nycteridae*. Wiebelsheim: Aula-Verlag, x+605–1186 pp.
Bruyndonckx N., Dubey S., Ruedi M. & Christe P. 2009: Molecular cophylogenetic relationships between European bats and their ectoparasitic mites (Acari, Spinturnicidae). *Molecular Phylogenetics and Evolution* **51**: 227–237.
Costa M. 1966: The present stage of knowledge of Mesostigmatic mites in Israel (Acari, Mesostigmata). *Israel Journal of Zoology* **15**: 69–82.
Csorba G., Ujhelyi P. & Thomas N. 2003: *Horseshoe Bats of the World* (*Chiroptera*: *Rhinolophidae*). Bishop's Castle, UK: Alana Books, xxxii+160 pp.
Darweesh N., Al-Melhim W. N., Disi A. M. & Amr Z. S. 1997: First record of the naked-bellied tomb bat, Taphozous nudiventris Cretzschmar, 1830, from Jordan. *Zoology in the Middle East* **15**: 13–14.
DeBlase A. F. 1972: Rhinolophus euryale and R. mehelyi (Chiroptera, Rhinolophidae) in Egypt and Southwest Asia. *Israel Journal of Zoology* **21**: 1–12.
DeBlase A. F. 1980: The bats of Iran: systematics, distribution, ecology. *Fieldiana Zoology*, *New Series* **4**: i–xvii+1–424 pp.
Deunff J. 1977: Observations sur les Spinturnicidae de la région paléarctique occidentale (Acarina, Mesostigmata): spécificité, répartition et morphologie. *Acarologia* **18**:602–617.
Disi A. M. & Amr Z. S. 1998: Distribution and ecology of lizards in Jordan. *Faunistische Abhandlungen*, *Staatliches Museum für Tierkunde Dresden* **21**(Supplementum 6): 43–66.
Dietz C. 2005: *Final Report*. *Operation Wallacea*. *Sinai 2005*. Unpublished report. Tübingen, 23 pp.
Dietz C., von Helversen O. & Nill D. 2007: *Handbuch der Fledermäuse Europas und Nordwestafrikas*. *Biologie – Kennzeiche – Gefährdung*. Stuttgart: Franckh-Kosmos Verlags GmbH & Co. KG, 400 pp.
Disi A. M. & Hatough-Bouran A. 1999: Biodiversity of the terrestrial vertebrate fauna of Petra (Jordan). *Časopis Národního Muzea*, *Řada Přírodovědecká* **168**: 83–98.
Domrow R. 1962: Mammals of Innisfail II. Their mite parasites. *Australian Journal of Zoology* **10**: 268–306.
Dor M. 1947: Observations sur les micromammiferes trouves dans les pelotes de la chouette effraye (Tyto alba) en Palestine. *Mammalia* **11**: 50–54.
Dusbábek F. 1962: Parasitische Fledermausmilben der Tschechoslowakei I. Fam. Spinturnicidae Oudms., 1901 (Acarina, Gamasides). *Časopis Československé Společnosti Entomologické* **59**: 357–380.
Dusbábek F. 1972: The zone of bat acarinia in central Europe. *Folia Parasitologica* **19**: 139–154.
Ebenau C. 1996: Faunistische Nachweise aus der Cater Magara (Syrien). *Der Antiberg*, *Mitteilungen zur Karst- und Höhlenkunde* [Hemer] **63**: 44–47.
Eisentraut M. 1959: Der Rassenkreis Rousettus aegyptiacus E. Geoff. *Bonner Zoologische Beiträge* **10**: 219–235.
Estrada-Peña A. & Sánchez A. C. 1988: Two new species of Steatonyssus (Acarina: Macronyssidae) from bats in the Canary Islands, with the description of male and protonymph of Parasteatonyssus hoogstraali (Keegan). *Revista Ibérica de Parasitología* **48**: 303–311.
Estrada-Peña A. & Serra-Cobo J. 1991: The acarinia and nycteribidia zones of Miniopterus schreibersii Kuhl. (Mammalia: Chiroptera) in the northeast of Spain. *Folia Parasitologica* **38**: 345–354.
Estrada-Peña A., Peribañez M. A. & Serra J. 1991: The life cycle of Spinturnix psi (Mesostigmata: Spinturnicidae) on Miniopterus schreibersii (Mammalia: Chiroptera). Pp.: 475–480. In: Dusbábek F. & Bukva V. (eds.): *Modern Acarology*. *Volume 2*. Prague & The Hague: Academia & SPB Academic Publishing bv, ix+779 pp.
Feldman R., Whitaker J. O., Jr. & Yom-Tov Y. 2000: Dietary composition and habitat use in a desert insectivorous bat community in Israel. *Acta Chiropterologica* **2**: 15–22.
Felten H. 1956: Fledermäuse fressen Skorpione. *Natur und Volk* **86**: 53–57.
Felten H., Spitzenberger F. & Storch G. 1977: Zur Kleinsäugerfauna West-Anatoliens. Teil IIIa. *Senckenbergiana Biologica* **58**: 1–44.
Fenton M. B. & Thomas D. W. 1980: Dry-season overlap in activity patterns, habitat use, and prey selection by sympatric African insectivorous bats. *Biotropica* **12**: 81–90.
Fenton M. B., Boyle N. G. H., Harrison T. M. & Oxley D. J. 1977: Activity patterns, habitat use, and prey selection by some African insectivorous bats. *Biotropica* **9**: 73–85.

Fenton M. B., Shalmon B. & Makin D. 1999: Roost switching, foraging behaviour, and diet of the vespertilionid bat, Otonycteris hemprichii. *Israel Journal of Zoology* **45**: 501–506.
Ferguson W. W. 2002: *The Mammals of Israel*. Jerusalem: Gefen Publishing House, 160 pp.
Filippova N. A. 1966: *Argasovye kleši* (*Argasidae*). *Fauna SSSR. Paukoobraznye. Tom IV. Vyp. 3* [*Argasid Ticks* (*Argasidae*). *The Fauna of the USSR. Arachnida. Volume IV. No. 3*]. Moskva & Leningrad: Nauka, 255 pp (in Russian).
Flanders J. & Jones G. 2009: Roost use, ranging behavior, and diet of greater horseshoe bats (Rhinolophus ferrumequinum) using a transitional roost. *Journal of Mammalogy* **90**: 888–896.
Furman A., Çoraman E., Bilgin R. & Karataş A. 2009: Molecular ecology and phylogeography of the bent-wing bat complex (Miniopterus schreibersii) (Chiroptera: Vespertilionidae) in Asia Minor and adjacent regions. *Zoologica Scripta* **38**: 129–141.
Furman A., Postawa T., Öztunç T. & Çoraman E. 2010: Cryptic diversity of the bent-wing bat, Miniopterus schreibersii (Chiroptera: Vespertilionidae), in Asia Minor. *BioMed Central Evolutionary Biology* **10**(121): 1–12.
Gaisler J. 2001a: Rhinolophus ferrumequinum (Schreber, 1774) – Große Hufeisennase. Pp.: 15–37. In: Krapp F. (ed.): *Handbuch der Säugetiere Europas. Band 4: Fledertiere. Teil I: Chiroptera I. Rhinolophidae, Vespertilionidae 1*. Wiebelsheim: Aula-Verlag, x+603 pp.
Gaisler J. 2001b: Rhinolophus euryale Blasius, 1853 – Mittelmeerhufeisennase. Pp.: 59–74. In: Krapp F. (ed.): *Handbuch der Säugetiere Europas. Band 4: Fledertiere. Teil I: Chiroptera I. Rhinolophidae, Vespertilionidae 1*. Wiebelsheim: Aula-Verlag, x+603 pp.
Gaucher P. 1992: New record of an Epauleted fruit bat Epomophorus labiatus Temminck, 1837 (Mammalia: Chiroptera: Pteropodidae) in Saudi Arabia. *Mammalia* **56**: 657–659.
Gaucher P. 1993: First record of Scotophilus leucogaster (Cretzschmar, 1826) (Mammalia: Chiroptera: Vespertilionidae) in Saudi Arabia. *Mammalia* **57**: 146–147.
Gaucher P. 1995: First record of Geoffroy bat Myotis emarginatus Geoffroy, 1806 (Mammalia: Chiroptera: Vespertilionidae) in Saudi Arabia. *Mammalia* **59**: 149–151.
Gaucher P. & Harrison D. L. 1995: Occurrence of Bodenheimer's Pipistrelle Pipistrellus bodenheimeri Harrison, 1960 (Mammalia, Chiroptera: Vespertilionidae) in Saudi Arabia. *Mammalia* **59**: 672–673.
Goiti U., Vecin P., Garin I., Saloña M. & Aihartza J. R. 2003: Diet and prey selection in Kuhl's pipistrelle Pipistrellus kuhlii (Chiroptera: Vespertilionidae) in south-western Europe. *Acta Theriologica* **48**: 457–468.
Goiti U., Aihartza J. R. & Garin I. 2004: Diet and prey selection in the Mediterranean horseshoe bat Rhinolophus euryale (Chiroptera, Rhinolophidae) during the pre-breeding season. *Mammalia* **68**: 397–402.
Goodman S. M. 1980: The food of the eagle owl (Bubo bubo ascalaphus) in Kharga Oasis, Egyptian Western Desert. *Journal of Arid Environments* **18**: 217–220.
Gray P. A., Fenton M. B. & Van Cakenberghe V. 1999: Nycteris thebaica. *Mammalian Species* **612**: 1–8.
Gregor F. & Bauerová Z. 1987: The role of Diptera in the diet of Natterer's bat, Myotis nattereri. *Folia Zoologica* **36**: 13–19.
Güttinger R., Lustenberger J., Beck A. & Weber U. 1998: Traditionally cultivated wetland meadows as foraging habitats of the grass-gleaning lesser mouse-eared bat (Myotis blythii). *Myotis* **36**: 41–49.
Haas G. E. & Tomich P. Q. 1973: The fleas (Siphonaptera) of Egypt. Early records from mammals. *Journal of the Egyptian Public Health Association* **48**:1–17.
Habersetzer J. 1981: Adaptive echolocation sounds in the bat Rhinopoma hardwickei – a field study. *Journal of Comparative Physiology A* **144**: 559–566.
Harrison D. L. 1956: Mammals from Kurdistan, Iraq, with description of a new bat. *Journal of Mammalogy* **37**: 257–263.
Harrison D. L. 1959a: *Footsteps in the Sand*. London: Ernest Benn Limited, 256 pp.
Harrison D. L. 1959b: Report on the bats (Chiroptera) in the collection of the National Museum of Southern Rhodesia, Bulawayo. *Occasional Papers of the National Museum of Southern Rhodesia* **23B**: 217–231.
Harrison D. L. 1963: A note of the occurrence of the greater mouse-tailed bat Rhinopoma microphyllum Brunnich, 1782, in Lebanon. *Mammalia* **27**: 305–307.
Harrison D. L. 1964: *The Mammals of Arabia. Volume I. Introduction. Insectivora – Chiroptera – Primates*. London: Ernest Benn Limited, xviii+192 pp.
Harrison D. L. 1972: *The Mammals of Arabia. Volume III. Lagomorpha – Rodentia*. London: Ernest Benn Limited, xvii+[288] pp.
Harrison D. L. & Bates P. J. J. 1989: Observation on two mammal species new to the Sultanate of Oman, Vulpes cana Blanford, 1877 (Carnivora: Canidae) and Nycteris thebaica Geoffroy, 1818 (Chiroptera: Nycteridae). *Bonner Zoologische Beiträge* **40**: 73–77.
Harrison D. L. & Bates P. J. J. 1991: *The Mammals of Arabia. Second Edition*. Sevenoaks: Harrison Zoological Museum, 354 pp.
Harrison D. L. & Lewis R. E. 1961: The large mouse-eared bats of the Middle East, with description of a new subspecies. *Journal of Mammalogy* **42**: 372–380.

Harrison D. L. & Makin D. 1988: Significant new records of vespertilionid bats (Chiroptera: Vespertilionidae) from Israel. *Mammalia* **52**: 593–596.
Hasbenli A. 1997: Contributions to bat flies of Turkey (Diptera: Nycteribiidae, Streblidae). *Gazi Üniversitesi Fen Bilimleri Enstitüsü Dergisi* **10**: 533–544.
Hayman R. W. & Hill J. E. 1971: Part 2. Order Chiroptera. Pp.: 1–73. In: Meester J. & Setzer H. W. (eds.): *The Mammals of Africa*. *An Identification Manual*. Washington: Smithsonian Institution Press.
von Heuglin T. 1877: *Reise in Nordost-Afrika*. *Schilderungen aus dem Gebiete der Beni Amer und Habab nebst zoologischen Skizzen und einem Führer für Jagdreisende*. *Zweiter Band*. Braunschweig: George Westermann, 304 pp.
Hoare L. R. 1991: The diet of Pipistrellus pipistrellus during the prehibernal period. *Journal of Zoology*, *London* **225**: 665–670.
Holderied M. W., Korine C., Fenton M. B., Parsons S., Robson S. & Jones G. 2005: Echolocation call intensity in aerial hawking bat Eptesicus bottae (Vespertilionidae) studied using stereo videogrammetry. *The Journal of Experimental Biology* **208**: 1321–1327.
Hoogstraal H. 1953: Ornithodoros salahi sp. nov. (Ixodoidea: Argasidae) from the Cairo citadel, with notes on Ornithodoros piriformis Warburton, 1918 and Ornithodoros batuensis Hirst, 1929 (Ixodoidea: Argasidae). *Journal of Parasitology* **39**: 256–263.
Hoogstraal H. 1955: Bat ticks of the genus Argas (Ixodoidea, Argasidae). I. The subgenus Chiropterargas. *Fieldiana*: *Zoology* **37**: 579–600.
Hoogstraal H. 1956: African Ixodoidea. I. Ticks of the Sudan (with special reference to Equatorial province and with preliminary reviews to the genera Boophilus, Margaropus, and Hyalomma). *Research Report of the U.S. Naval Medical Research Unit* **3**: i–ii+1–1101.
Hopkins G. H. E. & Rothschild M. 1956: *An Illustrated Catalogue of Rothschild Collection of Fleas* (*Siphonaptera*) *in the British Museum* (*NH*). *Volume II*. *Cotopsyllidae*, *Vermipsyllidae*, *Stephanocircidae*, *Ischnopsyllidae*, *Hypsophthalmidae*, *and Xiphiopsyllidae*. London: British Museum (Natural History), 445 pp.
Horáček I. 1991: Enigma of Otonycteris: ecology, relationship, classification. *Myotis* **29**: 17–30.
Horáček I., Benda P., Sadek R., Karkabi S., Abi-Said M., Lučan R., Hulva P. & Karanouh R. 2008: Bats of Lebanon. State of knowledge and perspectives. *Al-Ouat'Ouate*, *New Series* **14**: 52–65.
Horáček I., Benda P., Sadek R., Karkabi S., Abi-Said M., Lučan R., Uhrin M., Bou Joude I., Karanouh R. & Akil S. 2009: Bats census in Lebanese caves 2008 & 2009. *Al-Ouat'Ouate*, *New Series* **15**: 70–73.
Hulva P., Horáček I., Strelkov P. P. & Benda P. 2004: Molecular architecture of Pipistrellus pipistrellus / Pipistrellus pygmaeus complex (Chiroptera: Vespertilionidae): further cryptic species and Mediterranean origin of the divergence. *Molecular Phylogenetics and Evolution* **32**: 1023–1035.
Hulva P., Horáček I. & Benda P. 2007a: Molecules, morphometrics and new fossils provide an integrated view of the evolutionary history of Rhinopomatidae (Mammalia: Chiroptera). *BioMed Central Evolutionary Biology* **7**(165): 1–15.
Hulva P., Benda P., Hanák V., Evin A. & Horáček I. 2007b: New mitochondrial lineages within the Pipistrellus pipistrellus complex from Mediterranean Europe. *Folia Zoologica* **56**: 378–388.
Hůrka K. 1964: Distribution, bionomy and ecology of the European bat flies with special regard to the Czechoslovak fauna (Diptera, Nycteribidae). *Acta Universitatis Carolinae – Biologica* **1964**(3): 167–231.
Hůrka K. 1972: Basilia mongolensis nudior subsp. n. nebst Bemerkungen zur Nycteribien- und Strebliden fauna Thrakiens (Diptera: Pupipara). *Annalen des Naturhistorichen Museums in Wien* **76**: 709–713.
Hůrka K. 1980: Nycteribiidae – Muchulovití [Nycteribiidae – Bat Flies]. Pp.: 479–509. In: Chvála M. (ed.): *Fauna ČSSR*. *Svazek 22*. *Krevsající mouchy a strečci – Diptera*. *Čeledi Ceratopoginidae*, *Simuliidae*, *Tabanidae*, *Hypodematidae*, *Oestridae*, *Gasterophilidae*, *Hippoboscidae a Nycteribiidae* [*Fauna of Czechoslovakia*. *Volume 22*. *Blood Sucking Flies – Diptera*. *Families Ceratopoginidae*, *Simuliidae*, *Tabanidae*, *Hypodematidae*, *Oestridae*, *Gasterophilidae*, *Hippoboscidae*, *and Nycteribiidae*]. Praha: Academia, 540 pp (in Czech).
Hůrka K. 1982: On the insect bat ectoparasites of coastal Libya (Cimicidae, Nycteribiidae, Streblidae, Ischnopsyllidae). *Věstník Československé Společnosti Zoologické* **46**: 85–91.
Hůrka K. & Soós A., 1986: Nycteribiidae. Pp.: 226–234. In: Soós A. & Papp L. (eds.): *Catalogue of Palaearctic Diptera 11*. Amsterdam & Budapest: Akadémiai Kiadó & Elsevier, 346 pp.
Jobling B. 1934: A revision of the genus Nycteribosca Speiser (Diptera Pupipara, Streblidae). *Parasitology* **26**: 64–97.
Jobling B. 1958: Streblidae from Yemen with description of one subspecies of Ascodipteron (Diptera). *Fieldiana*: *Zoology* **39**: 185–189.
Jones G. 1990: Prey selection by the greater horseshoe bat (Rhinolophus ferrumequinum): optimal foraging by echolocation? *Journal of Animal Ecology* **59**: 587–602.
Jones G. & Rayner J. M. V. 1989: Foraging behaviour and echolocation of wild horseshoe bats Rhinolophus ferrumequinum and R. hipposideros (Chiroptera, Rhinolophidae). *Behavioral Ecology and Sociobiology* **25**: 183–191.
Karataş A. & Sözen M. 2004: Contribution to karyology, distribution and taxonomic status of the long-winged bat, Miniopterus schreibersii (Chiroptera: Vespertilionidae), in Turkey. *Zoology in the Middle East* **33**: 51–64.

Karataş A. & Sachanowicz K. 2008: Noteworthy bat records from Upper Mesopotamia, Turkey (Chiroptera). *Lynx*, *New Series* **39**: 103–108.
Karatas A., Weydan M., Sozen M., Shehab A. & Amr Z. 2008: Karyotypes of bats (Chiroptera: Rhinolophidae, Vespertilionidae) from Jordan. *Arab Gulf Journal of Scientific Research* **26**: 193–198.
Kock D. 1969: Die Fledermaus-Fauna des Sudan. *Abhandlungen der Senckenbergische Naturforschende Gesellschaft* **521**: 1–238.
Kock D. 1989: Fledermaus-Fliegen aus der E-Mediterraneis (Diptera: Nycteribiidae). *Entomologische Zeitschrift* **99**: 56–58.
Kock D. & Nader I. A. 1979: Two bat flies from the Kingdom of Saudi Arabia, their nomenclature, host specifity and zoogeography (Insecta: Diptera: Nycteribiidae). *Senckenbergiana Biologica* **60**: 65–73.
Kolenati F. A. 1859: Beiträge zur Kenntniss der Arachniden. *Sitzungsberichte der kaiserlichen Akademie der Wissenschaften in Wien*, *Mathematisch-Naturwissenschaftliche Classe* **35**: 155–190.
Koopman K. F. 1994: Chiroptera: Systematics. Pp.: 1–217. In: Niethammer J., Schliemann H. & Starck D. (eds.): *Handbuch der Zoologie*. *Band VIII*. *Mammalia*. *Teilband 60*. Berlin and New York: Walter de Gruyter, vii+224 pp.
Korine C. & Pinshow B. 2004: Guild structure, foraging space use, and distribution in a community of insectivorous bats in the Negev Desert. *Journal of Zoology*, *London* **262**: 187–196.
Koselj K. 2002: *Prehrana in ekologija južnega podkovnjaka* (*Rhinolophus euryale Blasius*, *1853*; *Mammalia*: *Chiroptera*) *v jugovzhodni Sloveniji* [*Diet and Ecology of the Mediterranean Horseshoe Bat* (*Rhinolophus euryale Blasius*, *1853*; *Mammalia*: *Chiroptera*) *in South-eastern Slovenia*]. Unpublished MSc. Thesis. Ljubljana: University of Ljubljana, 126 pp (in Slovenian).
Krull D., Schumm A., Metzner W. & Neuweiler G. 1991: Foraging areas and foraging behaviour in the notch-eared bat, Myotis emarginatus (Vespertilionidae). *Behavioral Ecology and Sociobiology* **28**: 247–253.
Kumerloeve H. 1975: Die Säugetiere (Mammalia) der Türkei. *Veröffentlichungen der Zoologischen Staatssammlung München* **18**: 69–158.
Kwiecinski G. G. & Griffits T. A. 1999: Rousettus egyptiacus. *Mammalian Species* **611**: 1–9.
Lanza B. 1960: Su due species criptiche di Orecchione: «Plecotus auritus» (L.) e «P. wardi» Thomas («Mamm.; Chiroptera»). *Monitore Zoologico Italiano* **68**: 7–23.
Lanza B. 1999: I parassiti dei pipistrelli (Mammalia, Chiroptera) della fauna italiana. *Museo Regionale di Scienze Naturali Torino*, *Monografie* **30**: 1–318.
LaVal R. K. & LaVal M. L. 1980: Prey selection by the slit-faced bat Nycteris thebaica (Chiroptera: Nycteridae) in Natal, South Africa. *Biotropica* **12**: 241–246.
Lewis R. E. 1962: A preliminary list of the fleas of Lebanon. *Proceedings of the Royal Entomological Society of London* (A) **37**: 49–60.
Lewis R. E. 1964: Additional records of fleas from Lebanon, Syria and Jordan. *Proceedings of the Royal Entomological Society of London* (A) **39**: 157–165.
Lewis R. E. 1973: Siphonaptera collected during the 1965 Street Expedition to Afganistan. *Fieldana*: *Zoology* **64**: i–xi+1–161.
Lewis R. E. & Harrison D. L. 1962: Notes on bats from the Republic of Lebanon. *Proceedings of the Zoological Society of London* **138**: 473–486.
Lugon A. & Roue S. 1999: Miniopterus schreibersii forages close to vegetation. Results from fecal analysis from two eastern French mate colonies. P.: 79. In: Cruz M. & Kozakiewicz K. (eds.): *VIIIth European Bat Research Symposium*. *Abstracts*. Kraków: Chiropterological Information Center, Institute of animal Systematics and Evolution PAS, 86 pp.
Maa T. C. 1968: On Diptera Pupipara from Africa, Part 1. *Journal of Medical Entomology* **5**(2): 238–251.
Makin D. 1976: Preliminary report of a survey of Microchiroptera in Israel. *Israel Journal of Zoology* **25**: 211.
Makin D. 1977: Atalefim afufe hidot [Riddle-shrouded bats]. *Teva va Aretz* **18**(2): 74–80 (in Hebrew).
Makin D. 1979: The quest for Israel's bats. *Israel – Land and Nature* **5**(1): 28–34.
Makin D. 1987: Tefuca uvezoologija shel ʻatlafi haraqim be'erec Jisrael [The insectivorous bats (Microchiroptera) of Israel, distribution and biology]. *Re'em* (*Oryx*), *Journal of the Israel Mammal Information Center* **6**: 12–76 (in Hebrew, with a subtitle in English).
Makin D. 1989: The status of bats in Israel. Pp.: 403–408. In: Hanák V., Horáček I. & Gaisler J. (eds.): *European Bat Research 1987*. Praha: Charles University Press, xx+718 pp.
Maraci Ö., Bilgin R., Lučan R. K., Bartonička P., Hulva P. & Horáček I. 2010: The sympatry of Miniopterus schreibersii schreibersii and Miniopterus s. pallidus in three caves: The smoking gun for their elevantion to full species status. Pp.: 220–221. In: Horáček I. & Benda P. (eds.): *15th IBRC – the Conference Manual*: *Programme*, *Abstracts*, *List of Participants*. *Volume of Abstracts of the 15th International Bat Research Conference*, *held in Prague*, *23–27 August 2010*. Kostelec nad Černými lesy: Lesnická práce s.r.o., 381 pp.
McAney M. & Fairley J. S. 1989: Analysis of the diet of the lesser horseshoe bat Rhinolophus hipposideros in the west of Ireland. *Journal of Zoology*, *London* **217**: 491–498.

Mendelssohn H. & Yom-Tov Y. 1999: *Fauna Palestina*. *Mammalia of Israel*. Jerusalem: The Israel Academy of Sciences and Humanities, 439 pp + xxxvii pl.
Micherdzinski W. 1980: *Eine taxonomische Analyse der Familie Macronyssidae Oudemans*, *1936*. *I. Subfamilie Ornithonyssinae Lange* (*Acarina*: *Mesostigmata*). Warszawa: Polska Akademia Nauk, 263 pp.
Mutere F. A. 1968: The breeding biology of the fruit bat Rousettus aegyptiacus E. Geoffroy living at 0°22'. *Acta Tropica* **25**: 97–108.
Nadachowski A., Śmiełowski J., Rzebik-Kowalska B. & Daoud A. 1990: Mammals from the Near East in Polish collections. *Acta Zoologica Cracoviensia* **33**: 91–120.
Nader I. A. 1969: Animal remains in pellets of the barn owl, Tyto alba, from the vicinity of An-Najaf, Iraq. *Bulletin of the Iraq Natural History Museum* **4**(1): 1–7.
Nader I. A. & Kock D. 1983a: Notes on some bats from the Near East (Mammalia: Chiroptera). *Zeitschrift für Säugetierkunde* **48**: 1–9.
Nader I. A. & Kock D. 1983b: A new slit-faced bat from central Saudi Arabia (Mammalia: Chiroptera: Nycteridae). *Senckenbergiana Biologica* **63**: 9–15.
Nader I. A. & Kock D. 1990: Eptesicus (Eptesicus) bottae (Peters 1869) in Saudi Arabia with notes on its subspecies and distribution (Mammalia: Chiroptera: Vespertilionidae). *Senckenbergiana Biologica* **70**: 1–13.
Norberg U. M. & Rayner J. M. V. 1987: Ecological morphology and flight in bats (Mammalia; Chiroptera): wing adaptations, flight performance, foraging strategy and echolocation. *Philosophical Transactions of the Royal Society B*, *Biological Sciences* **316**: 335–427.
Obrist M. K., Boesch M. & Flückiger P. 2004: Variability in echolocation call design of 26 Swiss bat species: consequences, limits and options for automated field identification with a synergic pattern recognition approach. *Mammalia* **68**: 307–322.
Obuch J. 1992: Tawny owl (Strix aluco) preying on bats. Pp.: 119–121. In: Horáček I. & Vohralík V. (eds.): *Prague Studies in Mammalogy*. Praha: Charles University Press, 246 pp.
Obuch J. 1994: K potrave výra skalného (Bubo bubo) a sovy obyčajnej (Strix aluco) vo východnej časti Turecka [On the food of eagle owl (Bubo bubo) and tawny owl (Strix aluco) in the Eastern part of Turkey]. *Tichodroma* **7**: 7–16 (in Slovak, with an abstract in English).
Obuch J. 1998: Zastúpenie netopierov (Chiroptera) v potrave sov (Strigiformes) na Slovensku [The representation of bats (Chiroptera) in the diet of owls in Slovakia]. *Vespertilio* **3**: 65–74 (in Slovak, with an abstract in English).
Obuch J. 2010: *Priestorová a časová diverzita potravy sovy obyčajnej* (*Strix aluco*) [*Spatial and Temporal Diversity of Diet of Tawnly Owl* (*Strix aluco*)]. Unpublished Ph.D. Thesis. Faculty of Forestry, Technical University in Zvolen, Zvolen, 45 pp + 62 tables (in Slovak).
Obuch J. & Benda P. 2009: Food of the barn owl (Tyto alba) in the Eastern Mediterranean. *Slovak Raptor Journal* **3**: 41–50.
Obuch J. & Krištín A. 2004: Prey composition of the little owl Athene noctua in an arid zone (Egypt, Syria, Iran). *Folia Zoologica* **53**: 65–79.
Obuch J. & Rybin S. N. 1993: Food of the eagle owl (Bubo bubo zaisanensis Chachlov) in southern Kirghizia (Osh District). *Folia Zoologica* **42**: 19–31.
Papadatou E., Butlin R. & Altringham J. D. 2008: Identification of bat sepcies in Greece from their echolocation calls. *Acta Chiropterologica* **10**: 127–143.
Péricart J. 1996: Family Cimicidae Latreille, 1802. Bedbugs. Pp.: 141–144. In: Aukema B. & Rieger C. (eds.): *Catalogue of the Heteroptera of the Palearctic Region*. *Volume 2*. *Cimicomorpha I*. Amsterdam: The Netherlands Entomological Society, 361 pp.
Pokines J. T. & Peterhans J. C. K. 1998: Barn owl (Tyto alba) taphonomy of the Negev Desert, Israel. *Israel Journal of Zoology* **44**: 19–27.
Peterson B. V., Martin R. L. & Maurer F. W. Jr. 1976: A record of some bat flies (Diptera: Nycteribiidae) from Turkey. *Entomological News* **87**: 239–242.
Presetnik P. 2002: *Prehrana in biologija dolgokrilega netopirja* (*Miniopterus schreibersii Kuhl*, *1817*) *na gradu Grad nad Goričkem* (*SV Slovenija*) [*Diet and Biology of Schreiber's Bat* (*Miniopterus schreibersii Kuhl*, *1817*) *at Grad nad Goričkem* (*NE Slovenija*)]. Unpublished M.Sc. Thesis. Ljubljana: University of Ljubljana, 57 pp (in Slovenian).
Qumsiyeh M. B. 1980: New records of bats from Jordan. *Säugetierkundliche Mitteilungen* **28**: 36–39.
Qumsiyeh M. B. 1985: The bats of Egypt. *Special Publication of the Museum of Texas Tech University* **23**: 1–101.
Qumsiyeh M. B. 1996: *Mammals of the Holy Land*. Lubbock: Texas Tech University Press, x+389 pp.
Qumsiyeh M. B. & Baker R. J. 1985: G- and C-banded karyotypes of the Rhinopomatidae (Microchiroptera). *Journal of Mammalogy* **66**: 541–544.
Qumsiyeh M. B., Schlitter D. A. & Disi A. M. 1986: New records and karyotypes of small mammals from Jordan. *Zeitschrift für Säugetierkunde* **51**: 139–146.
Qumsiyeh M. B., Disi A. M. & Amr Z. S. 1992: Systematics and distribution of the bats (Mammalia: Chiroptera) of Jordan. *Dirasat*, *Series B* **19**: 101–118.

Qumsiyeh M. B., Amr Z. S. & Al-Oran R. M. 1998: Further records of bats from Jordan and a synopsis. *Turkish Journal of Zoology* **22**: 277–284.
Radovsky F. J. 1967: *The Macronyssidae and Laelapidae* (*Acarina*: *Mesostigmata*) *Parasitic on Bats*. Berkeley & Los Angeles: University of California Press, viii+288 pp.
Rahmatulina I. K. 2005: *Rukokrylye Azerbajdžana* (*fauna*, *ekologiâ*, *zoogeografiâ*) [*Bats of Azerbaijan* (*Fauna*, *Ecology*, *Zoogeography*)]. Baku: Nacional'naâ Akademiâ Nauk Azerbajdžana, 480 pp (in Russian).
Rakhmatulina I. K. 1983: Ekologiâ sredizemnomorskogo netopyrâ (Vespertilio kuhlii Kuhl, 1819) v Azerbajdžane [Ecology of Vespertilio kuhlii Kuhl, 1819 in Azerbaijan]. *Bjulleten' Moskovskogo Obŝestva Ispytatelej Prirody*, *Otdel Biologičeskij* **88**(3): 33–42 (in Russian, with a summary in English).
Razgour O., Korine C. & Saltz D. 2010: Pond characteristic as determinants of species diversity and community composition in desert bats. *Animal Conservation* **13**: 505–513.
Rifai L. B., Al-Melhim W. N. & Amr Z. S. 1998: On the diet of the barn owl, Tyto alba, in northern Jordan. *Zoology in the Middle East* **16**: 31–34.
Riskin D. K. 2001: Pipistrellus bodenheimeri. *Mammalian Species* **651**: 1–3.
Rosický B. 1957: *Fauna ČSR*. *Svazek 10*. *Blechy* [*Fauna of Czechoslovakia*. *Volume 10*. *Fleas*]. Praha: Nakladatelství ČSAV, 439 pp (in Czech).
Rudnick A. 1960: A revision of the mites of the family Spinturnicidae (Acarina). *University of California Publications in Entomology* **17**(2): 157–284.
Rüppell E. 1842: Verzeichniss der in dem Museum der senckenbergischen naturforschenden Gesellschaft aufgestellten Sammlungen. Erste Abtheilung: Säugethiere und deren Skelette. *Museum Senckenberg* **3**: 145–196.
Russo D. & Jones G. 2002: Identification of twenty-two bat species (Mammalia: Chiroptera) from Italy by analysis of time-expanded recordings of echolocation calls. *Journal of Zoology*, *London* **258**: 91–103.
Rydell J. & Arlettaz R. 1994: Low-frequency echolocation enables the bat Tadarida teniotis to feed on tympanate insects. *Proceedings of the Royal Society of London B* **257**: 175–178.
Rydell J., Natuschke G., Theiler A. & Zingg P. E. 1996: Food habits of the barbastelle bat, Barbastella barbastellus. *Ecography* **19**: 62–66.
Sachanowicz K., Bogdanowicz W. & Michalak S. 1999: First record of Taphozous nudiventris Cretzschmar, 1830 (Chiroptera, Emballonuridae) in Turkey. *Mammalia* **63**: 105–107.
Şadoğlu P. 1956: Ocular reduction of the bat fly, Nycteribosca africana (Diptera, Streblidae) and comparison with those seen in some Nycteribiidae. *Review of the Faculty of Science*, *University of Istanbul*, *Series B* **21**(1–2): 103–138.
Saliba E. K., Amr Z. S., Wassef H. Y., Hoogstraal H. & Main A. J. 1990: The ticks (Ixodoidea) of East Jordan and the West Bank. *Dirasat*, *Series B* **17**(3): 156–175.
Salsamedi E., Aihartza J., Goiti U., Almenar D. & Garin I. 2005: Echolocation calls and morphology in the Mehelyi's (Rhinolophus mehelyi) and Mediterranean (R. euryale) horseshoe bats: implications for resource partitioning. *Hystrix*, *Italian Journal of Mammalogy* (*New Series*) **16**: 145–158.
Sanborn C. C. & Hoogstraal H. 1953: Some mammals of Yemen and their ectoparasites. *Fieldiana*: *Zoology* **34**: 229–252.
Schlitter D. A. & Qumsiyeh M. B. 1996: Rhinopoma microphyllum. *Mammalian Species* **542**: 1–5.
Seamark E. C. J. & Bogdanowicz W. 2002: Feeding ecology of the common slit-faced bat (Nycteris thebaica) in KwaZulu-Natal, South Africa. *Acta Chiropterologica* **4**: 49–54.
Seddon P. J., van Heezik Y. & Nader I. A. 1997: Mammals of the Harrat al-Harrah Protected Area, Saudi Arabia. *Zoology in the Middle East* **14**: 37–46.
Shalmon B., Kofyan T. & Hadad E. 1993: *A Field Guide to the Land Mammals of Israel*. *Their Tracks and Signs*. Jerusalem: Kater Publishing House, 216 pp (in Hebrew, with a subtitle in English).
Shehab A., Daoud A., Kock D. & Amr Z. 2004: Small mammals recovered from owl pellets from Syria (Mammalia: Chiroptera, Rodentia). *Zoology in the Middle East* **33**: 27–42.
Shehab A., Karataş A., Amr Z., Mamkhair I. & Sözen M. 2007: The distribution of bats (Mammalia: Chiroptera) in Syria. *Vertebrate Zoology* **57**: 103–132.
Shiel C. B., McAney C. M. & Fairley J. S. 1991: Analysis of the diet of Natterer's bat Myotis nattereri and the common long-eared bat Plecotus auritus in the West of Ireland. *Journal of Zoology*, *London* **223**: 299–305.
Siemers B. M. & Ivanova T. 2004: Ground gleaning in horseshoe bats: comparative evidence from Rhinolophus blasii, R. euryale and R. mehelyi. *Behavioral Ecology and Sociobiology* **56**: 464–471.
Sierro A. & Arlettaz R. 1997: Barbastelle bats (Barbastella spp.) specialize in the predation of moths: implication for foraging tactics and conservation. *Acta Oecologica* **18**: 91–106.
Simmons N. B. 2005: Order Chiroptera. Pp.: 312–529. In: Wilson D. E. & Reeder D. M. (eds.): *Mammal Species of the World*. *A Taxonomic and Geographic Reference*. *Third Edition*. *Volume 1*. Baltimore: The John Hopkins University Press, xxxviii+743 pp.
Simmons J. A., Kick S. A. & Lawrence B. D. 1984: Echolocation and hearing in the mouse-tailed bat, Rhinopoma hardwickei: Acoustic evolution of echolocation in bats. *Journal of Comparative Physiology A* **154**: 347–356.

Skuratowicz W. 1967: *Pchły – Siphonaptera* (*Aphaniptera*). *Klucze do oznaczania owadów Polski*. *Cz*. *XXIX* [*Fleas – Siphonaptera* (*Aphaniptera*). *Keys for Identification of Insects of Poland*. *Vol*. *XXIX*]. Warszawa: Polskie wydawnictwo naukowe, 142 pp (in Polish).
Smit F. G. A. M. 1954: New bat-fleas (Siphonaptera: Ischnopsyllidae). *Parasitology* **44**: 144–156.
Smit F. G. A. M. 1960: Contribution a l'étude de la fauna d'Afganistan 26. Siphonaptera. Fleas. *Entomologische Berichten* **20**: 146–153.
Spitzenberger F. 1979: Die Säugetierfauna Zyperns. Teil II: Chiroptera, Lagomorpha, Carnivora und Artiodactyla. *Annalen des Naturhistorischen Museums in Wien* **82**: 439–465.
Spitzenberger F., Strelkov P. P., Winkler H. & Haring E. 2006: A preliminary revision of the genus Plecotus (Chiroptera, Vespertilionidae) based on genetic and morphological results. *Zoologica Scripta* **35**: 187–230.
Šrámek J. 2010: *Populační a geografická proměnlivost létavců* (*Miniopterus*) *v západní Palearktidě* [*Population and Geographical Variation in Bent-winged Bats* (*Miniopterus*) *of western Palaearctic*]. Unpublished MSc. Thesis. Department of Zoology, Charles Univeristy, Praha, 145 pp.+CD (in Czech).
Starkoff O. & Cagnolati G. C. 1962: Nuove osservazioni faunistiche e biologiche sulle zecche italiane. *Parassitologia* **4**: 31–37.
Steck C. E. & Brinkmann R. 2006: The trophic niche of the Geoffroy's bat (Myotis emarginatus) in south-western Germany. *Acta Chiropterologica* **8**: 445–450.
Sullivan C. M., Shiel C. B., McAney C. M. & Fairley J. S. 1993: Analysis of the diets of Leisler's Nyctalus leisleri, Daubenton's Myotis daubentoni, and pipistrelle Pipistrellus pipistrellus bats in Ireland. *Journal of Zoology*, *London* **231**: 656–663.
Swift S. M. 1997: Roosting and foraging behaviour of Natterer's bats (Myotis nattereri) close to the northern border of their distibution. *Journal of Zoology*, *London* **242**: 375–384.
Swift S. M., Racey P. A. & Avery M. I. 1985: Feeding ecology of Pipistrellus pipistrellus (Chiroptera: Vespertilionidae) during pregnancy and lactation. II. Diet. *Journal of Animal Ecology* **54**: 217–225.
Taake K.-H. 1992: Strategien der Ressourcennutzung an Waldgewässern jagenden Fledermäuse (Chiroptera: Vespertilionidae). *Myotis* **30**: 7–73.
Till W. M. & Evans G. O. 1964: The genus Steatonyssus Kolenati (Acari: Mesostigmata). *Bulletin of the British Museum* (*Natural History*), *Zoology* **11**: 511–582.
Theodor O. 1954: 66b. Streblidae. Pp.: 1–12. In: Lindner E. (ed.): *Die Fliegen der palaearktischen Region*. *Lieferung XII*. Stuttgart: Schweizerbart.
Theodor O. 1956: On the genus Tripselia and the group of Basilia bathybothyra (Nycteribiidae, Diptera). *Parasitology* **46**(3–4): 353–394.
Theodor O. 1967: *An Illustrated Catalogue of the Rothschild Collection of Nycteribiidae in the British Museum* (*Natural History*), *with Keys and Short Descriptions for the Identification of Subfamilies*, *Genera*, *Species and Subspecies*. *Publication 655*. London: British Museum (Natural History), viii+506 pp.
Theodor O. 1968: A revision of the Streblidae (Diptera) of the Ethiopian region. *Transactions of the Royal Entomological Society of London* **120**(16): 313–373
Theodor O. 1975: *Diptera Pupipara*. *Fauna Palaestina – Insecta I*. Jerusalem: The Israel Academy of Sciences and Humanities, 170 pp.
Theodor O. & Costa M. 1960: New species and new records of Argasidae from Israël. Observations on the rudimentary scutum and the respiratory system of the larvae of the Argasidae. *Parasitology* **50**: 365–386.
Theodor O. & Costa M. 1967: *A Survey of the Parasites of Wild Mammals and Birds in Israel*. *Part One*. *Ectoparasites*. Jerusalem: The Israel Academy of Sciences and Humanities, 117 pp.
Theodor O. & Moscona A. 1954: On bat parasites in Palestine. I. Nycteribiidae, Streblidae, Hemiptera, Siphonaptera. *Parasitology* **44**: 157–245.
Tohmé G. & Tohmé H. 1985: *Les mammifères sauvages du Liban*. Beyrouth: Université Libanaise, 190 pp.
Topál G. 2001: Myotis nattereri (Kuhl, 1818) – Fransenfledermaus. Pp.: 405–442. In: Krapp F. (ed.): *Handbuch der Säugetiere Europas*. *Band 4: Fledertiere*. *Teil I: Chiroptera I. Rhinolophidae*, *Vespertilionidae 1*. Wiebelsheim: Aula-Verlag, x+603 pp.
Tristram H. B. 1884: *The Survey of Western Palestine*. *The Fauna and Flora of Palestine*. London: The Committee of the Palestine Exploration Fund, xxii+455 pp.
Ulanovsky N., Fenton M. B., Tsoar A. & Korine C. 2004. Dynamics of jamming avoidance in cholocating bats. *Proceedings of the Royal Society of London B* **271**: 1467–1475.
Usinger R. L. 1966: *Monograph of Cimicidae*. College Park: Entomological Society of America, xi+585 pp.
Vestjens W. J. M. & Hall L. S. 1977: Stomach contents of fourty-two species of bats from the Australasian region. *Australian Wildlife Research* **4**: 25–35.
Weber N. A. 1955: Notes on Iraq Insectivora and Chiroptera. *Journal of Mammalogy* **36**: 123–126.
Whitaker J. O. Jr. 1988: Collecting and preserving ectoparasites for ecological study. Pp.: 459–474. In: Kunz T. H. (ed.): *Ecological and Behavioral Methods for the Study of Bats*. Washington D.C.: Smithsonian Institution Press, xxii+533 pp.

Whitaker J. O. Jr. & Black H. 1976: Food habits of cave bats from Zambia, Africa. *Journal of Mammalogy* **57**: 199–204.
Whitaker J. O. Jr. & Karataş A. 2009: Food and feeding habits of some bats from Turkey. *Acta Chiropterologica* **11**: 393–403.
Whitaker J. O. Jr. & Yom-Tov Y. 2002: The diet of some insectivorous bats from northern Israel. *Mammalian Biology* **67**: 378–380.
Whitaker J. O. Jr., Shalmon B. & Kunz T. H. 1994: Food and feeding habits of insectivorous bats from Israel. *Zeitschrift für Säugetierkunde* **59**: 74–81.
Wolton R. J., Arak P. A., Godfray C. J. & Wilson R. P. 1982: Ecological and behavioural studies of the Megachiroptera at Mount Nimba, Liberia, with notes on Microchiroptera. *Mammalia* **46**: 419–448.
Yerbury J. W. & Thomas O. 1895: On the mammals of Aden. *Proceedings of the Zoological Society of London* **1895**: 542–555.
Yom-Tov Y. & Kadmon R. 1998: Analysis of the distribution of insectivorous bats in Israel. *Diversity and Distribution* **4**: 63–70.
Yom-Tov Y., Makin D. & Shalmon B. 1992a: The insectivorous bats (Microchiroptera) of the Dead Sea area, Israel. *Israel Journal of Zoology* **38**: 125–137.
Yom-Tov Y., Makin D. & Shalmon B. 1992b: The biology of Pipistrellus bodenheimeri (Microchiroptera) in the Dead Sea area of Israel. *Zeitschrift für Säugetierkunde* **57**: 65–69.
Zelenova N. & Yosef R. 2003: Bats in the Eilat region (Israel), spring 2002. *Nyctalus* (*Neue Folge*) **9**(1): 57–60.
Zohary M. 1973: *Geobotanical Foundations of the Middle East*. Stuttgart & Amsterdam: Gustav Fischer Verlag & Swets & Zeitlinger, xii+739 pp.

APPENDIX I

Gazetteer

site	province	coordinates	altitude [m a. s. l.]
Ain Amshit ... see Ar Rajif			
Al Azraq Al Janubi, Azraq wetland	Zarqa’	31° 50’ N, 36° 49’ E	515
Al Azraq Al Janubi, Shawmari Wildlife Reserve ... see Shawmari Wildlife Reserve			
Al Azraq Al Shimali, Qasr Azraq	Zarqa’	31° 53’ N, 36° 50’ E	523
Al Batra [Petra]	Ma’an	30° 20’ N, 35° 27’ E	880
Al Bishriyya, Bir Hamma lava cave	Mafraq	32° 08’ N, 36° 49’ E	780
Al Ghal	Aqaba	29° 31’ N, 35° 36’ E	815
Al Halabat Al Sharkiyah, Hammam As Sarh, ancient bath	Zarqa’	32° 05’ N, 36° 22’ E	595
Al Hamma, cave	Irbid	32° 42’ N, 35° 41’ E	–120
Al-Hazim	Zarqa’	31° 38’ N, 37° 14’ E	530
Al Hazim, Al Hazim Al Dhahek Well	Zarqa’	31° 36’ N, 37° 14’ E	534
Al Karak ... see Karak			
Al Khrba, Beni Kinan	Irbid	32° 35’ N, 36° 43’ E	425
Al Majdal	Irbid	32° 14’ N, 35° 51’ E	450
Al Maqar’iyya	Ma’an	30° 34’ N, 35° 33’ E	1157
Al Mustaba, Az Zarqa’ Valley, spring in valley slope	Irbid	32° 13’ N, 35° 53’ E	285
Al Qunayya, Zarqa’ River	Mafraq	32° 13’ N, 35° 59’ E	425
Al Qurayqira, Khirbet Feynan, mines	Tafila	30° 38’ N, 35° 29’ E	278
Al Qurayqira, Ratiyah	Tafila	30° 39’ N, 35° 29’ E	270
Al Qurayqira, Wadi Faynan	Tafila	30° 38’ N, 35° 27’ E	180
Al Qurayqira, Wadi Fidan	Tafila	30° 39’ N, 35° 24’ E	65
Al Qurayqira, Wadi Fidan ca. 3 km to northwest	Aqaba	30° 39’ N, 35° 24’ E	60
Al Qurayqira, Wadi Ghuweir, 2.5 km E of Khirbet Feynan	Aqaba	30° 37’ N, 35° 31’ E	308
Al Qurayqira, Wadi Ghuweir, Khirbet Feynan	Aqaba	30° 38’ N, 35° 29’ E	262
Al Qurayqira, Wadi Khalid	Tafila	30° 38’ N, 35° 28’ E	240
Al Wardeh Cave ... see Khashiba			
Amman, cave in Al-Mahhatta	ʿAmman	31° 57’ N, 35° 56’ E	750
ʿAmman	ʿAmman	31° 57’ N, 35° 57’ E	750
An Naqab	Ma’an	30° 00’ N, 35° 29’ E	1546
An Naqah	Karak	30° 59’ N, 35° 27’ E	–375
An Nuzha, Wadi Al Wala	ʿAmman	31° 33’ N, 35° 44’ E	335
Aqaba, Ottoman fortress	Aqaba	29° 31’ N, 35° 00’ E	10
Aqaba, Red Sea shore ca. 10 km to south	Aqaba	29° 27’ N, 34° 58’ E	5
Aqraba	Irbid	32° 44’ N, 35° 48’ E	375
Ar Raddas Station, Mujib Reserve	Karak	31° 26’ N, 35° 34’ E	–170
Ar Rajif, Jebel Masuda, Ain Amshit	Ma’an	30° 12’ N, 35° 23’ E	645
Ar Ramtha	Irbid	32° 34’ N, 36° 01’ E	515
Ar Ramtha, campus of the Jordan University of Science and Technology	Irbid	32° 30’ N, 35° 59’ E	580
ʿArjan, cave above the village	Irbid	32° 25’ N, 35° 45’ E	795
ʿArjan, creek below the village	Irbid	32° 24’ N, 35° 44’ E	575
ʿArjan, RSCN camp	Irbid	32° 23’ N, 35° 46’ E	1030
As Salihiyyah, wadi below the village	Karak	31° 10’ N, 35° 42’ E	845
Ash Shawbak	Ma’an	30° 31’ N, 35° 35’ E	1320
Ash Shawbak, Ash Shawbak Castle	Ma’an	30° 32’ N, 35° 34’ E	1278 (castle entrance 1402)
Ash Shunah Al Janubiyya, Wadi Shu’ayb ca. 5 km to NE	ʿAmman	31° 56’ N, 35° 39’ E	–80
Ash Shunah Al Janubiyya, Wadi Shu’ayb ca. 7 km to NE	ʿAmman	31° 57’ N, 35° 41’ E	61
Azraq ... see Al Azraq			
Azraq ed Druz [= Al Azraq Al Shimali]			
Azraq ash Sheishan [= Al Azraq Al Janubi]			
Az Zara Springs	ʿAmman	31° 36’ N, 35° 34’ E	–352
Bait Idis, Jesus’ Cave	Irbid	32° 27’ N, 35° 41’ E	509

site	province	coordinates	altitude [m a. s. l.]
Baptism Site ... see Bethania			
Bethania, Baptism Site	Balqa’	31° 50’ N, 35° 33’ E	–360
Burqa [= Qasr Burqu]			
Dayr ʿAlla	Balqa’	32° 12’ N, 35° 37’ E	–223
Dhana, watering place ca. 1 km E of the Rummana Camp	Tafila	30° 41’ N, 35° 35’ E	1177
Dhana, watering place at the Rummana Camp	Tafila	30° 41’ N, 35° 34’ E	1155
Dhana, sandstone caves ca. 2 km E of the Rummana Camp	Tafila	30° 41’ N, 35° 35’ E	1235
Dhana, small sandstone cave in the Rummana hill	Tafila	30° 41’ N, 35° 34’ E	1201
Dhana, village and village gardens	Tafila	30° 41’ N, 35° 37’ E	1224
Dhana, Wadi Dhana, Mahjub cave	Tafila	30° 39’ N, 35° 33’ E	510
Dhana, Wadi Dhana, rocks ca. 5 NE of Feynan Ecolodge	Tafila	30° 39’ N, 35° 32’ E	525
Dibbin, agricultural station ... see Dibbin, Dibbin Forest			
Dibbin, Dibbin Forest, system of underground spaces and corridors	Irbid	32° 14–15’ N, 35° 49–50’ E	625–790
Dibbine Forest Park ... see Dibbin, Dibbin Forest			
Dibbine National Park ... see Dibbin, Dibbin Forest			
Dibbine, Mugharet el Wardeh ... see Khashibah, ‘Al Wardeh Cave’ mine			
Dilagha, Jebel Masuda, a spring in the the Wadi Al Abiat	Ma’an	30° 07’ N, 35° 22’ E	974
Dir Deglah	Tafila	31° 40’ N, 35° 38’ E	425
Disa	Aqaba	29° 39’ N, 35° 31’ E	798
Duqra, Az Zarqa’ River valley 4 km to northwest	Mafraq	32° 10’ N, 36° 01’ E	425
Faidhat edh Dhahikiya	Zarqa’	[31° 35’ N, 37° 05’ E]	540
Ghadir Al-Qatawneh (Karak)	Karak	31° 13’ N, 35° 40’ E	479
Gharandal (Wadi Araba)	Aqaba	30° 05’ N, 35° 13’ E	285
Ghor As Safi, Lot’s Cave	Karak	31° 03’ N, 35° 30’ E	–262
Ghor es-Safi [Ghor As Safi], 2 km to east	Karak	31° 01’ N, 35° 30’ E	–250
Ghur As-Safi [Ghor As Safi]	Karak	31° 02’ N, 35° 29’ E	–370
Hammamat Borbatah ... see Wadi Al Hasa			
Iraq Al Amir, Wadi As Sir, artificial caves	ʿAmman	31° 55’ N, 35° 45’ E	515
Iraq Al Wahaj Cave ... see Kufranja			
Irbid, Dibbine National Forest ... see Dibbin, Dibbin Forest			
Irbid, Jerash, Jerash Refugee Camp ... see Jerash			
Jabal Al Bayda, sandstone rocks ca. 2 km to south	Ma’an	30° 23’ N, 35° 27’ E	1093
Jbeiha, Jordan University Campus	ʿAmman	32° 01’ N, 35° 52’ E	1003
Jerash, garden	Irbid	32° 17’ N, 35° 51’ E	756
Jerash, Roman ruins	Irbid	32° 17’ N, 35° 53’ E	580
Jesus’ Cave ... see Bait Idis			
Jordan Valley, Tabqat Fahl ... see Tabaqat Fahl			
Jufat Al Qafrayn, fishpond	Balqa’	31° 53’ N, 35° 37’ E	–235
Karak	Karak	31° 11’ N, 35° 42’ E	1013
Karak, Karak Castle	Karak	31° 11’ N, 35° 42’ E	995
Khashibah, ‘Al Wardeh Cave’ mine	Irbid	32° 13’ N, 35° 43’ E	665
Khirbat Sa’ad, near Nadira	Irbid	32° 20’ N, 35° 39’ E	550
Khirbet Feynan ... see Al Qurayqira			
Kufranja, Iraq Al Wahaj Cave	Irbid	32° 19’ N, 35° 43’ E	741
Ma’an	Ma’an	30° 12’ N, 35° 44’ E	1115
Madaba	ʿAmman	31° 43’ N, 35° 48’ E	770
Mahna, Umm Al Iraq Cave	Irbid	32° 22’ N, 35° 45’ E	914
Majdal	Irbid	32° 14’ N, 35° 51’ E	514
Malka, spring below the village	Irbid	32° 40’ N, 35° 45’ E	340
Malka, quarry below the village	Irbid	32° 39’ N, 35° 45’ E	450
Malka, Wadi Al Kurasi	Irbid	32° 41’ N, 35° 43’ E	131
Marj Al Hammam	Irbid	32° 23’ N, 35° 49’ E	1078
Mukawir, Palace of Machaerus ruins	ʿAmman	31° 34’ N, 35° 38’ E	1201
Mu’ta	Karak	31° 05’ N, 35° 42’ E	1150
Nahla, spring in the village	Irbid	32° 17’ N, 35° 51’ E	728

site	province	coordinates	altitude [m a. s. l.]
near the Dead Sea, between South Shounah and Swymah [= Ash Shunah Al Janubiyya and As Suwayma]	Balqa’	[31° 50’ N, 35° 36’ E]	–305
Petra ... see Al Batra			
Qasr Azraq ... see Al Azraq Al Shimali, Qasr Azraq			
Qasr Burqu, ancient fortress ruins	Mafraq	32° 37’ N, 37° 58’ E	651
Qasr Kharana, ancient caravanserai	ʿAmman	31° 44’ N, 36° 28’ E	656
Quseir Amra, ancient bath	ʿAmman	31° 48’ N, 36° 35’ E	570
Qurayqira ... see Al Qurayqira			
Quaraiquira ... see Al Qurayqira			
Quwaylibah	Irbid	32° 40’ N, 35° 48’ E	460
Ras’ an Naqb	Ma’an	30° 00’ N, 35° 29’ E	1546
Rashah, Mujib Reserve	Karak	31° 25’ N, 35° 40’ E	275
Rummana ... see Dhana			
Shawmari Wildlife Reserve, wildlife watering place	Zarqa’	31° 45’ N, 36° 46’ E	520
Shishan [= Al Azraq Al Janubi], house	Zarqa’	31° 50’ N, 36° 49’ E	515
Suelleh [= Suwaylih]			
Suwaylih	ʿAmman	32° 01’ N, 35° 51’ E	1020
Tabaqat Fahl, Roman nekropolis of Pella	Irbid	32° 27’ N, 35° 37’ E	–8
Tabqat Fahl ... see Tabaqat Fahl			
Tall Numiera, water pools	Karak	31° 08’ N, 35° 32’ E	–345
Umm Qais	Irbid	32° 39’ N, 35° 41’ E	350
Umm Qais, Mgharet Issa Cave	Irbid	32° 39’ N, 35° 41’ E	350
Wadi Abu Al ʿAsal	ʿAmman	31° 39’ N, 35° 35’ E	–326
Wadi Abu Khushabeh (Zgara)	ʿAmman	31° 35’ N, 35° 34’ E	–60
Wadi Al Abiat ... see Dilagha			
Wadi Dharih, small cave	Tafila	30° 58’ N, 35° 42’ E	392
Wadi Al Hasa, wadi ca. 1 km E of Hammamat Borbatah	Tafila	30° 59’ N, 35° 41’ E	287
Wadi As Sir ... see Iraq Al Amir			
Wadi Al Wala ... see An Nuzha			
Wadi Faynan ... Al Qurayqira , Wadi Faynan			
Wadi Fidan ... Al Qurayqira, Wadi Fidan			
Wadi Finan ... Al Qurayqira, Wadi Faynan			
Wadi Ghuweir ... see Al Qurayqira			
Wadi Ben Hammad [= Wadi Ibn Hammat]			
Wadi Ibn Hamad [= Wadi Ibn Hammat]			
Wadi Ibn Hammat, rocky canyon	Karak	31° 18’ N, 35° 40’ E	360
Wadi Khalid ... see Al Qurayqira, Wadi Khalid			
Wadi Khanzaireh (Wadi Araba)	Tafila	30° 52’ N, 35° 27’ E	–250
Wadi Mujib, siq estuary	ʿAmman	31° 28’ N, 35° 34’ E	–385
Wadi Musa (ca. 15 km N of Petra [= Al Batra]), Al Bayda Wastewater Treatment Station	Ma’an	30° 24’ N, 35° 27’ E	1038
Wadi Rum, Lawrence’s Pool	Aqaba	29° 34’ N, 35° 25’ E	1053
Wadi Rum, bedouin camp 1 km to east	Aqaba	29° 35’ N, 35° 26’ E	972
Wadi Shegaig, Mujib Reserve	Karak	31° 23’ N, 35° 38’ E	330
Wadi Weida’a, estuary	Karak	31° 15’ N, 35° 35’ E	–12
Wadi Zarqa Ma’in	ʿAmman	31° 36’ N, 35° 35’ E	–30
Zarqa’ River	–	31° 58’ – 32° 14’ N, 35° 31’ – 36° 07’ E	–
Zarqa’ Valley, above the King’s Tallal Dam	Irbid	32° 12’ N, 35° 51’ E	168
Zerka-Fluß [= Zarqa’ River]			
Zubiya, Zubiya Cave	Irbid	32° 26’ N, 35° 45’ E	812
Zubiya forest ... see Zubiya, Zubiya Cave			

APPENDIX II

List of the comparative material examined

Rousettus aegyptiacus (Geoffroy, 1810)

Cyprus: 1 m (NMP 90435 [S+A]), Androlikou Gorge, 2 km SW Prodromi, 20 April 2005, leg. P. Benda & V. Hanák; – 1 ind. (NMP 90399 [S]), Akamas, Baths of Aphrodite, 10 April 2005, leg. P. Benda & V. Hanák; – 1 m (NMP 91274 [S+A]), Akamas, Smigies Trail, Magnesia Mine, 27 March 2005, leg. I. Horáček, P. Hulva & R. Lučan. – **Egypt (Sinai)**: 1 m, 1 f (NMP 90527, 90528 [S+A]), Ain El Furtaga, 16 September 2005, leg. M. Andreas, P. Benda, J. Hotový & R. Lučan; – 1 m (NMP 90520 [S+A]), Ain Hudra, 14 September 2005, leg. M. Andreas, P. Benda, J. Hotový & R. Lučan; – 5 m, 6 f (NMP 90501, 90510 [Sk], 90502–90509, 90511 [S+A]), Feiran, 10 September 2005, leg. M. Andreas, P. Benda, J. Hotový & R. Lučan. – **Lebanon**: 1 m (AUB M021 [S]), Antelias, 19 March 1960, leg. J. E. Stencel; – 1 m, 1 f (NMP 91799, 91910 [S+A]), Antelias, Kassarat Cave, 25 January 2007, 25 January 2008, leg. P. Benda, R. Černý, I. Horáček, R. Lučan & M. Uhrin; – 1 f (AUB M006 [S]), cave 4 km SE of Beit Meri, 4 October 1959, leg. R. E. Lewis; – 1 m, 1 f (NMP 91904, 91905 [S+A]), Dahr el Mghara, Mgharet el Aaonamie Cave, 19 January 2008, leg. P. Benda, I. Horáček, R. Lučan & M. Uhrin; – 2 f (NMP 93697, 93699 [S+A]), Jeita Cave, 20 March 2009, leg. T. Bartonička, P. Benda & I. Horáček; – 2 m, 1 f (NMP 91765, 91766, 91899 [S+A]), Tarabulus, Mtal al Azraq Cave, 21 January 2007, 18 January 2008, leg. P. Benda, R. Černý, I. Horáček, R. Lučan & M. Uhrin. – **Syria**: 1 m, 1 f (NMP 48865, 48866 [S+A]), Talsh'hab, 25 May 2001, leg. M. Andreas, P. Benda, A. Reiter & D. Weinfurtová; – 1 m, 1 f (NMP 48264, 48265 [S+A]), Ya'ar Oden forest (Golan Heights), 18 July 1999, leg. P. Benda. – **Turkey**: 1 m (ZFMK 65.205 [S+B]), Dermustlu Köy, Höhle bei Antakya, 2 January 1952, leg. H. Kumerloeve.

Myotis nattereri (Kuhl, 1817)

Cyprus: 1 f (NMP 90418 [S+A]), Lefke, 15 April 2005, leg. P. Benda & V. Hanák; – 2 f (NMP 90429, 90430 [S+A]), Inçirli Cave, Çınarlı, 6 April 2005, leg. P. Benda, V. Hanák & I. Horáček. – **Israel**: 2 f (TAU 6106, 6107 [S+B]), Dor, glass factory, 24 April 1976, collector unlisted. – **Lebanon**: 1 m, 1 f (CUP LE76 [A], LE79 [S+A]), Aamchit, Saleh Cave, 25 June 2006, leg. I. Horáček, P. Hulva, R. Lučan & P. Němec; – 1 m (NMP 93556 [S+A]), Aanjar, 5 June 2010, leg. P. Benda & M. Uhrin; – 1 m (NMP 93558 [S+A]), Arnoun, Beaufort Castle, 6 June 2010, leg. P. Benda & M. Uhrin; – 1 f (CUP LE83 [A]), El Aaqoura, Er Rouais Cave, 26 June 2006, leg. I. Horáček, P. Hulva, R. Lučan & P. Němec; – 1 f (CUP LE49 [S+A]), El Fidar, 24 June 2006, leg. I. Horáček, P. Hulva, R. Lučan & P. Němec; – 1 m, 1 f (NMP 93525, 93526 [S+A]), Frat, Nahr Ibrahim, 29 May 2010, leg. P. Benda & M. Uhrin; – 1 m (NMP 93571 [A]), Jenta, 8 June 2010, leg. P. Benda & M. Uhrin; – 1 m (CUP LE37 [A]), Jezzine, Pont el Khalass, 23 June 2006, leg. I. Horáček, P. Hulva, R. Lučan & P. Němec. – **Syria**: 1 m, 5 fa (NMP 48910, 48911 [S+A], 48912 [S+B], 48909, 48913, 48914 [A]), Qala'at al Marqab, 1 June 2001, leg. M. Andreas, A. Reiter & D. Weinfurtová; – 3 f (NMP 90284–90286 [S+A]), Qala'at Salah ad Din, 13 October 2004, leg. R. Lučan; – 1 m (NMP 48870 [S+A]), Sarghaya, 28 May 2001, leg. M. Andreas, P. Benda, A. Reiter & D. Weinfurtová; – 1 m (NMP 48860 [S+A]), Talsh'hab, 25 May 2001, leg. M. Andreas, P. Benda, A. Reiter & D. Weinfurtová; – 3 m (NMP 48049–48051 [S+A]), Yabroud, 26 June 1998, leg. M. Andreas, P. Benda & M. Uhrin. – **Turkey**: 1 m (WIC 75/1 [S]), Alanya, 1975, leg. W. Issel; – 1 m, 9 f (SMF 36755, 36756, 36758–36762, 36769–36771 [S+B]), Incekum nr. Alanya, 21 May 1966, leg. H. Felten et al.; – 1 f (NMP 47924 [S+A]), Narlikuyu, Cennet Cave, 4 August 1992, leg. P. Benda; – 1 f (NMP 47916 [S+A]), Silifke, castle, 1 August 1992, leg. P. Benda; – 2 m (CUP T93/76, T93/77 [S+A]), Yalan Dünya Cave, 30 October 1993, leg. P. Benda & I. Horáček.

Plecotus christii Gray, 1838

Egypt: 1 m (NMP 90523 [S+A]), Ain Hudra, Sinai, 15 September 2005, leg. M. Andreas, P. Benda, J. Hotový & R. Lučan; – 1 f (NMP 90533 [S+A]), Ain Sudr, Sinai, 18 September 2005, leg. M. Andreas, P. Benda, J. Hotový & R. Lučan; – 2 m (NMP 92576, 92577 [S+A]), Al Qasr, Dakhla Oasis, 21 January 2010, leg. P. Benda, R. Lučan & I. Horáček; – 1 m (NMP 90119 [S+B]), Bir Kohila, Qattar Mts, 30 May 1984, leg. D. Osborn; – 1 m (NMP 90118 [S+B]), Bir Nagat, Qattar Mts, 4 June 1984, leg. D. Osborn; – 1 m (MSNG 54781 [A]), Dintoroli di Cairo, Egitto, 15 July 1906, leg. F. W. Innes Bey; – 1 ind. (MZUF 247 [S]), Egitto, 1843, collector unlisted; – 1 f (NMP 90497 [S+A]), El Milga, Sinai, 9 September 2005, leg. M. Andreas, P. Benda, J. Hotový & R. Lučan; – 1 m, 1 f (NMP 90519 [S+A], 90518 [A]), El Tur, Hammam Musa, Sinai, 10 and 11 September 2005, leg. M. Andreas, P. Benda, J. Hotový & R. Lučan; – 1 m, 1 f (NMP 90496, 90499 [S+A], incl. holotype of *Plecotus christii petraeus* Benda, 2008), Feiran, Sinai, 8 and 9 September 2005, leg. M. Andreas, P. Benda, J. Hotový & R. Lučan; – 1 m (NMP 93849 [S+A]), Hindaw, Dakhla Oasis, 6 December 2010, leg. R. Lučan; – 1 m (MSNG 45050 [S+A]), Luxor (Thebes), Egitto, 28 February 1882, leg. B. Chiappa; – 1 ind. (BMNH 66a [B], lectotype of *Plecotus christii* Gray, 1838), North Africa [= Nile Valley between Qena and Aswan; Qumsiyeh 1985], leg. T. Christie; – 1 m (BMNH 92.9.9.18 [S+A]), Pyramids of Giza, leg. J. Anderson, date unlisted; – 1 f (BMNH 1936.2.10.18. [S]), Siwa Oasis, leg. O. Cooper, date unlisted; – 1 m (IVB 100 [S+B]), Thebes, Valley of the Kings, 30

April 1969, leg. J. Gaisler; – 1 f (BMNH 3.12.8.5. [S+A]), Tor, Sinai, leg. J. Anderson, date unlisted; – 1 m (TAU M.7160 [S+B]), Um Hashiba, Sinai, 1 December 1977, collector unlisted. – **Israel**: 1 f (TAU M.7541 [S+B]), Amudai Amram, nr. Elat, 19 February 1981, collector unlisted; – 1 m (TAU M.6863 [S+B]), Avdat, 17 May 1976, collector unlisted; – 1 f, 1 ind. (TAU M.771, M.1343 [S+B]), Elat, resp. Eilath, 2 March 1951, 27 September 1954, collectors unlisted; – 1 f (TAU M.8455 [S+B]), 20 km N of Elat, 17 November 1988, collector unlisted; – 1 ind. (TAU M.9364 [S+mummy]), NE of Elat, 14 May 1995, collector unlisted; – 1 m, 1 f (TAU M.8583, M.8584 [S+B]), Neot HaKikar, 2 May and 14 June 1989, collectors unlisted. – **Libya**: 1 m, 1 f (NMP 49862, 49863 [S+A]), Al Jaghbub, 13 May 2002, leg. M. Andreas, P. Benda, V. Hanák, A. Reiter & M. Uhrin; – 3 m, 1 f (MSNG 26219a, b, 26220a, b [S+B]), Giarabub (Cirenaica), 7 and 10 December 1926, 17 March 1927, leg. C. Confalonieri; – 1 m (MSNG 47016 [S+A]), Oasi di Giarabub, Cirenaica, March 1926, leg. G. Krüger. – **Sudan**: 1 ind. (BMNH 49.2.8.35. [B]), Fifth Cataract of the Nile, leg. F. Galton, date unlisted. – 1 f (NMP 93679 [S+A]), Ferka, 10 December 2010, leg. P. Benda & J. Šmíd.

APPENDIX III

Biometric data on the bats from Jordan

Basic external and cranial measurements of the examined bat individuals recorded in Sinai (pp. 345–353). For collection acronyms and measurement abbreviations see pp. 192, 193. Arranged in numerical and alphabetical orders, according to collection number.

coll. No.	site	sex	age	G	LC	LCd	LAt	LA	LT	LCr	LCb/c	LaZ	LaI	LaN	AN	CC	M^3M^3	$CM^{2/3}$	LMd	ACo	CM_3
Rousettus aegyptiacus																					
NMP 47975	Tabaqat Fahl	f	j	79.0	120	15	82.1	21.4	–	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92362	Iraq Al Amir	f	a	119.0	136	19	93.6	21.8	–	41.92	40.64	25.07	7.87	16.45	12.45	8.68	12.44	15.68	32.68	14.16	17.31
NMP 92411	Iraq Al Amir	m	a	124.0	148	19	94.6	21.7	–	44.82	42.84	26.61	8.39	17.71	12.77	9.02	13.12	16.76	34.37	16.24	18.45
NMP 92430	Wadi Dhana	m	a	128.0	146	25	91.8	22.0	–	43.49	41.89	26.87	8.19	17.32	13.83	8.93	13.08	17.07	33.52	15.97	18.85
NMP 92431	Wadi Dhana	f	a	103.0	131	18	88.9	21.7	–	40.88	39.44	24.89	8.48	16.57	12.97	8.15	12.98	15.31	31.25	15.17	16.85
NMP 92432	Wadi Dhana	m	j	35.5	92	11	62.6	15.8	–	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92433	Wadi Dhana	f	G	109.0	138	19	93.3	22.3	–	42.35	40.36	25.76	8.23	17.33	12.98	7.72	12.16	15.98	32.96	14.08	17.22
NMP 92434	Wadi Dhana	f	a	96.5	132	15	88.7	20.1	–	40.24	38.67	25.23	8.06	16.41	12.62	8.44	12.52	16.13	30.75	14.31	17.38
NMP 92435	Wadi Dhana	m	j	34.3	90	14	32.9	16.5	–	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92436	Wadi Dhana	f	a	107.0	143	17	95.0	19.5	–	43.39	41.60	25.76	9.17	16.85	14.57	8.55	12.31	16.13	33.26	16.50	17.71
NMP 92437	Wadi Dhana	f	j	28.0	82	12	59.8	15.5	–	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92438	Wadi Dhana	f	a	97.8	137	19	87.9	22.1	–	41.32	39.93	25.36	8.42	16.54	12.73	7.78	12.11	15.41	31.56	14.97	16.70
NMP 92439	Wadi Dhana	f	j	31.2	85	12	58.7	15.4	–	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92440	Wadi Dhana	f	a	101.0	133	15	86.4	22.1	–	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92441	Wadi Dhana	m	j	30.8	84	12	58.3	14.8	–	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92442	Wadi Dhana	f	a	104.0	137	17	92.3	21.2	–	41.83	39.85	26.18	7.83	17.12	13.56	8.42	12.55	15.76	32.34	15.81	14.98
NMP 92443	Wadi Dhana	f	j	31.9	85	13	61.8	15.3	–	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92558	Iraq Al Wahaj	m	a	139.0	153	18	96.5	23.3	–	44.14	42.82	26.72	8.34	17.18	13.34	8.91	12.92	16.66	34.31	16.56	18.09
Rhinopoma microphyllum																					
NMP 47965	Tabaqat Fahl	f	a	29.7	88	68	68.6	22.5	7.3	21.07	19.16	12.79	2.75	9.05	8.13	5.91	9.68	7.57	15.02	5.96	8.20
Rhinopoma cystops																					
NMP 47966	Tabaqat Fahl	m	s	11.3	64	63	57.0	22.7	6.1	17.92	15.86	10.23	2.55	7.43	5.69	4.30	8.09	6.02	12.20	4.75	6.50
NMP 47967	Tabaqat Fahl	m	s	10.8	64	70	54.1	19.2	7.0	17.77	15.45	10.36	2.40	7.32	5.71	4.34	8.12	6.08	12.02	4.63	6.48
NMP 47968	Tabaqat Fahl	m	s	11.2	65	62	54.4	21.4	6.8	17.88	15.72	10.45	2.58	7.53	5.63	4.35	8.13	6.10	12.28	4.53	6.69
NMP 47969	Tabaqat Fahl	m	s	13.5	65	70	58.1	19.3	6.5	18.10		10.52	2.22	7.62	5.86	4.45	8.16	6.27	12.42	5.06	6.55
NMP 47970	Tabaqat Fahl	m	s	12.1	65	77	60.5	22.1	6.6	18.18	15.87	10.43	2.52	7.67	5.61	4.36	8.05	6.17	12.35	4.89	6.68
NMP 47971	Tabaqat Fahl	m	s	12.1	62	72	57.7	20.4	6.3	17.94	15.77	10.85	2.51	7.77	5.79	4.47	8.31	5.92	12.27	4.68	6.42
NMP 47972	Tabaqat Fahl	m	s	13.2	65	67	57.2	21.6	6.5	17.81	15.62	10.09	2.55	7.44	5.95	4.27	8.09	6.03	12.18	4.92	6.50
NMP 47973	Tabaqat Fahl	m	s	11.5	66	65	56.8	20.9	5.3	18.43	16.18	10.05	2.45	7.37	5.65	4.12	7.67	6.15	12.43	4.67	6.41
NMP 47974	Tabaqat Fahl	m	s	12.2	72	69	59.5	20.4	6.8	18.78	16.42	10.47	2.44	7.65	5.98	4.42	8.24	6.37	12.52	4.75	6.66
NMP 92363	Iraq Al Amir	m	a	12.0	63	73	56.3	20.1	7.7	18.05	15.86	10.49	2.40	7.73	5.87	4.26	7.96	6.13	12.21	4.61	6.69
NMP 92381	Ghor As Safi	f	s	11.1	70	70	57.8	21.5	7.5	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92382	Ghor As Safi	f	s	7.9	56	62	51.5	20.7	7.4	17.35	15.39	9.87	2.58	7.16	5.18	3.94	7.78	5.93	11.64	4.29	6.37
NMP 92383	Ghor As Safi	m	s/a	11.3	64	72	58.5	20.8	7.5	17.72	15.74	10.28	2.47	7.32	5.62	4.14	8.03	6.03	12.02	4.62	6.41
NMP 92415	Wadi Weida'a	f	s	8.9	62	66	55.0	20.4	6.9	17.42	15.58	9.97	2.63	7.43	5.57	4.31	7.98	6.02	11.83	4.43	6.45
NMP 92416	Wadi Weida'a	m	a	10.5	64	69	56.4	21.0	7.7	18.12	15.88	10.04	2.32	7.62	5.44	4.41	7.61	6.06	12.18	4.69	6.47
NMP 92417	Wadi Weida'a	m	a	10.1	67	69	58.0	22.8	7.8	18.51	16.11	–	2.51	7.59	5.80	4.46	8.33	6.27	12.28	4.66	6.63
NMP 92418	Wadi Weida'a	m	a	10.5	66	71	57.6	20.8	7.9	17.98	15.88	10.57	2.58	7.75	5.73	4.22	7.84	6.01	12.43	4.87	6.38

coll. No.	site	sex	age	G	LC	LCd	LAt	LA	LT	LCr	LCc	LaZ	LaI	LaN	AN	CC	M^3M^3	CM^3	LMd	ACo	CM_3
Rhinopoma cystops																					
NMP 92419	Wadi Weida'a	m	a	10.4	66	69	58.2	21.5	7.2	18.27	16.19	10.24	2.59	7.74	5.68	4.51	8.14	6.19	12.44	4.68	6.52
NMP 92420	Wadi Weida'a	m	a	10.2	66	–	54.8	20.2	7.4	18.13	16.14	10.42	2.63	7.71	5.51	4.38	8.06	6.17	12.43	4.86	6.67
NMP 92421	Wadi Weida'a	f	s	8.9	63	63	55.7	21.7	7.3	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92422	Wadi Weida'a	m	s	8.3	64	63	55.5	21.7	7.1	17.31	15.32	9.93	2.61	7.29	5.64	4.29	7.93	5.98	11.92	4.39	6.54
NMP 92423	Wadi Weida'a	f	a	8.6	60	65	56.5	21.1	7.3	17.86	15.89	10.27	2.38	7.44	5.56	4.44	8.12	5.02	12.31	4.68	6.49
NMP 92424	Wadi Weida'a	m	a	9.6	67	71	57.0	21.2	7.7	18.17	16.01	10.33	2.38	7.59	5.69	4.52	8.09	6.19	12.33	4.43	6.63
NMP 92444	Wadi Dhana	f	G	11.0	61	62	57.0	19.6	7.9	17.53	15.42	10.21	2.47	7.28	5.33	4.35	7.91	5.97	11.75	4.59	6.41
NMP 92445	Wadi Dhana	f	s	8.6	59	63	52.5	20.8	8.5	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92446	Wadi Dhana	f	G	9.6	60	61	55.9	19.9	7.4	17.47	15.39	10.27	2.34	7.69	5.45	4.42	8.17	5.96	11.68	4.35	6.42
NMP 92463	Aqaba	f	a	10.6	62	69	56.7	21.5	7.3	17.94	15.81	10.14	2.46	7.28	5.41	4.25	8.02	6.26	12.11	4.44	6.38
NMP 92464	Aqaba	f	a	9.7	62	64	55.7	20.5	8.1	17.50	15.38	9.74	2.39	7.16	5.46	4.23	7.68	5.88	11.72	4.67	6.32
NMP 92465	Aqaba	f	s/a	9.2	62	75	56.1	20.1	8.3	18.21	15.99	10.39	2.44	7.47	5.34	4.56	8.07	6.18	12.33	4.64	6.63
NMP 92502	Wadi Shu'ayb	f	s	9.7	63	64	57.7	21.8	8.1	17.69	15.49	10.27	2.38	7.42	5.46	4.28	8.17	6.04	11.92	4.63	6.37
NMP 92503	Wadi Shu'ayb	f	s/j	8.1	62	65	53.4	21.4	8.2	–	–	–	–	–	–	–	–	–	–	–	–
JUST –	Al Majdal	f	s	–	–	–	59.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JUST –	Al Majdal	m	–	–	–	–	58.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JUST –	Al Majdal	m	–	–	–	–	59.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JUST –	Baptism Site	f	a	–	–	–	55.9	–	–	–	15.63	–	–	–	–	–	–	–	–	–	–
JUST –	Wadi Araba	m	s	–	–	–	52.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Taphozous perforatus																					
NMP 92094	Az Zara Springs	m	a	–	–	–	64.0	–	–	–	19.33	11.76	5.48	9.45	7.42	3.66	8.22	8.73	14.90	5.33	9.53
RSCN –	Mujib Reserve	m	a	–	–	–	63.7	–	–	–	19.41	11.68	5.62	9.36	7.19	3.82	8.23	8.71	15.08	5.56	9.68
Nycteris thebaica																					
NMP 92805	Wadi Al Hasa	f	L	9.9	59	55	46.2	36.6	9.5	19.75	17.77	11.43	4.82	8.35	6.73	4.88	7.46	7.15	12.69	3.97	7.26
NMP 92806	Wadi Al Hasa	f	j	6.7	51	47	42.4	31.5	8.6	–	–	–	–	–	–	–	–	–	–	–	–
RSCN –	Ar Raddas	f	a	–	–	–	45.8	–	–	19.14	16.88	10.58	4.64	8.14	6.54	4.51	6.88	6.76	12.13	3.69	7.15
RSCN –	Ar Raddas	m	a	–	–	–	44.1	–	–	19.38	17.29	11.11	4.59	8.22	6.65	4.63	7.05	6.82	12.42	3.87	7.22
RSCN –	Ar Raddas	f	a	–	–	–	46.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Rhinolophus ferrumequinum																					
NMP 92403	Zubiya Cave	m	s	17.2	71	33	55.4	27.0	9.5	24.43	21.16	12.27	2.43	9.48	6.95	6.74	8.63	8.91	16.02	4.14	9.70
NMP 92404	Zubiya Cave	f	a	19.5	76	47	61.1	26.3	9.4	24.98	22.01	12.63	2.18	9.52	7.39	7.17	9.16	9.24	16.67	4.34	9.84
NMP 92405	Zubiya Cave	f	s	17.7	70	40	57.4	25.6	9.1	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92408	Dibbin Forest	m	a	17.5	76	39	57.1	25.4	9.4	24.38	21.20	12.29	2.36	9.66	6.86	6.86	8.64	8.98	16.31	4.24	9.76
NMP 92504	Tabaqat Fahl	f	a	17.7	72	42	58.0	24.6	9.4	24.66	21.38	12.81	2.49	9.94	7.76	6.91	9.17	9.11	16.45	4.08	9.89
NMP 92505	Tabaqat Fahl	–	j	–	–	–	25.4	14.6	6.5	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92506	Zubiya Cave	m	a	18.0	74	42	58.8	25.0	9.1	24.75	21.39	12.73	2.49	9.65	7.31	7.36	9.21	8.91	16.48	4.37	9.67
NMP 92507	Zubiya Cave	m	s/a	17.2	75	40	58.1	26.1	9.1	24.28	21.49	12.69	2.41	9.62	7.76	7.04	9.98	9.20	16.48	4.41	9.91
NMP 92562	Milka	m	a	16.5	74	37	56.4	27.4	9.1	23.88	20.53	12.41	2.65	9.44	7.54	6.52	8.54	8.62	16.04	4.18	9.30

coll. No.	site	sex	age	G	LC	LCd	LAt	LA	LT	LCr	LCc	LaZ	LaI	LaN	AN	CC	M^3M^3	CM^3	LMd	ACo	CM_3
Rhinolophus ferrumequinum																					
JUST –	Dibbin Forest	f	a	–	–	–	56.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JUST –	Dibbin Forest	m	a	–	–	–	57.7	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JUST –	Dibbin Forest	m	a	–	–	–	57.9	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JUST ZSA38	Quilbh	–	a	–	–	–	56.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Rhinolophus clivosus																					
NMP 92425	Wadi Ghuweir	m	a	7.6	56	29	49.3	24.6	8.7	21.14	18.04	10.26	2.48	8.38	6.39	5.52	7.54	7.48	13.49	3.57	8.13
NMP 92447	Ain Amshit	m	s	7.6	53	37	46.7	22.0	8.0	20.42	17.41	9.65	2.08	8.14	5.86	5.23	7.18	7.26	13.08	3.18	7.81
NMP 92495	Jabal Al Bayda	f	G	13.4	64	31	49.8	23.6	8.6	21.33	17.98	10.16	2.26	8.26	6.34	5.37	7.65	7.44	13.56	3.31	7.93
NMP 92496	Jabal Al Bayda	f	s	10.2	63	34	49.9	22.3	8.3	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92810	Wadi Al Dharih	f	j	7.7	59	36	49.1	21.3	7.9	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92811	Wadi Al Dharih	m	j	7.3	59	31	49.1	23.6	7.9	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92843	Al Batra	m	a	–	–	–	47.4	–	–	–	–	–	2.54	–	–	–	7.37	–	13.07	3.28	–
Rhinolophus hipposideros																					
NMP 92409	Dibbin Forest	f	a	4.5	47	30	37.6	17.9	7.4	–	13.58	7.53	1.54	6.37	4.61	3.54	5.48	5.22	9.61	2.16	5.51
NMP 92410	Dibbin Forest	f	a	4.5	46	28	36.9	18.0	7.1	16.21	13.67	7.63	1.59	6.43	4.93	3.64	5.48	5.42	9.55	2.15	5.57
NMP 92508	Zubiya Cave	m	s/a	3.8	45	27	36.4	18.4	7.2	16.11	13.61	7.34	1.43	6.28	4.68	3.58	5.38	5.36	9.67	1.93	5.52
NMP 92509	Zubiya Cave	f	G	5.9	48	30	37.9	17.6	7.1	–	13.67	7.33	1.58	6.59	4.62	3.45	5.36	5.39	9.75	2.18	5.49
NMP 92510	Zubiya Cave	f	G	5.5	43	26	37.5	17.4	6.9	–	13.42	7.29	1.49	6.46	4.71	3.48	5.28	4.98	9.40	2.02	5.36
NMP 92842	Bait Idis	–	–	–	–	–	35.6	–	–	–	13.24	7.16	1.37	6.16	4.71	3.54	5.10	5.04	9.24	1.83	5.24
JUST –	Dibbin Forest	m	a	–	–	–	36.9	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JUST –	Dibbin Forest	m	a	–	–	–	37.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JUST –	Dibbin Forest	m	a	–	–	–	38.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JUST –	Dibbin Forest	f	a	–	–	–	37.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Rhinolophus euryale																					
NMP 92406	Zubiya Cave	m	a	8.8	59	27	47.8	23.5	7.6	18.68	15.84	9.18	2.29	8.11	5.89	4.50	6.48	6.31	11.51	2.51	6.73
NMP 92407	Zubiya Cave	f	a	8.7	57	31	46.5	23.2	7.1	–	15.46	9.31	2.29	8.02	5.74	4.31	6.42	6.02	11.02	2.39	6.32
NMP 92511	Zubiya Cave	m	a	9.0	60	25	46.1	22.8	7.3	–	15.83	9.39	2.38	8.17	5.93	4.58	6.35	6.19	11.51	2.61	6.53
NMP 92512	Zubiya Cave	m	a	7.3	55	26	45.7	22.7	6.9	–	15.58	9.11	2.02	8.13	5.74	4.86	6.32	6.11	11.31	2.53	6.47
NMP 92513	Zubiya Cave	f	a	10.2	57	32	48.2	22.1	7.2	–	15.81	9.27	2.21	8.26	5.75	4.51	6.49	6.14	11.36	2.49	6.62
NMP 92514	Zubiya Cave	f	a	9.1	57	31	48.0	23.6	6.9	–	15.76	9.15	2.24	8.26	5.72	4.37	6.36	6.17	11.14	2.47	6.51
NMP 92515	Zubiya Cave	f	a	9.6	57	32	45.2	23.3	7.2	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92524	Al Wardeh	m	a	8.4	55	31	44.8	22.2	6.9	–	15.34	9.09	2.04	8.17	5.76	4.42	6.49	6.11	11.16	2.42	6.48
NMP 92525	Al Wardeh	f	a	9.7	57	30	44.7	21.9	7.2	–	15.51	9.09	2.34	8.20	5.88	4.38	6.42	6.02	11.11	2.47	6.41
NMP 92534	Iraq Al Wahaj	m	a	8.2	57	27	45.3	21.9	7.0	–	15.51	9.16	2.31	8.16	5.56	4.54	6.30	5.93	11.11	2.38	6.47
NMP 92535	Iraq Al Wahaj	m	a	9.4	56	26	44.8	22.1	7.4	–	15.81	9.28	2.19	7.98	5.81	4.56	6.58	6.28	11.22	2.48	6.58
NMP 92536	Iraq Al Wahaj	f	a	9.4	58	29	47.0	21.9	6.6	–	15.91	9.13	2.28	8.29	5.74	4.43	6.47	6.08	11.28	2.47	6.45
NMP 92537	Iraq Al Wahaj	f	a	9.3	59	31	44.3	22.7	6.8	–	15.81	9.38	2.25	8.17	5.79	4.49	6.58	6.20	11.34	2.55	6.51
NMP 92538	Iraq Al Wahaj	f	a	9.3	60	31	45.4	22.0	6.7	–	15.88	9.13	2.27	8.04	5.83	4.36	6.52	6.21	11.28	2.54	6.49

coll. No.	site	sex	age	G	LC	LCd	LAt	LA	LT	LCr	LCc/b	LaZ	LaI	LaN	AN	CC	M^3M^3	CM^3	LMd	ACo	CM_3
Rhinolophus euryale																					
NMP 92539	Iraq Al Wahaj	m	a	9.5	59	29	45.9	22.4	6.9	–	15.74	9.23	2.27	8.14	5.75	4.57	6.53	6.04	11.22	2.36	6.31
NMP 92540	Iraq Al Wahaj	f	a	8.6	56	25	45.5	21.2	6.4	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92834	Dibbin Forest	m	a	8.8	54	26	45.9	23.0	6.8	18.41	15.55	9.05	2.12	7.95	5.64	4.53	6.43	6.08	11.03	2.39	6.49
NMP 92835	Al Wardeh	m	a	7.8	54	31	45.8	22.5	7.4	18.48	15.68	9.34	2.25	8.07	5.87	4.45	6.22	6.03	11.18	2.45	6.50
JUST –	Dibbin Forest	f	a	–	–	–	46.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JUST –	Dibbin Forest	m	a	–	–	–	45.9	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Rhinolophus blasii																					
NMP 92387	Ash Shawbak	m	a	10.5	64	33	46.7	21.7	8.7	19.76	16.79	9.16	2.37	8.43	6.22	4.54	6.41	6.56	11.94	2.67	6.98
NMP 92388	Ash Shawbak	m	a	9.3	61	31	46.5	21.3	8.5	19.33	16.38	9.01	1.94	8.19	5.93	4.47	6.36	6.61	11.53	2.58	6.92
NMP 92389	Ash Shawbak	f	a	11.2	61	32	47.5	21.3	8.7	19.98	16.92	9.19	2.22	8.23	5.98	4.54	6.47	6.81	12.07	2.70	7.14
NMP 92390	Ash Shawbak	f	s	9.5	60	32	47.0	20.2	8.5	19.38	16.57	9.18	2.24	8.36	6.07	4.24	6.39	6.63	11.84	2.58	6.87
NMP 92391	Ash Shawbak	f	s	9.6	58	32	42.6	20.3	8.3	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92412	Iraq Al Amir	m	a	9.6	58	29	46.6	20.8	8.8	–	16.82	9.18	2.24	8.57	6.29	4.39	6.43	6.59	11.96	2.72	7.03
NMP 92429	Wadi Ghuweir		a	–	–	–	46.5	–	–	–	16.74	8.83	2.41	8.36	6.08	4.28	6.02	6.46	11.72	2.73	7.06
NMP 92516	Zubiya Cave	m	a	9.5	62	34	46.4	21.2	8.7	–	16.64	9.19	2.51	8.21	6.27	4.64	6.61	6.79	11.83	2.64	7.04
NMP 92517	Zubiya Cave	m	a	9.5	59	30	46.6	21.2	8.6	19.67	16.66	9.21	2.13	8.58	6.21	4.38	6.47	6.74	11.79	2.74	7.02
NMP 92518	Zubiya Cave	m	a	9.8	61	32	45.7	21.3	8.6	–	16.68	9.22	2.31	8.41	6.25	4.54	6.45	6.68	11.67	2.64	6.87
NMP 92526	Al Wardeh	f	a	11.8	61	31	46.7	21.9	8.6	–	17.21	9.08	2.38	8.45	6.23	4.42	6.44	6.76	12.14	2.87	7.18
NMP 92527	Al Wardeh	f	a	11.5	63	35	46.9	21.5	8.7	19.89	16.97	9.14	2.48	8.49	6.13	4.48	6.56	6.73	11.98	2.79	7.11
NMP 92541	Iraq al Wahaj	m	a	10.4	62	31	46.3	20.8	8.4	–	17.00	9.11	2.42	8.44	6.31	4.36	6.58	6.75	12.04	2.65	6.98
NMP 92542	Iraq al Wahaj	m	a	10.5	62	29	46.3	20.5	8.6	–	16.76	9.03	2.34	8.38	6.07	4.47	6.55	6.78	11.96	2.68	6.93
NMP 92543	Iraq al Wahaj	m	a	10.5	61	31	46.7	20.8	8.2	–	16.59	9.19	2.23	8.26	6.22	4.49	6.51	6.67	11.83	2.58	6.97
JUST –	Ash Shawbak	f	s	–	–	–	45.3	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JUST 296	Sol, Kerak	f	a	–	–	–	48.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Myotis blythii																					
NMP 92528	Al Wardeh	f	G	23.9	76	66	62.2	27.1	11.3	22.29	21.02	–	5.09	9.83	7.68	5.66	8.97	9.01	16.93	5.43	9.76
NMP 92529	Al Wardeh	m	a	24.0	79	64	57.8	25.7	10.6	22.07	21.00	14.36	5.22	9.96	7.73	5.85	9.12	9.39	17.08	5.45	10.03
NMP 92530	Al Wardeh	f	a	24.7	79	62	58.4	24.6	10.9	21.80	20.76	14.18	5.41	9.68	7.32	5.86	9.05	8.81	16.61	5.21	9.64
NMP 92531	Al Wardeh	f	j	10.5	59	33	37.0	16.0	6.5	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92544	Iraq Al Wahaj	m	a	27.1	77	63	59.7	24.9	10.1	22.09	21.12	14.21	5.47	9.97	7.84	6.13	9.43	9.46	16.97	5.51	10.09
NMP 92545	Iraq Al Wahaj	f	G	26.9	73	61	59.8	25.5	10.3	21.83	20.75	14.18	5.13	9.85	7.58	5.84	9.18	8.87	16.45	5.35	9.71
NMP 92546	Iraq Al Wahaj	f	a	21.4	73	59	57.3	25.8	10.2	20.93	19.92	13.24	5.09	9.54	7.71	5.48	8.41	8.65	15.79	5.04	9.18
NMP 92547	Iraq Al Wahaj	f	G	27.6	77	57	61.0	26.4	10.6	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92548	Iraq Al Wahaj	m	a	24.6	75	57	58.1	27.1	10.5	22.37	21.06	13.91	5.29	9.81	7.74	5.86	9.33	9.27	16.67	5.44	9.84
NMP 92549	Iraq Al Wahaj	m	a	21.9	71	56	57.5	25.3	9.9	21.85	20.76	13.68	5.24	9.82	7.76	5.83	9.03	9.13	16.46	5.04	9.78
NMP 92836	Al Wardeh	f	a	29.6	77	65	58.3	28.0	11.4	21.94	21.07	14.28	5.15	9.88	7.85	5.78	9.44	9.27	16.84	5.53	9.75
Myotis nattereri																					
NMP 92364	Iraq Al Amir	m	s/a	5.9	47	48	38.9	20.7	11.6	15.74	14.86	9.75	3.53	7.92	5.58	4.08	6.07	6.08	11.19	3.53	6.46

coll. No.	site	sex	age	G	LC	LCd	LAt	LA	LT	LCr	LCb	LaZ	LaI	LaN	AN	CC	M^3M^3	CM^3	LMd	ACo	CM_3
Myotis nattereri																					
NMP 92386	Dhana Reserve	f	a	6.4	47	53	41.4	21.2	10.2	15.74	14.64	9.89	3.58	7.81	5.75	3.90	6.18	6.10	11.38	3.57	6.46
NMP 92395	Ash Shawbak	m	a	5.1	48	51	39.6	19.4	11.0	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92396	Ash Shawbak	m	a	5.6	52	49	40.8	20.4	10.3	15.76	14.74	9.93	3.62	7.77	5.68	4.08	6.21	6.01	11.40	3.51	6.47
NMP 92397	Ash Shawbak	m	a	5.3	45	49	39.7	19.6	10.4	15.73	14.66	9.76	3.57	7.86	5.37	4.05	6.35	6.26	11.37	3.46	6.62
NMP 92398	Ash Shawbak	m	a	5.7	48	51	39.2	19.8	11.3	15.97	14.89	10.13	3.57	7.97	5.56	4.04	6.31	6.28	11.59	3.54	6.80
NMP 92399	Ash Shawbak	m	a	5.4	45	47	40.5	20.2	10.8	15.91	14.88	–	3.63	8.04	5.74	4.17	6.33	6.24	11.47	3.36	6.56
NMP 92400	Ash Shawbak	f	a	6.3	50	50	39.9	19.8	11.4	15.72	14.76	–	3.63	7.98	5.91	3.96	6.27	6.18	11.49	3.54	6.39
NMP 92401	Ash Shawbak	f	a	6.4	48	50	39.9	20.9	11.2	15.74	14.87	10.08	3.64	7.94	5.68	4.04	6.38	6.09	11.58	3.64	6.40
NMP 92402	Ash Shawbak	f	a	6.9	53	54	41.0	20.0	10.4	15.76	14.89	10.44	3.74	7.97	5.75	3.95	6.33	6.23	11.54	3.54	6.45
NMP 92413	Iraq Al Amir	m	a	5.9	51	49	40.4	20.1	10.3	15.97	14.98	9.88	3.83	7.76	5.94	4.05	6.31	6.27	11.38	3.52	6.45
NMP 92414	Iraq Al Amir	m	a	6.1	51	45	39.8	20.5	11.2	16.12	15.11	9.82	3.81	7.95	5.86	4.05	6.10	6.28	11.49	3.49	6.53
NMP 92500	Dhana Village	m	a	6.0	50	50	39.8	19.0	10.6			10.05	3.64	8.04		3.96	6.44	6.05	11.37	3.46	6.39
NMP 92519	Zubiya Cave	m	a	6.0	49	45	40.1	18.9	10.3	16.17	14.88	9.81	3.75	7.77	5.89	4.04	6.27	6.22	11.42	3.34	6.46
NMP 92550	Iraq Al Wahaj	f	a	7.1	48	45	40.4	20.0	9.9	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92551	Iraq Al Wahaj	f	a	7.8	52	46	41.1	20.4	10.6	15.84	14.94	10.31	3.73	7.87	5.91	4.21	6.49	6.31	11.37	3.61	6.63
NMP 92552	Iraq Al Wahaj	f	a	7.3	52	45	40.1	20.3	10.5	16.64	15.52	10.51	3.97	8.33	5.88	4.22	6.34	6.44	12.07	3.68	6.87
NMP 92553	Iraq Al Wahaj	m	a	6.1	51	44	39.8	19.8	10.3	15.62	14.58	9.74	3.52	7.56	5.62	3.91	6.09	6.05	11.04	3.31	6.37
JUST –	Dibbin Forest	m	a	–	–	–	39.9	–	–	–	–	–	–	–	–	–	–	–	–	–	–
RSCN –	Dibbin Forest	m	a	–	–	–	40.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Myotis emarginatus																					
NMP 92520	Zubiya Cave	f	a	8.4	51	49	41.1	19.0	9.9	16.17	15.25	9.87	3.59	7.28	5.75	4.25	6.38	6.63	12.19	3.66	7.07
NMP 92521	Zubiya Cave	f	a	7.6	49	46	39.8	18.7	9.6	15.79	14.89	9.61	3.77	7.52	5.60	4.07	6.01	6.47	11.56	3.51	6.82
NMP 92522	Zubiya Cave	f	G	9.1	52	47	40.3	19.0	8.6	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92523	ʿArjan	f	a	8.7	54	50	40.7	19.4	9.7	15.88	15.02	9.76	3.71	7.46	5.81	4.12	6.16	6.46	11.81	3.63	6.83
NMP 92554	Iraq Al Wahaj	f	a	8.0	54	46	39.4	19.0	9.1	16.17	15.17	9.64	3.48	7.33	5.92	4.12	6.36	6.54	11.76	3.73	6.85
NMP 92555	Iraq Al Wahaj	f	a	7.6	56	44	40.1	18.2	9.0	16.06	15.02	9.71	3.55	7.38	5.88	4.13	6.24	6.64	12.07	3.59	6.97
NMP 92556	Iraq Al Wahaj	f	G	10.5	53	47	40.2	18.0	8.8	15.68	14.75	9.79	3.94	7.28	5.83	4.02	6.26	6.42	11.76	3.54	6.74
NMP 92557	Iraq Al Wahaj	f	a	8.4	56	48	41.1	19.0	9.1	16.18	15.11	9.89	3.57	7.44	6.05	4.01	6.45	6.56	11.83	3.68	6.89
Eptesicus bottae																					
NMP 92098	Wadi Rum	m	s	–	–	–	42.4	–	–	16.16	16.01	10.62	3.55	7.57	5.52	5.11	7.29	5.86	11.44	4.21	6.47
NMP 92099	Wadi Rum	f	a	–	–	–	42.2	–	–	16.26	15.94	10.38	3.58	7.57	5.44	4.89	6.76	5.86	11.52	4.27	6.37
NMP 92100	Wadi Rum	f	a	–	–	–	44.0	–	–	16.17	15.92	10.57	3.42	7.48	5.52	4.96	7.08	5.87	11.43	3.94	6.36
NMP 92426	Wadi Ghuweir	f	G	9.7	63	53	43.4	18.9	7.4	16.38	16.22	10.82	3.52	7.51	5.79	5.21	6.93	5.82	11.96	4.22	6.48
NMP 92476	Al Ghal	m	a	9.0	60	55	42.4	18.3	7.1	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92477	Al Ghal	m	a	8.7	60	52	42.3	17.7	7.8	15.55	15.43	10.64	3.58	7.53	5.24	4.73	–	5.69	11.18	4.11	6.07
NMP 92478	Al Ghal	m	a	9.0	60	53	41.5	18.2	7.7	15.98	15.67	10.39	3.55	7.42	5.58	4.90	6.69	5.74	11.44	3.96	6.49
NMP 92479	Al Ghal	m	a	10.4	60	52	41.2	18.3	7.2	16.36	15.88	10.65	3.62	7.60	5.36	4.93	7.02	5.74	11.52	4.02	6.44
NMP 92480	Al Ghal	m	a	9.5	59	55	42.0	18.5	7.4	15.28	15.21	10.39	3.61	7.44	5.28	4.81	6.62	5.58	11.12	3.91	5.97

coll. No.	site	sex	age	G	LC	LCd	LAt	LA	LT	LCr	LCb	LaZ	LaI	LaN	AN	CC	M^3M^3	CM^3	LMd	ACo	CM_3
Eptesicus bottae																					
NMP 92481	Al Ghal	m	a	8.2	58	51	41.1	18.0	7.1	15.41	14.98	10.27	3.57	7.45	5.26	4.76	6.63	5.55	10.93	3.75	6.04
NMP 92482	Al Ghal	m	a	9.0	61	53	41.2	19.4	7.7	15.57	15.22	10.52	3.68	7.76	5.49	4.71	6.54	5.47	11.04	3.88	5.92
NMP 92483	Al Ghal	m	a	11.1	61	52	43.6	20.1	8.3	16.31	15.88	10.47	3.62	7.65	5.37	4.87	6.70	5.74	11.34	4.04	6.36
NMP 92484	Al Ghal	m	a	8.8	61	53	40.5	18.0	6.0	15.31	15.16	10.36	3.56	7.58	5.21	4.67	6.74	5.61	10.96	3.86	6.11
NMP 92485	Al Ghal	f	G	13.1	59	53	42.0	19.1	7.6	16.31	15.79	10.57	3.61	7.56	5.39	4.89	7.03	5.82	11.54	4.13	7.18
NMP 92486	Al Ghal	m	a	7.6	58	49	40.3	18.8	6.8	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92799	Wadi Weida'a	f	a	12.0	64	50	43.5	20.4	17.8	16.27	15.94	11.39	3.58	7.74	5.62	5.34	7.37	5.89	11.82	4.19	6.42
RSCN –	Mu'ta	f	a	–	–	–	42.1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
RSCN –	Rashah	f	a	–	–	–	45.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Hypsugo ariel																					
NMP 92095	Wadi Rum	m	s	–	–	–	29.3	–	–	11.21	10.67	7.02	2.74	5.54	4.02	3.35	4.63	3.82	7.46	2.30	4.10
NMP 92378	Tall Numiera	m	a	3.9	40	36	29.4	12.7	5.6	11.35	10.92	–	3.04	5.83	4.17	3.33	4.47	3.98	7.64	2.24	4.06
NMP 92380	Tall Numiera	f	s	2.4	37	38	30.4	13.4	4.4	11.18	10.71	7.01	2.66	5.68	3.79	3.37	4.69	3.91	7.55	2.33	3.99
NMP 92487	Al Ghal	m	a	2.7	39	39	30.6	12.8	4.6	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92488	Al Ghal	m	a	2.3	41		30.3	13.5	5.0	11.67	11.08	7.03	2.58	5.53	3.98	3.35	4.55	3.93	7.88	2.45	4.07
NMP 92489	Al Ghal	m	a	2.8	41	39	30.8	13.7	5.2	11.88	11.18	7.02	2.46	5.61	3.84	3.44	4.82	3.91	7.94	2.36	3.96
NMP 92490	Al Ghal	m	a	2.3	39	40	30.5	13.5	5.6	11.34	10.91	6.83	2.68	5.63	3.83	3.39	4.48	3.92	7.79	2.38	4.21
NMP 92491	Al Ghal	m	a	2.6	40	39	29.7	12.5	4.7	11.49	10.98	6.84	2.76	5.63	3.96	3.25	4.42	3.75	7.75	2.32	3.87
NMP 92492	Al Ghal	m	a	2.5	39	37	28.9	12.8	5.1	11.35	10.83	6.41	2.58	5.33	4.02	3.26	4.59	3.96	7.48	2.24	4.17
NMP 92493	Al Ghal	m	a	2.7	41	38	30.1	13.1	5.1	11.89	11.27	6.91	2.61	5.61	3.97	3.48	4.71	4.03	7.98	2.34	4.29
NMP 92494	Al Ghal	f	G	4.8	42	44	33.7	14.0	5.3	11.81	11.51	7.18	2.64	5.72	3.86	3.59	4.87	4.08	8.17	2.57	4.25
NMP 92804	Wadi Al Hasa	f	a	3.0	42	40	30.1	12.9	4.4	11.29	10.90	7.01	2.73	5.76	3.94	3.53	4.74	3.87	7.74	2.43	4.08
Pipistrellus pipistrellus																					
NMP 92379	Tall Numiera	f	a	3.6	41	37	30.4	12.8	5.7	11.88	11.43	–	3.23	6.13	4.21	3.48	4.75	4.21	8.13	2.25	4.38
NMP 92427	Wadi Ghuweir	f	G	5.4	46	36	31.0	12.4	4.8	11.59	11.14	7.54	3.07	6.07	4.40	3.50	4.88	4.07	7.96	2.35	4.30
NMP 92458	Ain Amshit	m	a	2.9	43	39	30.2	11.7	4.4	11.15	10.76	7.27	2.93	5.67	4.03	3.45	4.63	4.02	8.05	2.31	4.30
NMP 92459	Ain Amshit	f	a	3.8	44	37	31.2	12.3	4.4	11.85	11.38	7.48	3.11	6.08	4.13	3.48	4.89	4.18	8.24	2.34	4.41
NMP 92460	Ain Amshit	f	a	3.7	41	36	31.4	11.8	3.9	11.77	11.34	7.24	3.08	5.88	4.21	3.57	4.89	4.18	8.04	2.26	4.39
NMP 92461	Ain Amshit	f	a	3.3	41	34	29.8	11.4	4.8	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92462	Ain Amshit	f	j	0.6	–	–	9.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92807	Al Maqar'iyya	f	a	4.1	46	35	31.6	12.3	4.9	11.84	11.34	7.48	2.86	6.02	4.14	3.50	4.95	4.21	8.16	2.41	4.36
NMP 92808	Al Maqar'iyya	f	a	3.7	44	35	31.4	13.1	5.3	11.53	11.08	–	2.98	5.83	4.21	3.45	4.81	4.08	8.07	2.14	4.27
NMP 92809	Al Maqar'iyya	m	j	2.8	40	34	29.1	11.9	4.8	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92813	As Salihiyyah	m	j	3.2	41	33	28.5	11.7	4.6	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92814	As Salihiyyah	m	j	3.2	44	35	29.8	10.6	5.1	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92815	As Salihiyyah	f	a	3.5	42	37	30.9	12.4	4.7	11.37	10.73	7.04	3.02	5.75	4.22	3.31	4.61	4.02	8.17	2.28	4.22
NMP 92825	Wadi Al Walah	m	a	3.2	41	36	29.1	11.6	4.4	11.44	10.44	6.91	3.05	5.58	4.02	3.25	4.33	3.73	7.56	2.06	4.02
NMP 92827	ʿArjan	m	a	3.8	46	33	29.1	11.6	5.5	11.57	11.28	7.34	3.05	5.91	4.08	3.43	4.64	4.07	7.98	2.38	4.23

coll. No.	site	sex	age	G	LC	LCd	LAt	LA	LT	LCr	LCb	LaZ	LaI	LaN	AN	CC	M^3M^3	CM^3	LMd	ACo	CM_3
Pipistrellus pipistrellus																					
NMP 92828	ʿArjan	f	a	4.2	47	36	31.0	12.7	5.5	11.81	11.36	7.48	3.18	6.04	4.37	3.64	4.83	4.21	8.21	2.38	4.48
NMP 92829	ʿArjan	f	L	4.2	46	36	31.6	12.5	5.1	11.74	11.38	7.42	2.94	5.94	3.93	3.47	4.83	4.18	8.29	2.44	4.41
NMP 92830	ʿArjan	f	L	4.2	45	34	30.9	11.9	5.2	11.43	11.15	7.42	2.84	5.82	4.07	3.43	4.67	4.17	8.11	2.46	4.39
NMP 92831	ʿArjan	f	a	4.6	47	34	30.0	12.6	5.2	11.48	11.02	–	2.97	6.09	4.14	3.41	4.69	4.13	–	–	–
NMP 92832	ʿArjan	f	L	4.5	47	35	30.4	13.3	5.2	–	–	–	–	–	–	–	–	–	–	–	–
JUST 179	Al Batra	–	–	–	–	–	30.7	–	–	12.03	11.57	–	2.93	5.93	4.15	3.54	4.88	4.28	8.43	2.38	4.44
Pipistrellus kuhlii																					
NMP 92365	Qasr Kharana	m	a	8.1	52	43	34.4	12.7	6.1	13.31	12.74	8.65	3.28	6.74	4.76	4.31	5.81	4.97	9.51	3.14	5.36
NMP 92367	Ham. As Sarh	m	a	6.1	51	45	34.8	14.2	6.5	13.43	13.01	8.81	3.34	6.63	4.83	4.33	5.84	5.03	9.54	2.88	5.37
NMP 92368	Al Azraq	m	a	5.8	49	41	33.8	14.3	7.1	12.97	12.54	8.52	3.21	6.44	4.48	4.21	5.62	4.83	9.48	3.03	5.24
NMP 92369	Al Azraq	m	a	5.6	45	43	34.5	15.6	6.8	13.05	12.62	8.68	3.37	6.64	4.73	4.09	5.62	4.85	9.42	3.06	5.21
NMP 92370	Al Azraq	m	a	5.3	47	42	33.9	14.6	6.2	13.02	12.62	8.27	3.27	6.58	4.47	4.11	5.40	4.92	9.34	2.94	5.24
NMP 92371	Al Azraq	m	a	4.8	44	39	32.8	14.6	5.9	12.48	12.13	8.32	3.21	6.26	4.56	4.04	5.38	4.58	8.97	2.96	4.92
NMP 92372	Al Azraq	f	a	5.1	47	39	35.6	13.9	5.3	13.04	12.64	8.42	3.05	6.42	4.59	4.17	5.68	4.93	9.37	2.94	5.24
NMP 92373	Al Azraq	f	s/a	5.6	52	41	35.2	14.5	6.4	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92374	Al Azraq	f	s/a	4.3	43	41	33.1	15.5	6.4	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92559	Milka	m	a	5.0	47	41	33.4	15.4	6.5	13.46	13.06	8.46	3.21	6.32	4.75	4.22	5.44	4.96	9.76	2.96	5.34
NMP 92560	Milka	m	a	5.2	47	45	34.0	13.4	6.1	13.14	12.64	8.63	3.28	6.44	4.56	4.08	5.51	4.88	9.64	3.04	5.11
NMP 92561	Milka	f	a	7.6	53	43	36.3	15.6	6.5	12.97	12.72	8.69	3.46	6.51	4.73	4.31	5.81	4.88	9.49	3.19	5.33
NMP 92816	As Salihiyyah	m	a	5.3	47	44	33.8	14.3	5.5	13.07	12.66	8.34	3.17	6.31	4.52	4.21	5.51	4.63	–	–	–
NMP 92817	As Salihiyyah	f	L	5.9	53	41	35.2	14.5	5.9	13.48	12.82	8.57	3.38	6.75	4.87	4.21	5.61	4.69	9.79	3.01	5.26
NMP 92818	As Salihiyyah	f	L	5.6	51	45	35.8	14.1	5.9	13.21	12.79	8.66	3.28	6.58	4.75	4.38	5.74	4.97	9.84	3.02	5.41
NMP 92819	As Salihiyyah	f	L	5.5	52	43	34.5	13.7	5.4	13.47	12.98	8.72	3.32	6.83	4.75	4.32	5.68	5.09	9.72	3.16	5.39
NMP 92820	As Salihiyyah	f	a	5.9	49	43	34.8	14.5	6.1	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92822	Al Azraq	f	L	5.5	52	42	34.1	15.2	6.0	12.94	12.63	8.41	3.45	6.48	4.73	4.27	5.63	4.76	9.58	2.94	5.09
NMP 92823	Shawmari Res.	f	L	4.8	50	41	32.8	15.0	6.0	12.68	12.13	8.27	3.32	6.27	4.35	4.03	5.52	4.64	9.07	2.75	5.03
NMP 92833	Nahla	m	a	5.9	52	43	35.2	15.0	5.7	13.56	13.03	8.73	3.37	6.47	4.71	4.24	5.79	5.12	9.63	3.07	5.44
NMP 92840	Jufat Al Qafrayn	m	a	5.8	53	45	35.9	14.7	5.9	13.27	13.04	8.63	3.14	6.48	4.86	4.34	5.71	5.04	9.65	3.07	5.36
NMP 92841	Jufat Al Qafrayn	f	a	5.8	50	42	35.4	14.7	5.5	13.17	12.77	8.53	3.16	6.52	4.48	4.15	5.44	4.86	9.48	2.94	5.08
JUST –	Dir Deglah	f	a	–	–	–	34.9	–	–	13.64	–	–	–	–	–	–	–	–	–	–	–
JUST –	Dir Deglah	f	a	–	–	–	35.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JUST –	Ramtha, JUST	–	–	–	–	–	35.1	–	–	13.28	–	–	–	–	–	–	–	–	–	–	–
JUST ZSA28	Ramtha, JUST	f	s	–	–	–	34.4	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JUST ZSA339	Al Khrba	f	s	–	–	–	35.2	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Otonycteris hemprichii																					
NMP 92366	Qasr Kharana	m	a	22.0	82	57	61.2	42.0	18.0	21.93	20.64	14.31	4.02	10.32	7.21	6.04	9.51	8.32	15.71	7.27	9.36
NMP 92375	Qasr Burqu	m	s/a	21.4	80	59	59.7	41.4	17.8	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92376	Qasr Burqu	m	a	21.4	80	60	62.4	39.7	17.0	23.09	21.67	14.29	4.02	10.76	7.06	6.02	9.51	8.32	16.18	6.89	9.22

coll. No.	site	sex	age	G	LC	LCd	LAt	LA	LT	LCr	LCb	LaZ	LaI	LaN	AN	CC	M^3M^3	CM^3	LMd	ACo	CM_3
Otonycteris hemprichii																					
NMP 92377	Qasr Burqu	f	a	22.4	83	62	63.8	41.2	17.4	23.22	22.19	15.02	4.18	10.18	7.36	6.42	9.89	8.65	16.71	7.42	9.74
NMP 92428	Wadi Ghuweir	m	a	17.7	75	60	64.4	41.7	18.5	22.38	21.36	14.12	4.11	9.98	7.12	5.87	9.56	8.28	16.08	6.89	9.41
NMP 92467	Al Ghal	m	a	16.0	76	62	61.7	42.7	16.9	22.11	21.07	13.92	4.01	9.97	7.43	5.74	9.32	7.94	15.74	7.06	8.83
NMP 92468	Al Ghal	m	a	16.9	75	57	60.8	41.2	17.5	22.47	21.52	14.43	4.11	10.24	7.21	–	9.97	8.09	15.99	6.86	9.21
NMP 92821	Qasr Kharana	f	L	27.4	86	58	64.9	42.1	17.4	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92824	Shawmari Res.	f	a	23.6	86	64	64.4	43.4	17.7	23.91	22.43	15.06	3.82	10.48	7.42	6.45	10.08	8.25	16.79	7.84	9.46
JUST –	Al Hazim	m	a	–	–	–	59.7	–	–	22.94	21.52	14.72	–	10.48	–	5.92	9.94	8.24	16.27	7.44	9.34
JUST –	Wadi Shegaig	m	a	–	–	–	65.5	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Barbastella leucomelas																					
NMP 92466	Al Ghal	f	a	6.2	54	51	39.3	18.6	9.1	14.25	13.11	7.27	3.47	7.07	5.21	3.67	5.24	4.41	8.68	2.44	4.82
NMP 92800	Dhana Reserve	m	a	6.2	53	52	38.3	19.5	9.0	13.93	12.97	7.38	3.47	6.97	5.07	3.43	5.31	4.43	8.67	2.36	4.91
NMP 92812	As Salihiyyah	m	a	6.0	54	55	39.4	19.5	9.0	14.32	13.26	7.28	3.52	6.98	5.30	3.56	5.37	4.47	8.93	2.47	4.83
Plecotus christii																					
NMP 92096	Wadi Rum	m	a	–	–	–	40.4	–	–	16.72	15.43	8.53	3.29	8.22	5.12	3.49	6.28	5.75	10.56	3.02	6.08
NMP 92097	Wadi Rum	m	a	–	–	–	39.9	–	–	16.67	15.45	8.48	3.16	8.02	5.19	3.55	6.04	5.71	10.51	3.06	6.03
NMP 92384	Dana Reserve	m	a	6.1	53	52	38.8	39.3	17.6	16.49	15.48	8.49	3.18	7.68	5.04	3.62	6.09	5.74	10.54	3.08	6.12
NMP 92385	Dana Reserve	f	a	6.3	54	55	40.8	39.4	18.9	17.48	16.38	8.61	2.96	7.75	5.10	3.63	6.23	5.95	11.29	3.16	6.34
NMP 92392	Ash Shawbak	f	a	6.2	52	48	39.3	39.1	17.6	16.35	15.12	8.38	3.22	7.87	5.18	3.58	5.81	5.49	10.28	2.93	6.94
NMP 92393	Ash Shawbak	f	a	6.1	50	53	39.7	39.0	19.6	16.62	15.56	–	3.24	7.83	5.21	–	6.16	5.75	10.44	2.94	6.07
NMP 92394	Ash Shawbak	f	a	8.1	55	55	41.8	41.9	20.2	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92448	Ain Amshit	m	a	5.3	51	50	40.7	39.9	18.8	16.84	15.66	8.59	3.15	8.11	5.06	3.64	6.11	5.75	10.51	3.17	6.11
NMP 92449	Ain Amshit	f	a	6.6	53	54	40.2	40.1	19.8	17.12	16.22	8.61	3.08	8.32	5.28	3.71	6.35	5.76	10.84	3.00	6.18
NMP 92450	Ain Amshit	m	a	5.5	53	54	40.9	40.5	19.4	16.93	15.85	8.39	3.38	8.18	5.15	3.42	5.75	5.69	10.69	2.88	6.04
NMP 92451	Ain Amshit	f	a	5.2	52	51	41.2	38.8	18.5	16.97	15.63	8.46	2.97	8.16	5.15	3.61	5.87	5.75	10.61	3.07	6.19
NMP 92452	Ain Amshit	m	a	6.2	50	53	39.1	39.1	18.9	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92453	Ain Amshit	f	s	5.8	53	52	42.0	42.0	20.4	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92454	Ain Amshit	f	a	6.8	55	57	42.4	40.2	18.7	17.14	16.18	8.61	3.17	8.36	5.10	3.53	6.02	5.58	10.94	3.14	6.04
NMP 92455	Ain Amshit	m	a	5.5	52	54	39.9	38.8	18.6	17.09	16.17	8.74	3.26	8.16	5.04	3.57	6.27	5.89	10.75	3.11	6.29
NMP 92456	Ain Amshit	m	a	5.1	51	52	39.8	38.2	18.4	16.94	15.77	8.51	3.10	7.93	5.18	3.48	6.00	5.63	10.68	3.02	6.08
NMP 92457	Ain Amshit	f	a	6.2	53	54	40.7	40.4	18.3	16.56	15.59	8.74	3.16	8.17	4.95	3.53	6.02	5.48	10.68	3.22	5.93
NMP 92469	Al Ghal	f	a	6.5	53	53	41.2	40.8	19.4	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92470	Al Ghal	f	a	6.3	52	53	40.0	40.1	20.0	17.00	15.84	8.65	3.18	7.95	5.34	3.58	6.17	5.76	10.68	3.07	6.14
NMP 92471	Al Ghal	f	a	5.9	51	52	40.7	41.4	19.2	16.79	15.73	8.45	3.14	8.15	5.14	3.66	5.96	5.70	10.63	3.05	6.06
NMP 92472	Al Ghal	f	a	5.8	53	49	40.5	41.6	18.7	16.98	15.88	8.29	3.24	8.04	5.27	3.48	5.98	5.75	10.75	2.98	6.17
NMP 92473	Al Ghal	f	a	5.9	53	53	40.8	40.0	19.7	16.84	15.82	8.62	3.26	8.11	5.09	3.54	5.98	5.64	10.62	3.10	6.06
NMP 92474	Al Ghal	f	a	5.4	52	51	39.8	40.1	19.0	16.76	15.73	8.59	3.14	8.33	4.93	3.48	6.08	5.74	10.63	3.07	6.35
NMP 92475	Al Ghal	f	a	5.7	52	–	41.5	39.3	18.2	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92497	Ash Shawbak	m	a	6.5	53	52	39.8	39.8	19.1	16.75	15.76	8.43	3.22	8.42	5.18	3.42	5.76	5.71	10.59	3.01	6.10

coll. No.	site	sex	age	G	LC	LCd	LAt	LA	LT	LCr	LCb	LaZ	LaI	LaN	AN	CC	M^3M^3	CM^3	LMd	ACo	CM_3
Plecotus christii																					
NMP 92498	Dhana Reserve	m	a	6.5	50	55	38.8	38.6	18.5	16.83	15.58	9.07	3.49	8.58	5.14	3.56	6.02	5.61	10.52	3.14	6.02
NMP 92499	Dhana Reserve	f	s	6.0	53	50	38.9	38.6	18.6	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92501	Mukawir	m	a	6.2	53	51	39.3	36.8	17.0	16.53	15.27	8.34	3.16	7.88	5.12	–	5.83	5.48	10.32	3.03	5.91
NMP 92801	Khirbet Feynan	m	a	5.4	51	46	40.0	38.6	17.8	16.68	15.66	8.43	3.06	7.68	4.88	3.34	5.69	5.66	10.56	2.84	6.07
NMP 92802	Khirbet Feynan	f	a	5.8	53	49	41.0	38.5	18.4	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92803	Khirbet Feynan	f	L	5.7	53	51	39.3	38.5	18.6	16.47	15.42	8.51	3.17	8.34	5.21	3.57	6.12	5.56	10.39	3.12	5.92
NMP 93038	Jabal Al Bayda	m	a	–	–	–	39.6	–	–	16.78	15.38	8.23	3.02	7.93	4.98	3.62	6.04	5.68	10.48	3.06	6.02
JUST –	Wadi Rum	–	a	–	–	–	40.7	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Miniopterus pallidus																					
NMP 92532	Al Wardeh	f	G	19.2	67	63	47.9	13.7	6.0	15.83	15.49	8.82	3.49	8.09	6.42	4.66	6.53	6.17	11.33	2.66	6.51
NMP 92533	Al Wardeh	f	a	14.1	64	63	45.5	14.4	6.4	15.31	15.08	8.61	3.44	8.08	6.33	4.53	6.27	6.02	11.08	2.47	6.36
NMP 92837	Al Wardeh	f	s	12.9	63	66	47.4	15.2	6.9	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92838	Al Wardeh	m	s/a	10.3	58	56	43.4	13.8	5.2	–	–	–	–	–	–	–	–	–	–	–	–
NMP 92839	Al Wardeh	f	a	10.5	59	61	46.4	13.2	5.5	14.84	14.34	8.52	3.47	7.93	6.27	4.58	6.36	5.88	10.58	2.51	6.29
Tadarida teniotis																					
NMP 92826	Wadi Al Walah	f	L	29.7	90	48	59.7	34.6	7.4	23.57	22.74	14.08	4.65	11.64	7.33	5.63	9.38	8.88	16.52	3.77	9.44
JUST –	Al Azraq	m	a	–	–	–	59.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–
JUST –	Al Azraq	m	–	–	–	–	60.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–
RSCN –	Ar Rashah	m	a	–	–	–	63.6	–	–	24.23	23.47	13.88	4.71	11.48	7.26	5.55	9.49	9.08	17.04	4.19	9.74
RSCN –	Zarqa Ma'in	f	a	–	–	–	61.9	–	–	24.27	23.61	13.53	4.59	11.48	7.27	5.39	9.05	9.01	16.94	3.88	9.67