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Distribution and subspecific variation of *Myotis blythi* and *Myotis myotis* in Turkey (Mamm., Vepertilionidae)

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Abstract

Distribution maps based on hitherto unpublished (19 of *Myotis blythi* and 16 of *M. myotis*) and published records of the two sibling species in Turkey allow in spite of a high degree of sympatricity for the first time a biogeographical interpretation. *M. myotis* prefers the more humid, *M. blythi* the more continental regions. In the arid Central Anatolian Region the frequency of both species is more or less equal, but in the even more continental mountainous East Anatolian region *M. myotis* becomes very local and *M. blythi* occurs frequently (up to 1980 m above sea level). Mean values of skull measurements in strictly W - E arranged populations of both species increase in a remarkably parallel manner. The only exception is formed by the Levante population of *M. myotis*, which is larger in all but one (C-C) measurements than the neighbouring populations, thereby justifying its treatment as subspecies (*M. myotis macrocephalicus* HARRISON & LEWIS, 1961). The increase of skull measurements of *M. blythi* represents a stepless cline. The possibility to separate Near Eastern *M. blythi* as subspecies from neighbouring populations under the name *omari*, given to a population from Isfahan, Iran, remains open for discussion. Interspecific distances between mean values of skull measurements remain more or less stable between compared populations, but the distances between maximum values in *M. blythi* and minimum values in *M. myotis* vary, being lowest in the Central Anatolian populations. Possible correlations between variation in skull size and diet are discussed.

Key words: Fauna of Turkey, Greece, Syria; *Myotis myotis, Myotis blythi*; geographic distribution, biogeographic distribution, altitudinal distribution, subspecific variation.

Zusammenfassung

Die Zusammenführung eigener, bisher unpublizierter Fundorte (19 von *M. blythi* und 16 von *M. myotis*) mit publizierten ergibt erstmals auswertbare Verbreitungsbilder der beiden Zwillingsarten in der Türkei. Trotz eines hohen Grads von Sympatrie (38 % der *M. blythi* Fundorte und 46 % der *M. myotis* Fundorte werden auch von der jeweils anderen Art bewohnt), ergeben sich bei Aufgliederung nach biogeographischen Regionen deutliche interspezifische Unterschiede. *M. myotis* bevorzugt humidere und damit waldreichere, *M. blythi* kontinentale und somit Steppen-Waldsteppen-Gebiete. In der ariden Zentralanatolischen Region kommen beide Arten in etwa gleicher Häufigkeit vor, doch die gebirgige, besonders kontinental geprägte Ostanatolische Region wird von *M. myotis* fast nicht besiedelt. Hier reicht *M. blythi* bis in Seehöhen von 1980 m. Die Auswertung der Schädelmaße von 66 türkischen *M. blythi* (+ 31 aus angrenzenden Ländern) und 37 (+ 21) ebensolchen *M. myotis* ergab bei strikt von W - E gerichteter Anordnung der Populationseinheiten eine bei beiden Arten allmähliche, ± parallel verlaufende Größenzunahme der Mittelwerte der meisten Maße. Eine Ausnahme macht die levantinische Population von *M. myotis*, die in allen Maßen außer C-C größer als die im W und E angrenzenden Populationen ist und somit eine klar abgegrenzte Unterart (*M. myotis macrocephalicus* HARRISON & LEWIS, 1961) darstellt. Angesichts der in Form einer ungestuften Kline verlaufenden, steten Größenzunahme von W nach E bei *M. blythi* ist die Verwendbarkeit des Namens *omari*, der für eine Population aus Isfahan beschrieben wurde, grundsätzlich diskutierbar. Die interspezifischen Abstände zwischen den Mittelwerten diverser Schädelmaße der einzelnen Populationen bleiben ± gleich, bei den Abständen zwischen Maximalwert von *M. blythi* und Minimalwert von sympatrischen *M. myotis* fallen die zentralanatolischen Populationen durch geringe Distanzen bei mehreren Maßen auf. Mögliche Zusammenhänge zwischen der Variation der Schädelmaße und der Nahrung werden diskutiert.

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Introduction

The two Mouse eared bats represent an interesting pair of sibling species: *Myotis blythi* is less specialized than the more advanced, geologically younger *M. myotis* (TOPÁL & TUSNÁDI 1963), which has evolved under relatively cold and humid conditions of the Quaternary in Europe (STRELKOV 1972). According to BENDA & HORÁČEK (1995a) *M. myotis* is of W-mediterranean origin and ecologically linked to deciduous or mixed woodland with open patches. From here it spread through central and E-Europe to Asia Minor, where it reaches its present boundary. ARLETTAZ (1995) made probable, that the long discussed N-African population of Mouse eared bats belongs to this species too (for discussion see BENDA & HORÁČEK 1995 a and b). *M. blythi* is of Asiatic origin and ecologically linked to semiarid warm and open habitats (BENDA & HORÁČEK 1995a). At present it occurs in NW China, NW India, Central Asia, Caucasus and Crimea (STRELKOV 1972) W to the Iberian Peninsula. It may never have reached Africa. Individuals of both species often coexist in the same roosts and are almost indistinguishable in external measurements and colouration.

Recent investigations in Central Europe have shown, that though both species are opportunistic feeders, the composition of their diets is clearly different under sympatric conditions (ARLETTAZ & al. 1993): *M. myotis* feeds mainly on large forest dwelling beetles, while the smaller species preys mainly upon Orthoptera living in open landscapes. *M. myotis* has a large skull with a prominent sagittal crest and a relatively short rostrum, whereas *M. blythi* has a smaller skull with relatively long rostrum and the sagittal crest is lacking or very weak. It is tempting to speculate, that these differences in skull size and proportions are due to different prey sizes and hardness.

The present study deals with two questions: 1) whether under the most diverse climatic conditions of Anatolia, that support forests of different types, forest steppes and true steppes, the two Mouse eared bats exhibit spatial segregation or sympatric occurrence and 2) whether variation in skull measurements of the two species can be linked to climatic or vegetation factors and/or interspecific competition.

Material and methods

The material consisting of 37 *M. myotis* and 66 *M. blythi* from Turkey was collected during 7 excursions (1967, 1968, 1969, 1971, 1975, 1984 and 1986) and is stored in the mammal department of the Natural History Museum in Vienna (NMW). Further Turkish material used is a small collection donated by Prof. M. Çağlar to this museum and a sample of *Myotis blythi* from the vicinity of Düzici (formerly Harunye) in the Vilayet Adana collected by Franz Tölg in 1914. These Turkish specimens are supplemented by material from neighbouring countries (all NMW): 11 *M. myotis* and 21 *M. blythi* from Greek Thrace, collected in 1963, 1966 and 1986 by members of the mammal department of the NMW, 2 *M. blythi* from Iran (collected by E. Zugmayer in 1905), 8 *M. myotis* and 8 *M. blythi* from Syria (collected by V. Pietschmann in 1914) and 2 *M. myotis* from Lebanon (collected by F.Leuthner in 1886).

In caves and old buildings the bats were taken by hand or with a handnet or they were mistnetted.

External measurements and weights were taken in the field. For cranial measurements a sliding vernier caliper was used. If not otherwise stated the material was collected by the members of the excursions of the mammal department of the NMW. For each locality geographical coordinates and altitude (in metres) are given as exact as possible.

The following abbreviations are used: BB breadth of braincase; C-M^3 maxillary toothrow (crowns); C-C rostral breadth across upper canines; CBL condylobasal length; FA-length of forearm without carpus; FA+ length of forearm with carpus; GTL greatest length of skull (sensu HARRISON & BATES 1991); HB head and body length; IC width of interorbital constriction; M-M rostral breadth across upper molars; MB mastoid breadth; ML mandible length; RL length of rostrum (from back of the crown of M^3 to anterior edge of os premaxillare); ZB zygomatic breadth.

Material examined

Myotis blythi TOMES, 1857

Turkey:

Vil. Adana: 37 17/ 36 27, 600 m: S Düzici: 4 ♀ (4 alc., 4 skulls) 1914 (NMW 13148-51), F. Tölg leg.

Vil. Ağrı: 39 32/ 44 09, 1980 m: Ishakpasa Saray in Yüksek Doğubeyazit: 1 ♂ (1 skin, 1 skull) 21. July 1984 (NMW 34339)

Vil. Antalya: 36 40/ 31 45, 200 m: Alara hanı: 1 ♂, 1 ♀ (2 skins, 2 skulls) 16. Aug. 1986 (NMW 37234-35); 36 12/ 29 43, 700 m: 1 km N Ağullu: 1 ♂ (1 skin, 1 skull) 13. Aug. 1986 (NMW 37231)

Vil. Aydın: 37 31/ 27 17, 25 m: Milet: 1 ♂ (1 skin, 1 skull) 7. Aug. 1986 (NMW 37228).

Vil. Bingöl: 39 20/ 40 30, 1600 m: Kerek mağarası, Kiği: 13 ♀ (13 skins, 13 skulls) 13. July 1984 (NMW 34343-34355).

Vil. Bitlis: 38 29/ 42 08, 1820 m: Alaman hanı: 3 ♂, 2 ♀ (5 skins, 5 skulls) 16 July 1984 (34357-61); 38 23/ 42 37, 1740 m: between Çanak düzü and Anadere: 2 ♂ (2 skins, 2 skulls) 17 July 1984 (NMW 34362-63); 38 22/ 42 06, 1680 m: Han 2 km N Bitlis: 1 ♂ (1 skin, 1 skull) 15 July 1984 (NMW 34356).

Vil. Çanakkale: 40 15/ 26 25: Hill SW Yalova: 2 ♂ (2 skins, 2 skulls), 30 May 1967 (NMW 11812-13).

Vil. Diyarbakır: 38 11/39 43, 600 m: Hilar mağarası, 6 km SW Ergani: 4 ♂ (4 skins, 4 skulls) 26. July 1984 (NMW 34369-72).

Vil. Erzincan: 39 0/ 38 46, 850 m: 13 km E Başpınar: 2 ♂ (2 skins, 2 skulls) 9. July 1984(NMW 34341-42).

Vil. Hatay: 36 15/ 36 13, 110 m: Cave in Narlıca: 2♂, 1 ♀ (3 alc., 3 skulls): 12. Sept. 1971 (NMW 14580-82); 36 11/ 36 05, 90 m: Harbiye:1 ♀ (1 skin, 1 skull) 21. May 1960 (NMW 20 503).

Vil. Isparta: 37 48/ 31 04, 1050 m: Zindan mağarası near Anamas: 2 ♂ (2 skins, 2 skulls) 25. June 1969 (NMW 24609-10).

Vil. Istanbul: 40 59/ 28 46, 100 m: Yarımburgaz mağarası in Küçükçekmece: 1 ♀ (1 skin, 1 skull), 31. July 1960, (NMW 20 504), M. Çağlar leg. et don.

Vil. Izmir: 39 07/ 27 11, 5o m: Bergama, Asklepion: 2 ♂, 1 ♀ (3 skins, 3 skulls), 4. Aug. 1986 (NMW 37223-25); Bergama, hellenistic aqueduct: 1 ♂ (1 skin, 1 skull), 5. Aug. 1986 (NMW 37226).

Vil. Kırklareli: 41 36/ 28 06, 100 m: Cave S Kıyıköy: 3 ♂ (3 alc., 3 skulls), 3. June 1968 (NMW 13433-35).

Vil. Nevşehir: 38 43/ 34 56, 1150 m: Sarıhan: 2 ♂ (2 skins, 2 skulls), 17. July 1975 (NMW 20638-39); 38 22/ 34 31, 1150 m: 24 km W Derinkuyu: 2 ♀ (1 alc., 1 skin. 2 skulls), 14. July 1975 (NMW 20635-36).

Vil. Niğde: 38 26/ 34 10, 1270 m: Ağzıkarahan: 3 ♂ (3 skins, 3 skulls) 18. July 1975 (NMW 20640-42).

Vil. Van: 38 28/ 43 20, 1770 m: Van kalesi: 1 ♂ (1 skin, 1 skull) 19. July 1984 (NMW 34340); 38 19/ 43 00, 1720 m: Isle Akdamar: 4 ♂ (4 skins, 4 skulls) 18. July 1984 (NMW 34364-66, 34338); 38 14/ 43 13, 1960 m: 6 km S Kızıltaş: 2 ♂ (2 skins, 2 skulls) 19. July 1984 (NMW 34367-68).

Greece:

Nomos Xanthi: 41 05/ 24 47: Railway tunnel N Toxotai: 7 ♀ (7 skins, 7 skulls) 21. Sept. 1966 (NMW 11447-53); 40 59/ 24 59 1 km S Mandra: 4 ♂ (2 alc., 2 skins, 4 skulls) 28. Sept. 1966 (NMW 11476-77, 11480-81).

Nomos Evros: 41 21/ 26 26: Cave near Kouvobono: 2 ♂, 6 ♀ (6 alc.,2 skins, 8 skulls) 22. June 1963 (NMW 9438-45), K. Bauer leg.

Iran:

Azarbijan: 38 12/ 46 18: near Khoy: 2 ♂ (2 alc., 2 skulls) 1905 (NMW 23474-75), E. Zugmayer leg.

Syria:

36 14/ 37 05: Haleb: 1 ♂, 7 ♀ (8 alc., 8 skulls) 4. July 1914 (NMW 22048-55), V. Pietschmann leg.; Camp Fauar, Golan: 1 ♀ (1 skin, 1 skull) June 1976 (NMW 21931) P. Schneider & K. Kollnberger leg.

Myotis myotis BORKHAUSEN, 1797

Turkey:

Vil. Aydın: 37 31/ 27 17, 25 m: Milet: 2 ♂ (2 skins, 2 skulls) 7. Aug. 1986 (NMW 37229-30).

Vil. Balıkesir: 39 35/ 27 11, 300 m: Cave 8 km E Havran: 1 ♂, 3 ♀ (4 skins, 4 skulls) 3. Aug. 1986 (NMW 37218-21).

Vil. Burdur: 37 43/ 30 20, 1000 m: Insuyu mağarası, 12 km S Burdur: 1 ♂, 2 ♀ (3 skins, 3 skulls) 24. Feb. 1969 (NMW 24612-14).

Vil Denizli: 37 49/ 29 23, ca 600 m: Cave near Dereköy, 2 km S Kaklık: 1 ♀ (1 skin, 1 skull) 25. Feb. 1969 (NMW 24611).

Vil. Diyarbakır: 38 30/ 40 30, 940 m: Birklin mağarası 11 km NW Lice: 1 ♀ (1 skin, 1 skull) 27. July 1984 (NMW 34334); 38 11/ 39 43, 600 m: Hilar mağaraları 6 km SW Ergani: 2 ♂ (2 skins, 2 skulls) 26. July 1984 (NMW 34332-33).

Vil. Hatay: 36 15/ 36 36 11/ 36 05, 90 m: Harbiye: 1 ♀ (1 skin, 1 skull) 21 May 1960 (NMW 20503), M. Çağlar leg. et don.

Vil. Isparta: 37 48/ 31 04, 1050 m: Zindan mağarası near Anamas: 6 ♂, 2 ♀ (5 alc., 2 skins, 8 skulls) 25. June 1969 (NMW 24615-22).

Vil. Istanbul: 40 59/ 28 46, 100 m: Yarımburgaz mağarası in Küçükçekmece: 1 ♀ (1 skin, 1 skull) 31. July 1960 (NMW 20502), M. Çağlar leg. et don.;41 09/ 28 28, 120 m: Karababa mağarası, Çatalça: 1 ♀ (1 skin, 1 skull) 3. April 1960 (NMW 20501), M. Çağlar leg. et don.

Vil. Izmir: 39 07/ 27 11, 50 m: Bergama, Asklepion: 1 ♀ (1 skin, 1 skulls), 4. Aug.1986 (NMW 37222); 37 51/ 27 15, 20 m: Efes, Vedius Gymnasion: 1 ♂ (1 skin, 1 skull), 6. Aug. 1986 (NMW 37227); 37 56/ 27 20, 20 m: Efes, Han N Vedius Gymnasion: 1 ♂ (1 skin, 1 skull) 2. Aug. 1984 (NMW 34337).

Vil. Kırklareli: 41 36/ 28 06, 100 m: Cave S Kıyıköy: 2 ♂ (2 alc., 2 skulls), 3. June 1968 (NMW 13420, 13432).

Vil. Konya: 37 53/ 32 09, 1500 m: Han 39 km W Konya: 1 ♂ (1 skin, 1 skull) 29. July 1984 (NMW 34335).

Vil. Nevşehir: 38 45/ 34 38, ca 1150 m: Acık Saray near Gülşehir: 1 ♂ (1 skin, 1 skull) 15. July 1975 (NMW 20637); 38 39/ 34 52, 1120 m: Ruins of Göreme: 1 ♂ (1 alc., 1 skull) 4. July 1975 (NMW 20630); 38 22/ 34 31, 1150 m: 24 km W Derinkuyu: 4 ♀ (3 alc., 1 skin. 4 skulls), 14. July 1975 (NMW 20631-34).

Vil. Niğde: 38 26/ 34 10, 1270 m: Ağzıkarahan: 1 ♂ (1 skin, 1 skull) 18. July 1975 (NMW 20543).

Greece:

Nomos Xanthi: 41 05/ 24 47: Railway tunnel N Toxotai: 2 ♂, 1 ♀ (3 skins, 3 skulls) 21. Sept. 1966 (NMW 11444-46).

Nomos Serrai: 41 02/ 24 00: Cave of Alistrati: 7 ♂, 1 ♀ (6 alc.,2 skins, 8 skulls) 9. Oct. 1978 (NMW 27555-557, 27561-62) K. Mais & O. Schmitz leg., 22. Sept. 1986 (NMW 37237-39).

Syria:

36 14/ 37 05: Haleb: 2 ♂, 6 ♀ (8 alc., 8 skulls) 4. July 1914 (NMW 22040-47), V. Pietschmann leg.

Lebanon:

33 52/ 35 28: Beirut 2 ♀ (2 alc., 2 skulls) 1886 (NMW 23357-58), F. Leuthner leg.

Results

Distribution

A. Geographic distribution

Recent publications (VON HELVERSEN 1989, ALBAYRAK 1990, 1993, STEINER & GAISLER 1994) and own material presented here have increased our knowledge of the distribution of *M. myotis* and *M. blythi* in Turkey considerably. In the maps (fig.1 and 2) all known records are presented as accurate as possible. In both species a few localities could not be found on maps.

M. blythi (66 localities) seems to be more common than *M. myotis* (54 localities). In large parts of Turkey the two Mouse-eared bats occur sympatrically. 25 localities, that is 38 % of all known Turkish *M. blythi* localities and 46 % of *M. myotis* localities, were inhabited by both species.

In Eastern and South-Eastern Anatolia, where *M. blythi* is widespread, *M. myotis* becomes very scarce and seems to reach its eastern border in the Vilayet Diyarbakır (fig. 2). Birklin mağarası near Lice is the easternmost documented record. SATUNIN (1913) did not distinguish *M. blythi* and his record from Aralık (Kars) belongs most probably to *M. blythi.*

B. Climatic distribution

For investigation of climatic preferences of the two Mouse-eared bats the biogeographical regions defined by EROL (1983) were used. Turkey is divided into 7 regions:

1. Marmara region, comprising Thrace and NW Anatolia. The climate is relatively cool and wet.
2. Aegean region, stretching from S of Ulu dağ in the N to a line between Denizli and Köyceğiz in the S. The Eastern border is drawn between Afyon Karahisar and Kütahya. The climate is submediterranen with winter rainfall.
3. Mediterranean region with the Toros mountains as main feature. The climate is true mediterranean with heavy winter rainfall and warmer summers than in the Aegean region.
4. Black Sea region with the Pontus mountains as main feature. The climate is cool and humid. Humidity increases from W to E.
5. Central Anatolia, with hot and arid climate.In the centre flat basins with true steppe vegetation, ridges and mountains with xerothermic vegetation at the borders.
6. Eastern Anatolian region, a high plateau with high mountains. The climate is continental, continentality is increasing from W to E.
7. SE Anatolian region, a low plateau S of the Eastern Toros mountain chain; very hot summers and cold winters support steppes and steppe forests.

The distribution of the localities of the two Mouse-eared bats over these regions (tab.1) shows, that *M. myotis* prefers the regions with the highest humidity (Mediterranean and Black Sea regions), is moderately frequent in regions with moderate temperature and humidity and is scarce in very continental regions (E and SE Anatolian region). In contrast to this, the largest percentage of *M. blythi* localities lies in the Eastern Anatolian region, the smallest in the Aegean region. Very interesting are the following results:

1) In the temperate arid climate of the Central Anatolian region the frequency of both species is almost equal. 2) Although 12 % of *M. blythi* localities are in the Black Sea region, a closer inspection reveals, that *M. blythi* has not been recorded from the very

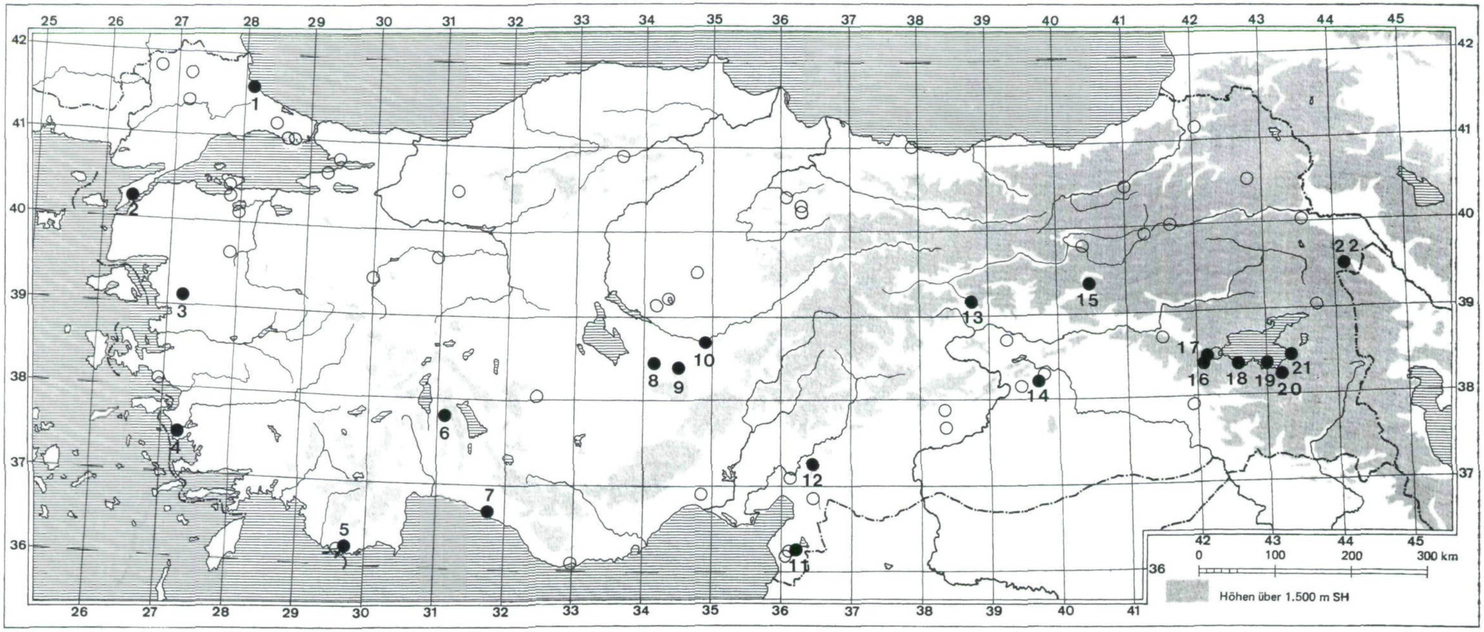


Fig. 1: Distribution of *Myotis blythi* in Turkey based on records of ALBAYRAK (1990 and 1993); BENDA & HORÁČEK (1995b), DE BLASE & MARTIN (1973); ÇAĞLAR (1965 and 1969); FELTEN et al. (1977); HARRISON (1964); VON HELVERSEN (1989); NADACHOWSKI et al.(1990); STEINER & GAISLER (1994), and own material: 1: Kırklareli, Cave S of Kıyıköy; 2: Çanakkale, SW Yalova; 3: Izmir, Bergama; 4: Aydın, Milet; 5: Antalya, NE Ağullu; 6: Isparta, Zindan mağarası; 7: Antalya, Alara hanı; 8: Niğde, Ağzıkarahan; 9: Nevşehir, 24 km W Derinkuyu; 10: Nevşehir, Sarıhan; 11: Hatay, Cave near Narlıca; 12: Adana, S Düzici; 13: Erzincan, 13 km E Başpınar; 14: Diyarbakır, Hilar mağarası; 15: Bingöl, Kerek mağarası; 16: Bitlis, 2 km N of Bitlis; 17: Bitlis, Alaman hanı; 18: Bitlis, Çanak düzu-Anadere; 19: Van, Isle of Akdamar; 20: Van, S Kızıltaş; 21: Van, Van kalesi; 22: Ağrı, Ishakpasa saray.

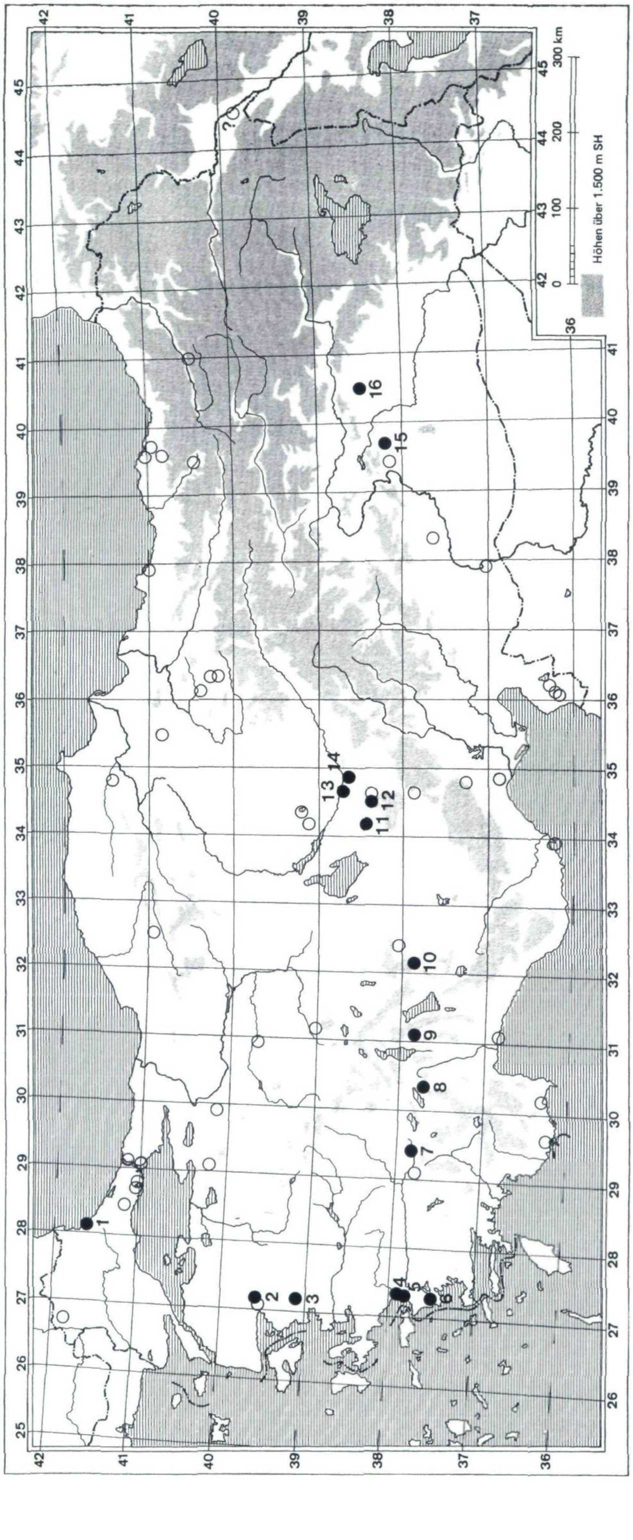


Fig. 2: Distribution of *Myotis myotis* in Turkey based on records of ALBAYRAK (1990 and 1993); BENDA & HORÁČEK (1995b); DE BLASE & MARTIN (1973); ÇAĞLAR (1965 and 1969); CORBET & MORRIS 1967); FELTEN et al. (1977); VON HELVERSEN (1989); KAHMANN & ÇAĞLAR (1960); von LEHMANN (1966); SATUNIN (1913); STEINER & GAISLER (1994), and own material: 1: Kırklareli, Cave S Kıyıköy; 2: Balıkesir, Cave E Havran; 3: Izmir, Bergama; 4: Izmir, Efes; Han; 5: Izmir, Efes, Vedius Gymnasion; 6: Aydın, Milet; 7: Denizli, Cave near Dereköy; 8: Burdur, Insuyu mağarası; 9: Isparta, Zindan mağarası; 10: Konya, 39 km W Konya; 11: Niğde, Ağzıkarahan; 12: Nevşehir, 24 km W Derinkuyu; 13: Nevşehir, Göreme; 14: Nevşehir, Açık Saray; 15: Diyarbakır, Hilar mağarası; 16: Diyarbakır, Birklin mağarası.

Tab. 1: Distribution of Turkish localities of *M. blythi* and *M. myotis* over biogeographic regions (EROL 1983).

Biogeographic regions	percentage of all localities per species	
	M. blythi	*M. myotis*
Marmara	19.7	16.7
Aegean	6.1	14.8
Mediterranean	18.2	22.2
Black Sea	12.1	22.2
Central Anatolia	12.1	16.7
Eastern Anatolia	24.2	1.8
Southeastern Anatolia	7.5	5.5

humid and densely wooded northern slope of the Eastern Pontus, where *M. myotis* occupies a small area in the vicinity of Trabzon (ÇAĞLAR 1965, 1969, ALBAYRAK 1990).

C. Altitudinal distribution

The altitudinal distribution of *M. blythi* and *M. myotis*, as far as indicated by own collection sites with exact altitudes, is distinctly different in showing a peak between 1500 and 2000 m above sea level for *M. blythi*, whereas the highest record of *M. myotis* is 1500 m (W of Konya) (fig.3). So, contrary to what STRELKOV (1972) expected, it is not *M. myotis*, that becomes a mountain bat in the southern parts of its range, but *M. blythi*. A maternity colony of *M. blythi* was found in an altitude of 1600 m above sea level (Kiği) and a summering male in 1980 m (Ishakpaşa saray).

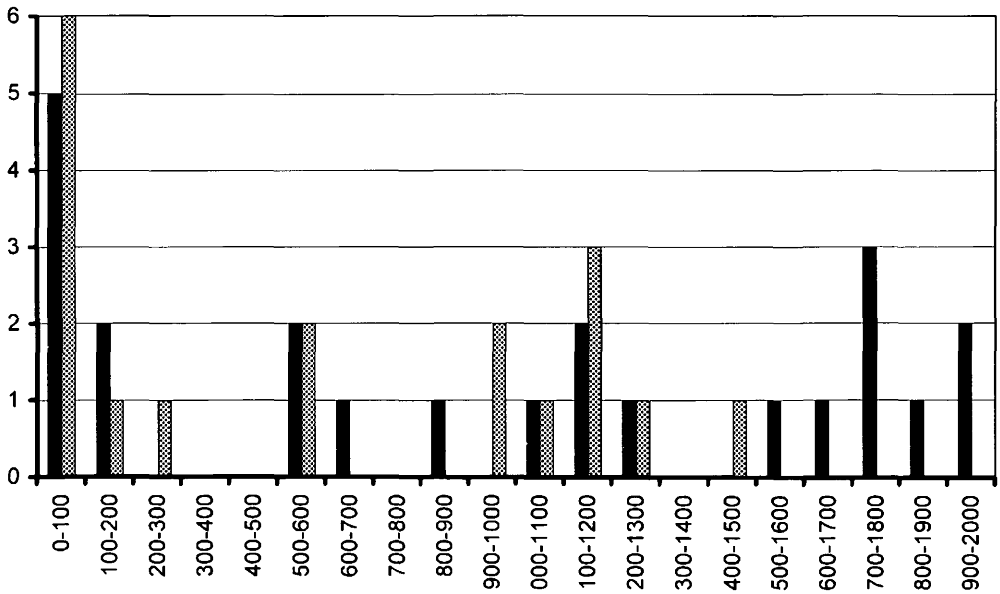
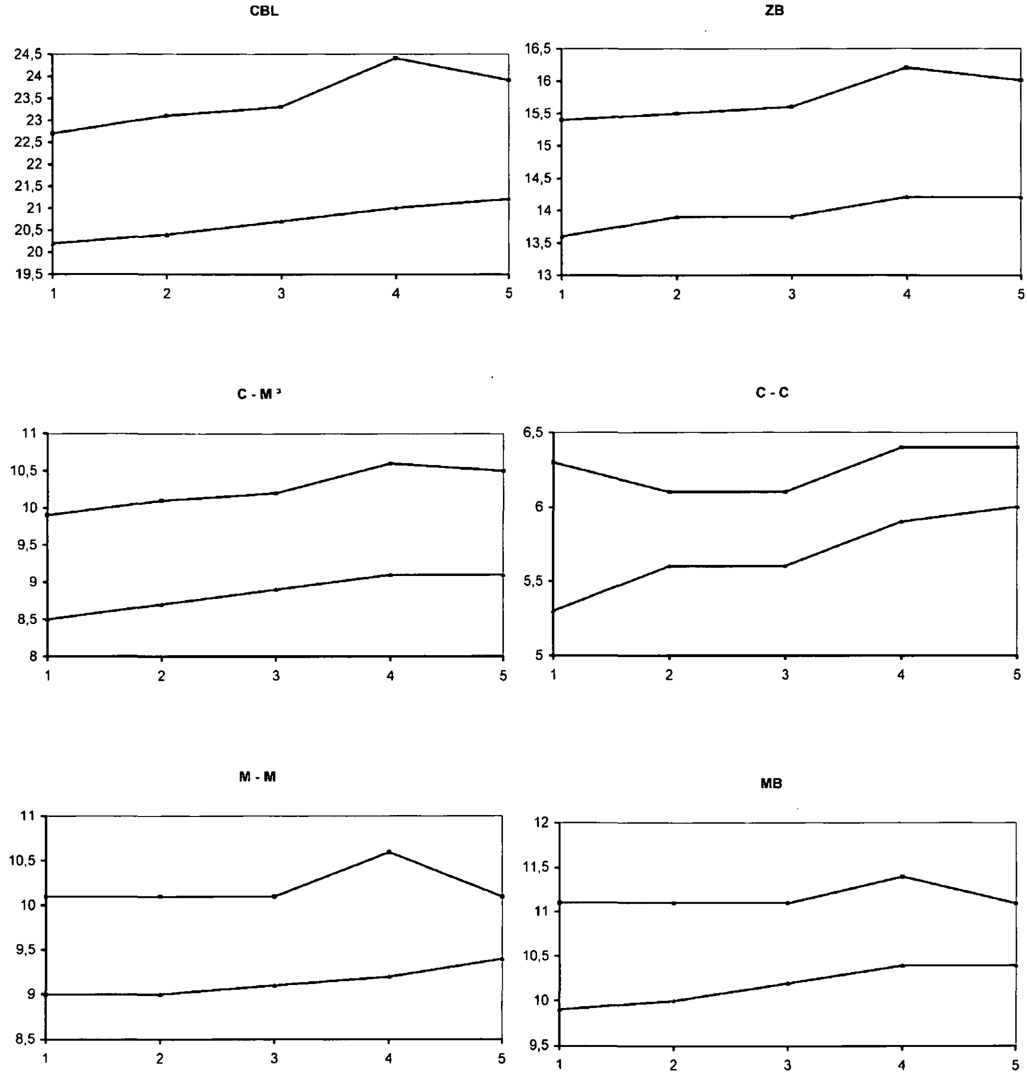


Fig. 3: Altitudinal distribution of Turkish localities of *M. myotis* (grey columns) and *M. blythi* (black columns). Ordinate, meters above sea level; abscissa, number of localities.

Tab. 2: External and cranial measurements of *Myotis myotis* (upper line) and *M. blythi* (lower line) arranged from W to E.
* without pregnant and lactating females.

	W Thrace (W of 25°E)				W Turkey (between 25°E and 29°E)				Central Anatolia (between 29° and 35°E)				Levante (between 35° and 38°E)				E Anatolia (E of 38°E)			
	range	mean	s	n	range	mean	s	n	range	mean	s	n	range	mean	s	n	range	mean	s	n
HB	73.0 - 87.0	80.5	3.8	12	72.0 - 87.0	81.4	4.6	12	70.0 - 90.0	78.4	4.9	20	80.0 - 86.0	83.1	2.1	10	82.0 - 83.0			3
	69.5 - 75.0	72.1	1.8	11	65.0 - 79.0	71.6	4.1	13	66.0 - 73.0	71.0	2.1	8	70.0 - 79.0	74.1	2.1	16	72.0 - 80.0	77.7	2.5	35
Ear	21.7 - 29.5	26.4	2.2	11	25.8 - 28.3	27.0	0.9	12	24.1 - 29.6	26.4	1.5	9	24.8 - 28.2	26.2	0.9	10	24.3 - 27.2			3
	22.8 - 25.0	23.9	0.7	11	23.3 - 25.4	23.3	1.2	12	18.2 - 24.8	21.5	2.1	8	21.0 - 25.2	23.5	0.7	16	21.2 - 25.8	24.3	1.2	35
FA-♂	58.0 - 63.4	60.0	1.8	8	57.9 - 63.0	60.7	1.8	6					62.4 - 63.0			2	57.5 - 61.7			3
	54.0 - 54.1			2	52.1 - 57.0	55.4	2.0						54.6 - 58.5	57.1	1.8	3	53.8 - 60.8	58.5	1.8	20
FA+♂	59.2 - 64.6	61.7	1.7	8	59.1 - 64.9	62.2	1.9	6					64.8 - 65.1			2	58.8 - 63.7			3
	55.9 - 56.0			2	53.6 - 58.8	57.0	2.0	4					56.6 - 60.4	59.1	1.8	3	55.3 - 63.5	60.2	1.9	30
FA-♀	62.1			1	61.3 - 64.0	62.8	1.1	4					65.6 - 67.6	66.6	0.7	8	67.0			3
					55.6			1					56.7 - 61.3	59.1	1.2	12	56.1 - 63.6	58.8	1.8	15
FA+♀	64.1			1	62.8 - 65.9	64.1	0.9	4					67.7 - 69.8	68.8	0.7	8	68.6			3
					57.0			1					59.0 - 63.8	61.3	1.3	12	58.0 - 65.0	60.7	1.8	15
weight*	24.5 - 34.0	30.3	3.2	12	24.0 - 30.5	27.8	2.0	8	24.0 - 42.0	31.0	4.3	13	30.0 - 31.0			2	28.0 - 34.5			3
	19.5 - 21.8	22.6	2.2	11	21.0 - 27.0	23.2	1.5	12	24.0 - 28.0	25.8	1.2	8	23.5 - 29.0	26.0	1.6	12	22.0 - 33.0	28.0	3.2	20
CBL	22.0 - 23.6	22.7	0.6	11	22.0 - 23.8	23.1	0.5	12	22.3 - 24.1	23.3	0.4	17	23.7 - 24.9	24.4	0.4	10	23.6 - 24.1			3
	19.5 - 20.7	20.2	0.4	11	19.8 - 21.0	20.4	0.3	18	20.0 - 21.5	20.7	0.5	7	20.5 - 21.6	21.0	0.3	17	20.3 - 21.9	21.2	0.4	35
									type series *M. m. macrocephalicus*				23.9 - 24.9							
									type series *M. b. omari*				20.6 - 21.4							
GTL	24.0 - 26.0	24.8	0.6	10	24.0 - 25.9	25.1	0.5	12	24.3 - 26.0	25.3	0.4	17	25.8 - 26.8	26.3	0.3	9	25.6 - 26.3			3
	21.1 - 22.5	21.9	0.4	11	21.1 - 22.5	22.0	0.3	19	21.5 - 23.0	22.3	0.5	7	22.3 - 23.3	22.8	0.3	17	22.2 - 23.5	23.0	0.4	35
C-M³	9.3 - 10.1	9.9	0.2	12	9.7 - 10.4	10.1	0.2	12	9.4 - 10.7	10.2	0.3	19	10.3 - 10.8	10.6	0.1	10	10.4 - 10.5			3
	8.1 - 8.9	8.5	0.2	11	8.3 - 9.1	8.7	0.2	19	8.3 - 9.3	8.9	0.4	8	8.7 - 9.6	9.1	0.3	16	8.4 - 9.6	9.1	0.3	35
									type series *M. m. macrocephalicus*				10.4 - 10.6							
									type series *M. b. omari*				9.4 - 9.9							
BB	9.8 - 10.5	10.2	0.2	10	10.0 - 10.6	10.3	0.2	12	9.7 - 11.0	10.3	0.3	19	9.7 - 11.5	10.6	0.5	10	10.3 - 10.7			3
	9.3 - 9.9	9.5	0.2	11	9.3 - 10.3	9.6	0.3	19	9.4 - 9.8	9.5	0.2	8	9.4 - 10.3	10.0	0.3	17	9.4 - 10.2	9.8	0.3	35
ZB	15.0 - 15.8	15.4	0.3	9	14.7 - 16.6	15.5	0.5	11	15.0 - 16.3	15.6	0.3	19	15.5 - 16.7	16.2	0.3	10	15.9 - 16.0			3
	13.0 - 14.0	13.6	0.4	10	13.5 - 14.2	13.9	0.2	18	13.0 - 14.4	13.9	0.4	8	13.5 - 14.7	14.2	0.3	16	13.3 - 14.9	14.2	0.3	35
									type series *M. m. macrocephalicus*				15.5 - 16.1							
									type series *M. b. omari*				13.9 - 14.2							
RL	11.0 - 11.7	11.4	0.2	12	11.4 - 12.0	11.7	0.2	12	11.2 - 12.0	11.7	0.2	17	11.3 - 12.6	12.0	0.3	9	11.8 - 12.2			3
	9.7 - 10.5	10.1	0.3	11	9.8 - 10.5	10.1	0.2	19	10.0 - 11.0	10.4	0.4	8	10.2 - 10.8	10.5	0.2	17	10.1 - 11.1	10.7	0.2	35
IC	5.1 - 5.6	5.3	0.2	10	5.1 - 5.5	5.3	0.1	11	5.1 - 5.5	5.3	0.1	18	5.2 - 5.6	5.4	0.1	10	5.4 - 5.5			3
	4.8 - 5.4	5.1	0.2	11	4.9 - 6.0	5.3	0.2	19	5.1 - 5.5	5.3	0.1	7	5.0 - 5.4	5.3	0.1	17	4.9 - 5.6	5.3	0.2	35
C-C	5.9 - 6.9	6.3	0.3	12	5.8 - 6.5	6.1	0.2	12	5.8 - 6.5	6.1	0.2	17	6.3 - 6.5	6.4	0.1	10	6.3 - 6.5			3
	5.3 - 5.9	5.6	0.2	11	5.1 - 6.0	5.6	0.2	19	5.3 - 5.9	5.6	0.2	7	5.7 - 6.3	5.9	0.2	17	5.5 - 6.4	6.0	0.5	35
M-M	9.6 - 10.4	10.1	0.2	12	9.9 - 10.4	10.1	0.2	12	9.7 - 10.7	10.1	0.3	19	10.3 - 10.8	10.6	0.2	10	10.0 - 10.4			3
	8.6 - 9.4	9.0	0.3	11	8.5 - 9.2	9.0	0.2	19	8.7 - 9.5	9.1	0.3	7	8.6 - 9.9	9.2	0.3	17	9.0 - 9.9	9.4	0.2	35
MB	10.7 - 11.8	11.1	0.3	9	10.7 - 11.4	11.1	0.2	10	10.7 - 11.4	11.1	0.2	19	11.1 - 11.7	11.4	0.2	9	11.1 - 11.4			3
	9.6 - 10.2	9.9	0.2	11	9.5 - 10.4	10.0	0.3	19	9.9 - 10.7	10.2	0.3	8	10.0 - 10.8	10.4	0.2	16	9.5 - 10.7	10.4	0.3	34
ML	17.8 - 18.9	18.3	0.4	12	17.3 - 19.6	18.6	0.6	12	18.0 - 19.3	18.8	0.4	19	19.5 - 20.0	19.7	0.2	8	19.1 - 19.6			3
	15.4 - 16.5	16.0	0.3	11	15.7 - 17.0	16.3	0.3	19	16.0 - 17.6	16.7	0.5	9	16.3 - 17.2	16.8	0.3	17	16.2 - 17.7	17.0	0.4	35
									type series *M. m. macrocephalicus*				19.1 - 20.1							
									type series *M. m. omari*				16.5 - 17.6							



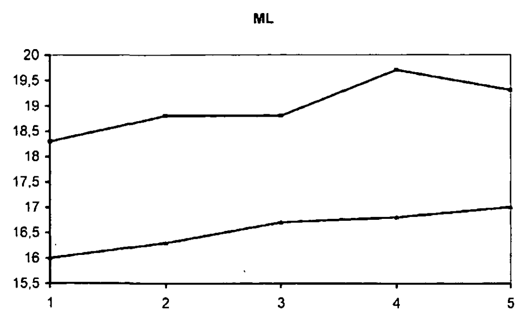
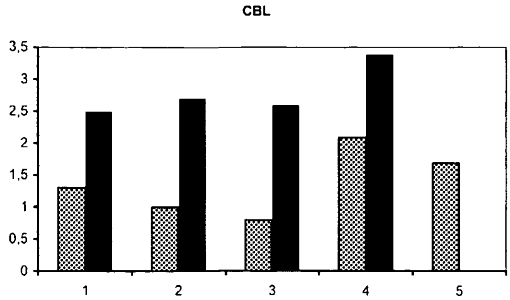
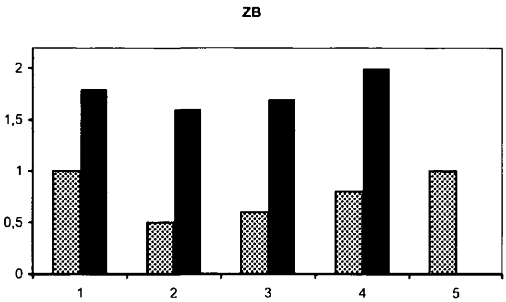
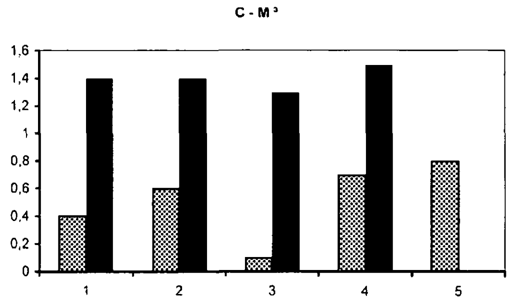
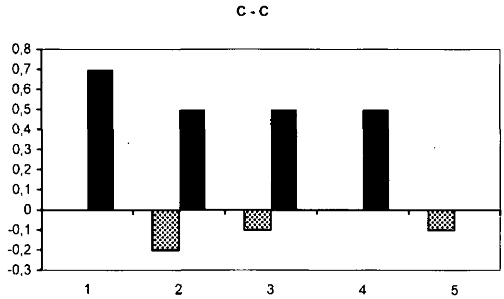


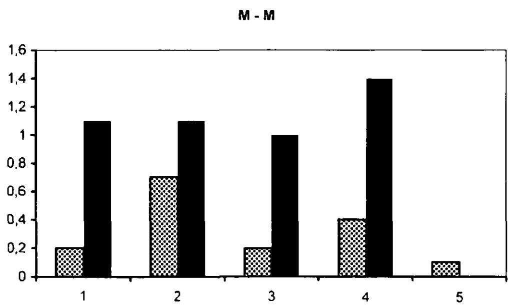
Fig. 4: Variation of mean values of skull measurements in 5 population samples of *M. myotis* (upper line) and *M. blythi* (lower line. Ordinate: population 1 - 5; abscissa: skull measurement in millimeters. 1: W Thrace (W of 25° E); 2: W Turkey (between 25° and 29° E); 3: Central Anatolia (between 29° and 35 ° E); 4: Levante (between 35° and 38 ° E); 5: East Anatolia E of 38°.

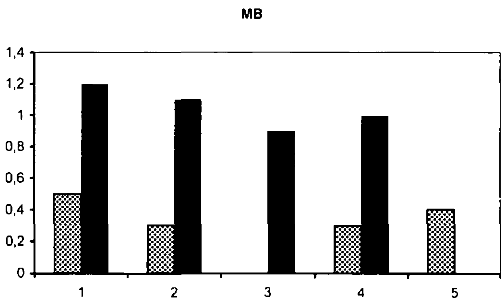












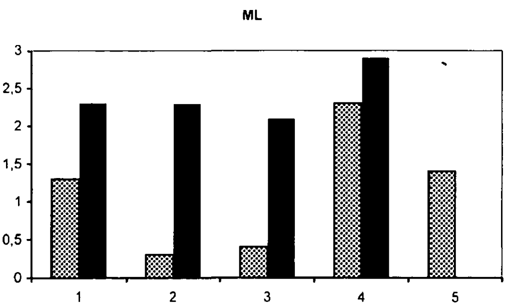


Fig. 5: Variation of interspecific distances of skull measurements in 5 population samples of *M. myotis* and *M. blythi*. Ordinate: populations 1 - 5 as in fig. 4. Grey column: distance between maximum value of *M. blythi* and minimum value of *M. myotis*. Black column: distance between mean values of skull measurement in *M. blythi* and *M. myotis*; abscissa: millimeters.

Subspecific variation

HARRISON & LEWIS (1961), STRELKOV (1972) and FELTEN (1977) reported the existence of a clinal increase of size in both species from W to E, i.e. from the small *M. blythi oxygnathus* in continental Europe to the large *M. b. omari* THOMAS, 1906 (terra typica Derbent, W Isfahan, Iran) and the small Central European and W mediterranean populations of *M. m. myotis* to the large *M. myotis macrocephalicus* HARRISON & LEWIS, 1961 (terra typica E Amchite, Lebanon) in the Near East. Lack of material from Asia Minor forced them to leave open the question whether *omari* and *macrocephalicus* were just the ends of stepless clines or clearly defineable taxa. BENDA & HORÁČEK (1995b), analyzing large material from the whole range of both species, decided, that in each species the marginal populations were separated from the central population by a distinct step in the overall cline and therefore deserved subspecific status.

The material presented here allows for the first time to observe the development of body and skull sizes of both species in the area between medium sized central populations and large sized eastern populations, namely from the SE-Balkans to Eastern Anatolia.

A tentative arrangement of samples according to biogeographic regions failed to produce any explicable pattern. But when samples were arranged strictly from W to E as in tab. 2, the measurements of both species increased more or less constantly.

The development of the mean values (fig. 4) of condylobasal length, mandible length and rostral breadth over M-M from W to E are similar in the facts, that the five population units of *M. blythi* exhibit a steady increase, and that the gradual increase in *M. myotis* is broken by the Levante population, which is distinctly larger than the neighbouring populations to the W and the E. A set of other measurements (zygomatic breadth, mastoid breadth and maxillary toothrow) produces rather similar patterns as the first set. The only difference is, that the Eastern Anatolian population of *M. blythi* is not larger than the Levante population. The rostral breadth over the canines, a measurement used already by STRELKOV (1972) to differentiate between *M. blythi* populations, follows a different pattern. The mean values of these measurements vary in remarkably parallel courses, with sharp increases in the Levante populations in both species and further increases in eastern direction. The mean values of the W Thrakian populations are more separated than in all other populations.

From the fact, that in the Levante population of *M. myotis* all measurements with the exception of C-C, which does not stop to increase in eastern direction, are on the average larger than in any other population of *M. myotis*, it seems justified to regard *M. myotis* from Adana, Hatay, Syria, Lebanon and Israel as a distinct subspecies, *M. myotis macrocephalicus* HARRISON & LEWIS, 1961.

In *M. blythi* most skull measurements increase gradually from W to E, only in C-C there is like in *M. myotis* a sharp increase in the Levante population. *M. b. omari* therefore seems to be a name for the end of a size cline (see measurements in table 2). It seems impossible to use the name to denominate a subspecies, as the range of such a subspecies cannot be defined.

STRELKOV (1972) realized the parallel development of skull measurements of sympatric populations of the two sibling species. He and later BENDA & HORÁČEK (1995b) discussed the question whether climatic influence or the necessity to keep a certain interspecific distance in size were the causes of this phenomenon.

As I found, that an arrangement of populations according to biogeographic (climatic) provenience did not result in any clear size pattern, I compared the amount of differences a) between the mean values of measurements regional samples of both species and b) between the maximal individual values in *M. blythi* and the minimal values in *M. myotis* (fig. 5). Keeping in mind, that the sample sizes are not large enough to test any results statistically, it seems, that the interspecific distances between the mean values remain more or less equal in the different populations, being largest in the Levant population (CBL, ML, C-M^3, ZB, and - less convincingly - in M-M). But in the mastoid breadth and the distance between the upper canines the interspecific distances between mean values grow smaller from W to E. In C-C there is either no difference or even an overlap in the variations.

As far as the interspecific distance between the extremes of variation is concerned, a special position of the Central Anatolian populations seems to be obvious. In comparison to other populations the difference is smallest there (in CBL, C-M, M-M and MB), or second smallest (in ML and ZB), which means, that individual variation of both species or one species is larger there than in other population.

To sum up, it can be stated, that in most skull measurements the differences between the mean values tend to remain more or less stable (exception C-C), but, notwithstanding this fact, the Central Anatolian populations are characterized by minimal distances between largest *M. blythi* and smallest *M. myotis* individuals.

Discussion

The distribution of *M. myotis* and *M. blythi* over the biogeographic regions of Turkey is characterized by a tendency to prefer more continental conditions in the smaller species and more humid conditions in *M. myotis*. This is concordant with the results of different authors, who found, that *M. myotis* in Central Europe feeds mainly on forest-dwelling beetles (BAUEROVA 1978, RUDOLPH 1989, AUDET 1990), whereas *M. blythi* preys here mainly on crickets in open, grassy habitats (ARLETTAZ et al. 1993). The differences in skull form and size are largely the result of different heaviness of the masticatory apparatus and for this reason can be accepted as an indicator of difference in feeding niches. The fact, that differences between skull sizes of sympatric populations remain largely the same, can be taken as indication for existence of food niche segregation in these populations.

But how does the coexistence in conditions, in which niche segregation is no longer possible work, like in the arid plains of Central Anatolia, where the vegetation consists of true steppe and steppe forest (WALTER & AKSOY 1986)? From ARLETTAZ' (1996) investigations on the diets of both species in Switzerland during the whole activity period we know, that both Mouse eared bats are opportunistic predators with highly flexible foraging behaviour, It must be assumed, that in treeless regions *M. myotis* is capable to switch to a diet different from the usual and that the diets of both species under such conditions are not as different as usual. It is interesting to see, that *M. myotis* in Central Anatolia does not shrink to the same or almost the same size as *M. blythi* in order to make use of the same prey as the smaller species. The mean values of most skull measurements remain eqally distant as in other populations, the individual variations of these measurements however is larger there than in other populations, suggesting that small *M. myotis* and large *M. blythi* there may feed on practically the same prey items.

Another question concerns the reason, why *M. myotis* reaches its specific boundary in Eastern Anatolia and Syria. Is it the lack of suitable prey?

The probably close interrelationships beween prey and skull parameters could provide a clue to the understanding of the reasons of the increase in skull size from W to E, the foundations of sympatric occurrence, range patterns and subspecific variations of the sibling Mouse eared bats. Food analyses of Anatolian populations of both species seem to be a prerequisite for further dealing with these questions.

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