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Contribution to the Distribution, Morphological Peculiarities, and Karyology of the Greater Noctule, *Nyctalus lasiopterus* (Chiroptera: Vespertilionidae), in Southwestern Turkey

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Abstract: The Greater Noctule, *Nyctalus lasiopterus*, was recorded from southwestern Turkey for the third time. The dorsal fur of the Greater Noctule, which also covers the underpart of the wing membrane, along with the forearm and propatagium, is uniformly dark brown. The cranium shows typical characteristics of the noctule bats. In addition to these, the exoccipital is convex and is markedly visible in the planar view of the skull. There is a small depression mid braincase. The dental formula is i: 2, c: 1, pm: 1, m: 3/i: 3, c: 1, pm: 2, m: 3 = 32. The diploid number of chromosomes and the number of chromosomal arms are $2n = 42$ and $FN = 54$, respectively.

Key Words: *Nyctalus lasiopterus*, distribution, morphology, karyology, Turkey

Büyük Akşamcı Yarasa'nın "*Nyctalus lasiopterus*" (Chiroptera: Vespertilionidae) Güneybatı Türkiye'deki Yayılışı, Morfolojisi ve Karyolojisi Üzerine Katkılar

Özet: Büyük akşamcı yarasa olarak bilinen *Nyctalus lasiopterus*'un üçüncü kaydı Güneybatı Anadolu'dan bu çalışmayla verildi. Bu türün propatagium'u ve önkolu boyunca kanat membranının alt kısmını da örten sırt kürkü homojen bir şekilde koyu kahverengidir. Kafa iskeleti cinsin karakteristik özelliklerini yansıtmaktadır. Bununla birlikte exoccipal kemik arkaya doğru konveks bir yapı göstermekte ve kafaya üstten bakıldığında belirgin olarak görülmektedir. Beyin kapsülünün orta kısmında küçük bir çöküntü bulunmaktadır. Diş formülü i: 2, c: 1, pm: 1, m: 3 / i: 3, c: 1, pm: 2, m: 3 = 32'dir. Diploid kromozom ve kromozom kol sayısı sırasıyla $2n = 42$ ve $FN = 54$ olarak saptanmıştır.

Anahtar Sözcükler: *Nyctalus lasiopterus*, yayılışı, morfoloji, karyoloji, Türkiye

Introduction

Turkey, which has territory both in Europe and Asia, plays an important role in biodiversity. Hosey (1982) supported the assumption that the Bosphorus is a geographical barrier separating populations of the Balkan Peninsula and southwestern Asia. Many climatic and vegetation types also serve as ecological and geographical barriers, enhancing local species richness (Akman and Ketenoğlu, 1986; Demirsoy, 2002). The number of bat species in Turkey, including recent taxonomic changes, exceeds 30, and the family Vespertilionidae Gray, 1825 is represented by 26 species (Wilson and Reeder, 1993; Demirsoy, 1996; Benda and Horáček, 1998; Benda and

Tsytulina, 2000; Horáček et al., 2000). This number was reported as 34 in Europe by Mitchell-Jones et al. (1999).

The Greater Noctule, *Nyctalus lasiopterus* (Schreber, 1780), ranges from northernmost Africa (Morocco and Libya) and western Europe (from France, Portugal, and Spain) through Switzerland, Italy, southeast Poland, Slovakia, and Hungary, and from the Balkans to Ukraine, European Russia (up to Moscow in the north), the Caucasus, Anatolia to Iran, Uzbekistan, the Ust-Yurt Plateau in Kazakhstan, and the Urals Mountains (to 53° E to 42° S and 57° N) (Koopman 1994; Horáček et al., 2000). Until now this species had only been known in

Turkey from Uludağ Mountain near Mustafakemalpaşa (Bursa province) (Kahmann, 1962) and from Rize (Karataş et al., 2007). Even though the Greater Noctule has a large distribution area, data on its distribution and geographical variation are rather sparse.

Until 1984, the karyotype of the Greater Noctule had not been investigated in Europe (Zima and Král, 1984); however, the karyology of *N. lasiopterus* was later studied in Japan by Ando et al. (1977) and Harada et al. (1982), and then in Greece by Volleth (1987). Subsequently, the Japanese population was considered a separate species, *Nyctalus aviator*. The aim of the present study was to contribute to the data on the distribution, geographical variation, and karyology of *N. lasiopterus* in Turkey.

Material and Methods

In August of 2006, 4 female specimens of *N. lasiopterus* were captured with a mist-net in the Çiğlıkara National Park near Elmalı (Antalya) (lat 36°31'N, long 29°49'E) (Figure 1). The morphological characteristics of these specimens were examined based on external and cranial measurements (in millimeters), and body weight (in grams) of each animal. The karyotypes of the 4 female *N. lasiopterus* specimens were analyzed using the conventional colchicine hypotonic citrate technique from bone marrow. The conventional stained chromosomes of metaphase cells were analyzed and photographed by light microscopy. By examining the photographs of about 20–30 metaphase cells of each animal, the diploid number of chromosomes (2n), the fundamental number of chromosomal arms (FN), and the number of autosomal arms (FN_a) were determined, along with metacentrics, submetacentrics, subtelocentrics, and acrocentrics, with respect to centromere positions. The specimens were skinned and stuffed in the standard museum manner. The karyotype preparations and animals examined were deposited at the Department of Biology, Ankara University.

Abbreviations used in the text

TBL: total body length; TL: tail length; HFL: hind foot length; EL: ear length; TrL: tragus length; TrW: tragus width; FAL: forearm length; TiL: tibia length; WSL: wingspan length; W: weight; ZB: zygomatic breadth; IC: interorbital constriction; GLS: greatest length of skull; CBL: condylobasal length; RW: rostrum width; MAB:

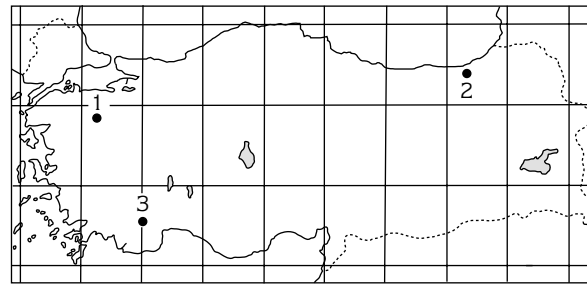


Figure 1. The first (1), second (2) and third record locations of *N. lasiopterus* in Turkey. 1. Uludağ Mountain, Mustafakemalpaşa (Bursa). 2. Rize, 3. Çiğlıkara, Elmalı (Antalya).

mastoid breadth; WB: width of braincase; HB: height of braincase; MAL: mandible length; UML: maxillary tooth row (C–M₃); LML: mandibular tooth row (C–M₃).

Results and Discussion

Distribution and Habitat

Individuals of *N. lasiopterus* were captured in the Çiğlıkara Nature Park (a protected area of 15,889 ha), which was established in 1991 and is a mountainous area covered by cedar (*Cedrus libani*) forest and juniper trees. From this area, 4 bats were caught in a forest clearing at an altitude of 1600 m using a mist-net. Mitchell-Jones et al. (1999) reported that this species occupies mixed forests with deciduous trees. The present study represents the first record of this species from a cedar forest. *N. lasiopterus* was first reported in Turkey near Mustafakemalpaşa, which is located on the west slope of Uludağ Mountain (Bursa province) in northwestern Turkey (Kahmann, 1962). More recently, the second specimen of the genus was recorded in the offshore platform around Rize by Karataş et al. (2007) (Figure 1). Our finding represents the third record of this species from Turkey and the first from the southwestern part of the country. When European records of this species are considered (Mitchell-Jones et al. 1999), they are rarer than the records of any other vespertilionid bat. These findings together with other rare records are thought to indicate vicariance in the distribution of the Greater Noctule.

According to Akman and Ketenoğlu (1986), the climatic zone of the record site of *N. lasiopterus* in southwestern Turkey is classified as Mediterranean humid-type, while that of Uludağ Mountain is Mediterranean semi-arid-type. Based on the record

locations and distribution area of the Greater Noctule in Turkey, it can be said that this species has wide climatic tolerance.

External Characters

The Greater Noctule is the largest species among the other representatives of the genus in Turkey. The maximum wing span was measured as 455 mm, and total body and forearm length of adults ranged from 152 to 162 mm, and 62 to 68 mm, respectively (Table 1). Other external measurements are given in Table 1. Dietz and von Helversen (2004) reported that forearm length varies from 64 to 68 mm and that the dorsal fur is uniformly reddish-brown. This report is generally consistent with our findings; however, a reddish color was not evident in our specimens. The dorsal color of our specimens is uniformly dark brown with no variation. The ventral fur is slightly lighter than the dorsal fur. The hairs covering the neck region are longer and a bit darker than those of the dorsal and ventral fur. The tip and bases of both the dorsal and ventral fur are almost the same color. The muzzle is broad with enlarged short ears. The tragus is short, broad, and mushroom-shaped, distally (Figure 2). The underpart of the wing membrane, along with the forearm and propatagium, are also covered by fur. The calcar is present and reaches almost midway to the tail

membrane, and the postcalcarial lobe is well developed (Figure 3). The tip of the tail protrudes from the interfemoral membrane by as much as 1-2 mm.

Cranial Characters

The skull is robust. The rostrum is square with the typical nasal slit and is curved downwards. The interorbital constriction is wide and the smooth braincase is turned markedly upwards posteriorly in the lambdoid crest of the braincase. There is also a marked small depression on the mid-braincase (Figure 4). Zygomatic arches are very slender. The sagittal crest is absent, but the lambdoid crest is well developed. The exoccipital condyles form the most posterior projecting point of the skull. The supraoccipital is markedly convex and is visible from above (Figure 4). There is a marked notch at the caudal margin of the palatine, and the pterygoid processes do not contact the anterior tips of the tympanic bullae, which are relatively small (Figure 5). The basisphenoid is wide and deep. The mandible is robust, and its coronoid, condylar, and angular processes are relatively small and not well developed. The coronoid process is not in an upright position and is markedly separated from the condylar process (Figure 6). In general, the cranial characteristics of our Greater Noctule specimens are similar to those described for *N. noctula* by Harrison and Bates (1991), and Dietz and von Helversen

Table 1. The external cranial measurements (mm) and weights (g) of *N. lasiopterus* specimens (n = 4).

	5628♀	5646♀	5647♀	5650♀	Mean (range)
TBL	162	155	152	157	156.5 (152–162)
TL	65	67	65	68	66.3 (65–68)
HFL	11	14.5	15	15	13.9 (11–15)
EL	23	21	21	23	22 (21–23)
TrL	9	10	9	9	9.3 (9–10)
TrW	6.5	6.5	7	7	6.8 (6.5–7)
FAL	68	65	66	62	65.3 (62–68)
TiL	28	23	21	23	23.8 (21–28)
WSL	455	445	444	420	441 (420–455)
W	44	42	45	39	42.5 (39–45)
ZB	15	14.5	14.7	14.2	14.6 (14.2–15)
IC	5.9	5.9	5.8	5.7	5.8 (5.7–5.9)
GLS	22.2	22.4	23	21.8	22.4 (21.8–23)
CBL	22.1	21.9	22.4	21.4	22 (21.4–22.4)
RW	9.3	9.3	9.8	9.4	9.5 (9.3–9.8)
MAB	9.7	9.8	9.4	9.5	9.6 (9.4–9.8)
WB	11.3	11.2	11.3	11.1	11.2 (11.1–11.3)
HB	8.6	8.7	8.9	8.3	8.6 (8.3–8.9)
MAL	17.3	16.6	17.2	17	17.0 (16.6–17.3)
UML	8.7	8.5	8.5	8.7	8.6 (8.5–8.7)
LML	9.1	9.1	9.6	9.5	9.3 (9.1–9.6)



Figure 2. Left side of the face of a stuffed *N. lasiopterus* specimen. Note the shapes of the ear and tragus.

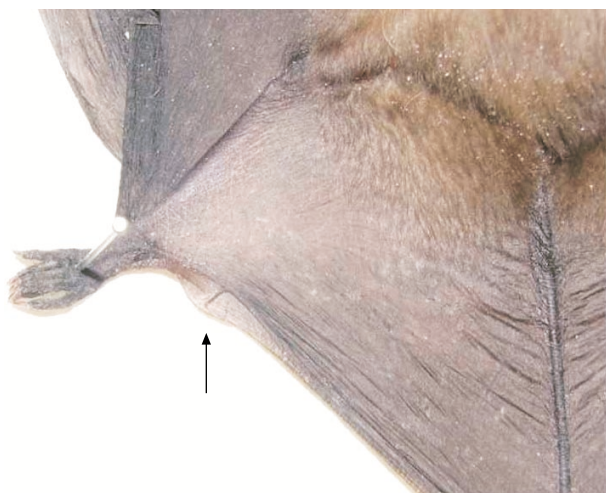


Figure 3. The left foot and postcalcarial lobe of *N. lasiopterus* from Elmali (Antalya).

(2004); this finding supports that there are no marked morphological differences between these 2 species, except for the metric characteristics.

The dental formula is $i: 2, c: 1, pm: 1, m: 3/i: 3, c: 1, pm: 2, m: 3 = 32$. The first upper incisor is markedly higher than the second one. The lower incisors are almost of the same height and are trifid. In general, tooth morphology is almost consistent with that of *N. noctula* given by Harrison and Bates (1991); however, these authors reported a different dental formula for *N. noctula* as $i: 2, c: 1, pm: 2, m: 3/i: 3, c: 1, pm: 2, m: 3 = 34$



Figure 4. Planar view on the skull of *N. lasiopterus* from Elmali (Antalya). Arrows indicate the supraoccipital protrusion (1) and depression on the braincase (2).

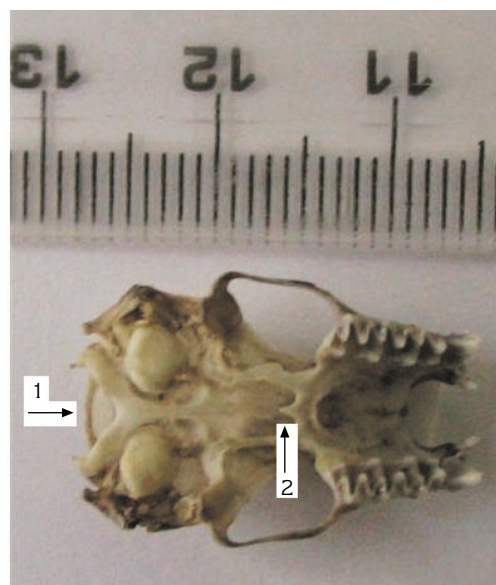


Figure 5. Ventral view of the skull of *N. lasiopterus* from Elmali (Antalya). Arrows indicate the supraoccipital protrusion (1) and palatal notch (2).

Karyology

The detailed karyotype of the Greater Noctule is herein reported for the first time for the Middle East and Europe. The diploid chromosome number is $2n = 42$. The

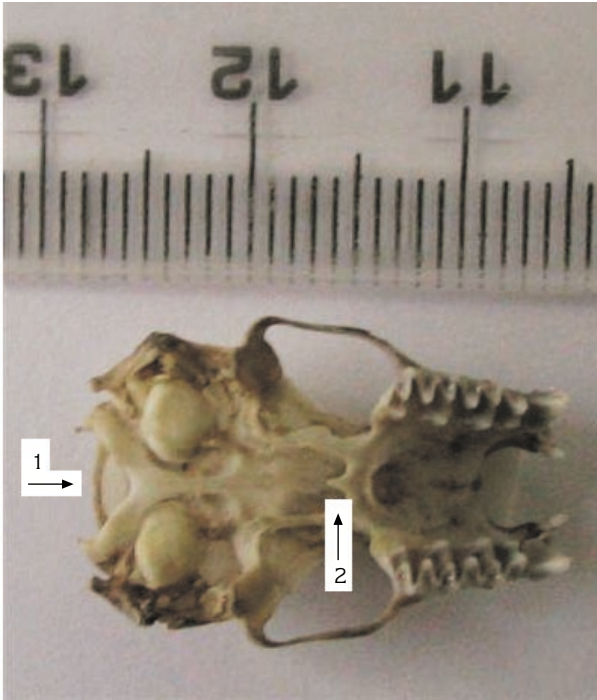


Figure 6. Left mandible of *N. lasiopterus* from Elmalı (Antalya).

chromosome set is composed of 12 metacentrics or submetacentrics, and 30 acrocentric chromosomes. The fundamental number of chromosomal arms (FN) and the number of autosomal arms (FN_a) is 54 and 52, respectively. Since we did not collect male individuals, the Y chromosome is not described in our study; however, considering the X chromosomes of other noctule species, we can postulate the X chromosome of the Greater Noctule is a medium-sized metacentric (Figure 7). The diploid chromosome number varies from 36 to 50 among the species of the genus *Nyctalus* (Ando et al., 1977;

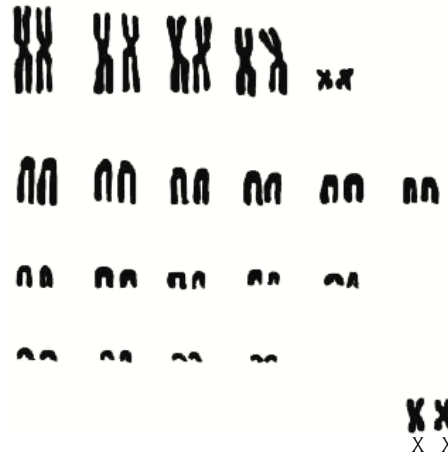
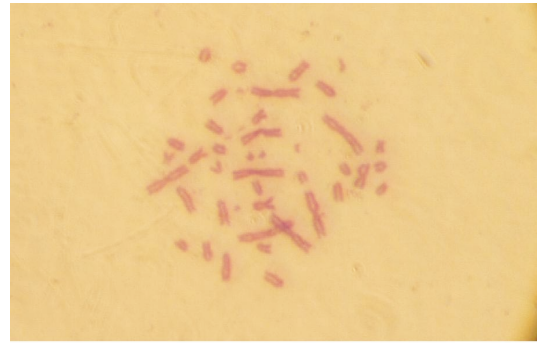


Figure 7. Karyotype of a female *N. lasiopterus* from Elmalı (Antalya): 2n = 50, FN = 54.

Zima, 1978; Harada et al., 1982) (Table 2). The diploid chromosome number of our specimens is consistent with that described from in Greece by Volleth (1987); however, she provided no data for the FN of the Greater Noctule. For this reason we did not compare the FN of Turkish specimens to European ones.

Table 2. Comparison of the chromosomal results for the species of the genus *Nyctalus*.

Species	2n	NF	X	Y	Reference
<i>N. velutinus</i>	36	52	M	?	Lin et al., 2002
<i>N. noctula</i>	42	50	M	Sm	Dulic et al., 1967
<i>N. noctula</i>	42	50	M	D _A	Vorontsov et al., 1969; Zima, 1978; Volleth, 1987
<i>N. aviator</i>	42	50	Sm	M	Ando et al., 1977
<i>N. aviator</i>	42	50	M	A	Harada et al., 1982
<i>N. lasiopterus</i>	42	-	-	-	Volleth, 1987
<i>N. lasiopterus</i>	42	54	M	-	This study
<i>N. furvus</i>	44	50	M	A	Harada et al., 1982
<i>N. furvus</i>	44	52	Sm	-	Ando et al., 1977
<i>N. leisleri</i>	46	50	Sm	-	Fedyk and Fedyk, 1970
<i>N. leisleri</i>	46	50	Sm	A	Zima, 1978
<i>N. leisleri</i>	46	-	-	-	Volleth, 1987

M: metacentric; Sm: submetacentric; A: acrocentric; D_A: dot-like acrocentric.

Further studies should be conducted in other parts of the Mediterranean biotope in Turkey. Additionally, further studies should address breeding biology and the interaction of the Greater Noctule with other species.

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