

Rhinolophus landeri.

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Rhinolophus landeri (Martin, 1837)

Lander's Horseshoe Bat

Rhinolophus landeri Martin, 1837:101. Type locality "Fernando Po."

Rhinolophus lobatus Peters, 1852:41. Type locality "Africa orientalis, Sena, Tette" (=Sena, Mozambique) restricted by Moreau et al., 1946:399 (see below).

Rhinolophus angolensis de Seabra, 1898:250. Type locality "Hanza, Angola."

Rhinolophus dobsoni Thomas, 1904:156. Type locality "Kordofan," province, Sudan.

Rhinolophus axillaris Allen et al., 1917:429. Type locality "Aba, Uele district, Belgian Congo." (=Republic of Congo).

CONTEXT AND CONTENT. Order Chiroptera, Suborder Microchiroptera, Family Rhinolophidae, Subfamily Rhinolophinae, Genus *Rhinolophus*. The family is monogeneric; the single genus *Rhinolophus* includes all 69 extant species (Nowak, 1991). There are three recognized subspecies of *R. landeri* (Koopman, 1994):

R. l. landeri Martin, 1837:101, see above.

R. l. lobatus Peters, 1852:41, Type locality "Sena, south bank of Zambesi River, Sena District, Mozambique," restricted by Moreau et al., 1946:399 (*axillaris* Allen and *dobsoni* are synonyms).

R. l. angolensis de Seabra, 1898:250, see above.

Koopman (1982) includes *R. l. angolensis* in *R. l. landeri*, whereas Hayman and Hill (1971) and Koopman (1975) treat it as a member of the *R. landeri* group, without specifying its status therein.

DIAGNOSIS. *Rhinolophus landeri* can be distinguished from other rhinolophids by the shape of its lancet. The concave lancet from the posterior noseleaf has a narrowly pointed shape whereas in other species the margins are almost straight and the lancet is an equilateral triangle (Rosevear, 1965). The greatest breadth of the horseshoe is less than 9 mm (Smithers, 1983).

In the field, *Rhinolophus landeri* is most similar to *R. blasii* and *R. alcyone*. *R. landeri* can be distinguished from *R. blasii* using the following characters: first phalanx of the fourth finger is notably shortened in relation to metacarpal length in *R. landeri*, but not *R. blasii*; connecting process is pointed in *R. landeri* but rises to a high narrow horn in *R. blasii*; molar width is less than half the width of the palate between molars in *R. landeri*, but more than half the palate width in *R. blasii* (Meester et al., 1986; Smithers, 1983). *R. landeri* can be distinguished from *R. alcyone* using the following characters: forearm length <48 mm in *R. landeri* and >49 mm in *R. alcyone*; skull length is <21 mm in *R. landeri* and >22 mm in *R. alcyone* (Hayman and Hill, 1971; Meester et al., 1986; Rosevear, 1965).

GENERAL CHARACTERS. Rhinolophids have a complex nose-leaf outgrowth of skin around the nostrils, consisting of three parts that vary among species in size, shape and arrangement (Nowak and Paradiso, 1983; Rosevear, 1965). In general, the anterior noseleaf is broad, thin, and shaped like a horseshoe. It is deeply notched at the midpoint of the anterior margin and includes the nostrils in a depression at the inner margin. It is positioned above the upper lip and covers the sides and top of the muzzle (Fig. 1). The posterior triangular noseleaf (lancet) is pointed at the apex, slightly erect, and attached only at the base. Both the horseshoe and lancet are flat. The central noseleaf comprises an erect transverse flap (sella), flattened from side to side, that is positioned between the eyes and nostrils. The sella is attached at its base by folds and ridges, and connected to the posterior noseleaf by a ver-

tical connecting process. The two lobes at the base of the sella form a receptacle that may be open or closed and varies in depth according to species (Rosevear, 1965).

The pelage of *R. landeri* and the molt cycles are similar between sexes and subspecies. However, the pelage of *R. landeri* does vary in color. In Nigeria, near Shagunu on the Niger River, the dorsum can be sepia gray (gray-brown) or may vary in color from dirty yellow to bright reddish-golden. The lighter golden color likely results from high ammonia concentrations in the guano and so is environmentally induced (Menzies, 1973). In Rio Muni, west Africa, the color of the pelage varies among specimens from orange-brown to dark gray-brown; one individual was pale gray-brown (Jones, 1971). The underparts are a paler shade of the upper body color, and the wing and interfemoral membranes are dark brown (Smithers, 1983). The golden phase has been captured all year round. However, male and female *R. landeri* may molt into the gray phase; both gray bats and gold bats with gray or naked shoulders have been caught during May and July. Young bats are gray but their color turns to gold by November (Menzies, 1973).

The characteristic feature of the skull is a dome situated just above the nasal aperture (Fig. 2). On either side of this projection the skull is deeply emarginate (Smithers, 1983). Cranial measurements (in mm) for *R. landeri* from northwest Nigeria include the following: length of condylocanine, 18-19.5; length of canine to M3, 6-6.5; width across M3, 6-7; with no differences between sexes (Menzies, 1973). Cranial measurements (in mm) for *R. l. landeri*: total length of skull, 17.2-19.7; length of canine to M3, 6.3-7.1; width across M3, 6.4-7.0 (Rosevear, 1965). Additional skull measurements (in mm) for two male specimens from Rio Muni (Ikunde and Bolondo counties): length of condylobasal, 15.2 and 15.4; zygomatic breadth, 9.2 and 9.6; interorbital breadth, 1.7 and 1.9; length of maxillary toothrow, 6.3 and 6.4; length of mandibular toothrow, 6.7 and 7.1 (Jones, 1971). Gape distance ($\bar{X} \pm 1 SD$) is 6.60 ± 0.20 ($n = 3$; O'Shea and Vaughan, 1980). The two upper incisors are mounted in a partly cartilaginous projection of the palatine bone and are set forward of the canines. The lower incisors are trifid. The small anterior upper premolar is visible to the naked eye and lies in the toothrow, separating the canines from the posterior premolars (Rosevear, 1965). The lower anterior premolar is 0.5-0.75 the height of the posterior one, and the middle premolar is external to the toothrow. The dental formula is $i 1/2, c 1/1 p 2/3, m 3/3$, total 32. Young horseshoe bats shed milkteeth before birth (Nowak and Paradiso, 1983).

Rhinolophus landeri is a medium sized rhinolophid. Body measurements (range, in mm) for the *R. landeri* group are, total



FIG. 1. Lateral view of the head of *Rhinolophus landeri* from Zimbabwe. Photograph courtesy of M. B. Fenton.

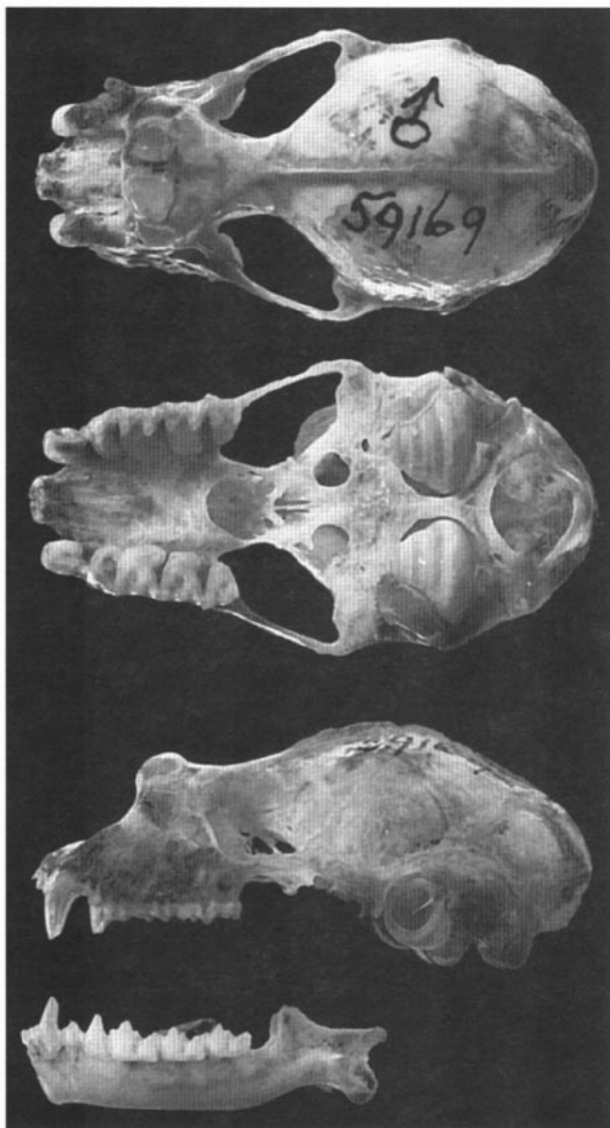


FIG. 2. Dorsal, ventral, and lateral views of cranium and lateral view of mandible of *Rhinolophus landeri* (ROM 59169, male), from Diani Beach, Kenya. Greatest length of skull is 18.7 mm. Photographs courtesy of the Royal Ontario Museum.

length, 75–81; length of tail, 22–31; length of forearm, 38–45; length of tibia, 16.5–18.5; length of ears, 15–17. External measurements (in mm) of two male *R. landeri*: total length, 75.0 and 76.0; length of tail, 22.0 and 23.0; length of forearm, 42.0 and 43.5; length of hind foot, both 9.0; length of ears, both 16.0 (Jones, 1971). In another study, length of forearm was 38.0–41.0 mm, mean 39.2 mm, with no differences noted between sexes (Menzies, 1973). Body measurements (in mm) for *R. l. landeri* are, length of forearm, 40.5–44.5; length of tibia, 16.5–18.5 (Rosevear, 1965). Body measurements (in mm, $n = 8$ individuals) for *R. l. lobatus* include head to tail, 78–81; length of tail, 25–31; length of forearm, 42.5–45; length of ears, 15–17 (Smithers and Wilson, 1979).

The body mass of *R. landeri* is 5–11 g; the mean mass varies among studies. *R. landeri* from northwest Nigeria had a mean mass of 7.0 g (Menzies, 1973), whereas those from Kruger National Park (Pafuri region) had a mean (± 1 SD) body mass of 9.0 ± 1.0 g ($n = 7$ —Aldridge and Rautenbach, 1987). In the Transvaal males had masses of 10–11 g (Rautenbach, 1982), whereas two males from Rio Muni had masses of 8.6 and 9.2 g (Jones, 1971). *R. l. landeri* had an average mass of 6.2 g (Rosevear, 1965). *R. l. lobatus* had a mean mass of 6.0 g; the range was 5.0–7.0 g ($n = 10$ —Smithers and Wilson, 1979).

The ears are well separated and capable of independent movement. The inner margin of the ear is convex and the outer margin

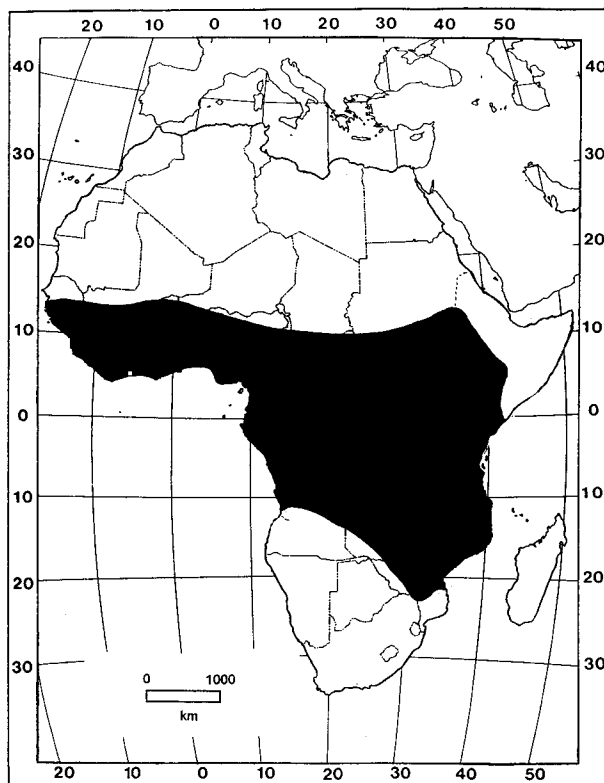


FIG. 3. Geographic distribution of *Rhinolophus landeri* (taken from Smithers, 1983).

is convex at the base with an abrupt concavity near the apex, forming a sharp outwardly-curving tip. The tragus is absent but the antitragus occurs as a large flap across the bottom of the ear (Rosevear, 1965). No sexual dimorphism has been reported for this species.

DISTRIBUTION. *Rhinolophus landeri* occurs in the Northern Tete district, Mozambique northwards from about 24°S, Malawi, southeastern and northwestern Zambia, Republic of Congo, Tanzania, Somalia, Uganda, Kenya, Ethiopia, Southern Sudan, Central African Republic, westwards to Cameroon, Nigeria, Burkina Faso, Sierra Leone and Gambia, and southwards to Northern Transvaal, Angola, and Zimbabwe (Fig. 3—Meester et al., 1986; Smithers, 1983). This bat is poorly represented in collections in the southern regions of its distribution, such that there is only one specimen from Angola and five specimens from the Transvaal (Smithers, 1983). In west Africa, *R. landeri* is predominantly a forest species. However, in the southern parts of the range, south of the Sahara and into the southern African subregion (Zimbabwe, Mozambique, and the Transvaal), it occurs in savanna and riverine woodlands and other well-watered areas (Smithers, 1983).

Lander's horseshoe bats have been reported at an altitude of 2,000 m on Mount Elgon in Kenya (Aggundey and Schlitter, 1984). On Cameroon Mountain they have been taken at an altitude of 1,200 m and at 900 m on Bintamane Mountain in Sierra Leone (Rosevear, 1965). Little is known about the geographic distribution of subspecies. *R. l. lobatus* has been reported in Sudan (Koopman, 1975), whereas *R. l. landeri* is thought to occur in west Africa east to Cameroon (Kock, 1969).

The Rhinolophidae are known from the late Eocene to Recent in Europe, and from the Recent over the present range (Nowak and Paradiso, 1983). The genus *Rhinolophus* is Recent (Nowak, 1991).

FORM AND FUNCTION. Echolocation in rhinolophids is specialized for flutter detection via Doppler-shifted echoes of narrow-band signals produced at high duty-cycle for locating and targeting flying insects. Echolocation sounds are emitted through the nose. The search-phase echolocation calls of *R. landeri* in the Pafuri region of Kruger National Park are constant frequency-frequency modulated (CF-FM) in shape, with frequency range of 105–

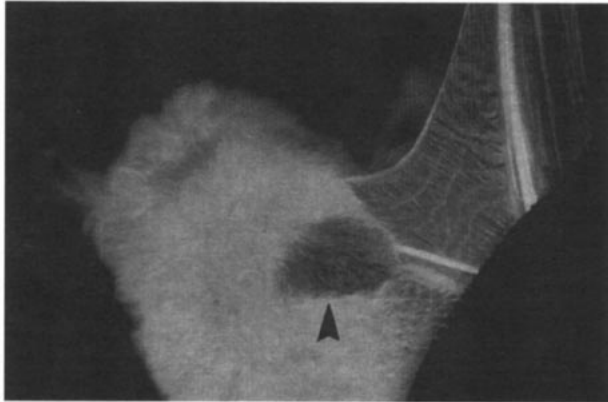


FIG. 4. Darkened tuft of stiff hairs lying in the glandular armpit sac of *Rhinolophus landeri* from Zimbabwe (indicated by arrow). This is a lateral view of the torso, left side of the bat. Photograph courtesy of M. B. Fenton.

110 kHz and a duration of 15 ms (Aldridge and Rautenbach, 1987). In rhinolophids, the terminal component of echolocation calls is usually only moderately broad, averaging 15–20 kHz. However, the FM sweep of *R. landeri* may be as much as 40 kHz (Hill and Smith, 1984). The peak frequency of 100–110 kHz during the constant frequency portion of their call is less conspicuous than lower peak frequencies to moths that detect echolocation calls of bats (Fenton, 1985).

The pulse rates of hand-held *R. l. lobatus* appeared to fall into three categories, but they may be modifications of each other (Novick, 1958). The duration (range, in ms) of each group of pulses are as follows: long pulses, 25 to >45, with two or three brief modulations of amplitude by about 50%; medium pulses consisting of alternating high intensity (2.2–22, average of 8) and low intensity (2.5–8, average of 5) periods of sound; and short pulses, 2.3–11, average 7. The pulses of flying *R. landeri* show the same patterns of either long pulses or trains of alternating high and low frequencies. None of these pulses, in either hand-held or flying bats, varies in their frequency pattern (Novick, 1958). The midportions of the calls averaged 82 kHz, with a range of 73–84 kHz. This is quite different from the midpoint of 55 kHz for a hand-held *R. landeri* (O'Shea and Vaughan, 1980).

Flight parameters (mean \pm 1 SD, $n = 7$) for *R. landeri* caught in Kruger National Park (Pafuri region) were as follows: body mass (m), 9 ± 1.0 g; wing-loading (Qs), 6.7 ± 0.3 Nm⁻²; aspect ratio (R), 6.1 ± 0.3 ; wingtip shape index (I), 2.6 ± 1.2 . Bats with these characters—relatively low mass (<15 g), wing-loading (6–8 Nm⁻²), aspect ratios (5.5–6.5), and flight speeds (minimum flight speed = 3.5–4.5 ms⁻¹), with relatively high maneuverability and clutter-resistant echolocation calls, should be able to maneuver and forage in cluttered habitats. In a flight tunnel, the minimum inter-string distance (minimum negotiable distance, MND) that an individual *R. landeri* could negotiate was 0.11 m ($\bar{X} \pm 1$ SD, 0.16 ± 0.04 m, $n = 5$; Aldridge and Rautenbach, 1987).

Some males have tufts of stiff hairs lying in a glandular sac in the armpits (Fig. 4). When these hairs are present, axillary nipples are well developed. These tufts appear to be seasonal and are likely a secondary sexual characteristic associated with scent dispersal during sexual behaviour (Kingdon, 1974).

ONTOGENY AND REPRODUCTION. In general, rhinolophids reach sexual maturity at two years of age. *R. landeri* is monoestrous with a litter size of one. South of the equator (i.e. the austral cycle), copulation occurs in June and the gestation period is about three months. Young likely are born during the warm wet season from September to November. In Kivu, Tanzania, one pregnant female was caught on 28 August (Anciaux de Faveaux, 1978a). In Zimbabwe, one pregnant female was taken in October (Smithers, 1983). In Malawi and near Kibwezi, Kenya, young were born in November (Happold and Happold, 1990; O'Shea and Vaughan, 1980). In all reported cases, litter size was one. North of the equator (i.e. the boreal cycle), copulation and ovulation occur in November, gestation occurs from February to April, and young are usually born in late April and early May (Anciaux de Faveaux,

1978a; Menzies, 1973). In Nigeria, some females caught in November had morulae present in the fallopian tubes and sperm in the uteri, but none was pregnant (Menzies, 1973). The unattached trophoblasts in the uteri and large corpora lutea in the ovaries indicate that ovulation occurs in late November; only the left uterine horn is functional. In male *R. landeri*, testes also reach their maximum size (50% larger than in July) in November; sperm are present, however, in the testes and epididymes from July through December (Menzies, 1973). None of the females collected in Nigeria during late December was pregnant, and serial sections revealed unattached trophoblasts in the uterus and large corpora lutea in the ovaries. No development of the unattached trophoblast occurs in December or January. The two-month delay of implantation (i.e. delay of development) may be explained by climatic conditions (e.g. rainfall and flooding); parturition at a time of increased humidity may favor the development of young (Menzies, 1973; but see Krutzsch, 1979). Gestation occurs from February to April, and some embryos are half grown by March. In the Nuba mountains and in Jebel Digodo, Sudan, 13 females each carried an embryo on 30 March (Kock, 1969). Young are born in late April and early May, at which time most males leave the colony, and some adults begin to molt. Neonates and young up to 1 month of age may be carried by their mothers while foraging. By the end of May, the young born earliest in the season are flying independently. Lactation and molting continue through June (Menzies, 1973). By July, most females have ceased to lactate, but some individuals may still be molting. Males return to the colony in July.

ECOLOGY AND BEHAVIOR. The most important habitat requirement of *R. landeri* for diurnal rest and breeding is a quiet roost site (Rosevear, 1965). *R. landeri* are gregarious and roost in caves, mine adits, and in crevices amongst piles of boulders. The number of individuals within a roost may depend on roost size (Smithers, 1983). Lander's horseshoe bats were found roosting in a hollow baobab tree (*Adansonia digitata*—Fenton, 1975). Some individuals also have been taken from water wells (Koopman et al., 1978) and buildings (Rosevear, 1965). In Nigeria, as many as 1,000 individuals roosted in one horizontal cleft measuring 5 m wide, 1–2 m high and approximately 10–15 m deep (Menzies, 1973). Near Sultan Senoussi, Central African Republic, hundreds of *R. landeri* occupied a cave with *Hipposideros caffer*, *Coleura afra* and *R. fumigatus* (Schlitter et al., 1982). However, to the south, roosts usually contain 1–12 individuals (Smithers, 1983). In Nyakishozi, Rwanda, a small colony contained 12 *R. landeri* (Verschuren, 1965). In Shaba, Republic of Congo, colonies of *R. l. lobatus* range in size from 20 to 50 individuals, often in association with *H. ruber* and *R. fumigatus* (Anciaux de Faveaux, 1978b). Individuals do not cluster in roosts, but hang from the ceiling with their wings wrapped around the body and the interfemoral membrane folded up over the back. *R. landeri* have been captured at cave entrances using mist nets and taken by hand while roosting (Schlitter et al., 1982). Specimens have also been caught with mist nests stretched over water and as they flew into houses (Jones, 1971). They are hardy in captivity, feeding eagerly on live insects after a few trials, and accept the constraints of cage life calmly. They also learn more rapidly than most bats and are trainable (Novick, 1958).

The habitat surrounding one *R. landeri* roost was sparsely wooded, transitional (Guinea-Sudan) savanna. They were also found near a narrow but clear band of riverine forest along the banks of the nearby Niger River (Menzies, 1973). In Kenya, *R. landeri* were collected in dense thornscrub with scattered patches of grassland (O'Shea and Vaughan, 1980). These authors noted the intersection of the Athi River with the study area, and also described a thin strip of riparian vegetation in that area which differed from the rest of the surrounding region.

Rhinolophus landeri is a flutter detector (Barclay and Brigham, 1991) and takes flying prey, usually moths (Fenton et al., 1977). The majority of insect wings (92%) found beneath a *R. landeri* roost were noctuid moths along with the wings of one butterfly, *Charaxes varanes* (Fenton, 1975). They usually forage within 6 m of the ground. O'Shea and Vaughan (1980), who classify *R. landeri* as an aerial insectivore, found that *R. landeri* forages at a mean height of 1.0 m (range 0.0–2.0 m).

Rhinolophus landeri has broad and rounded wings adapted for slow and maneuverable flight to hovering, with the flight path fluttery and butterfly-like. They fly with their mouths closed except when capturing an insect. Since their short tails and interfemoral

membranes are too small to form a pouch to hold insects, large prey are tucked under the arm while the bat manipulates it with its mouth (Nowak and Paradiso, 1983).

A number of parasitic mites has been reported from *R. landeri* including *Eyndhoveria euryalis* and *Paraperiglischrus rhinolophinus* (Spinturnicidae), *Bewsiella fledermaus* (Macronyssidae), *Whartonia atracheata* (Leeuwenhoedidae), and *Labidocarpoidea guineae* (Chirodiscidae). *R. l. lobatus* has been reported to be host to *Spinturnix walderae* and *Steatonyssus benoitii* (Spinturnicidae—Anciaux de Faveaux, 1976).

GENETICS. The karyotype of *R. landeri* consists of a diploid number of 58 and a fundamental number of 60; four autosomes are biarmed. The X chromosome is submetacentric, the Y is unknown. In other rhinolophids, the diploid number ranges from 54 to 62, the fundamental number ranges from 60 to 62, the X chromosome is submetacentric, and the Y chromosome is acrocentric (Rautenbach, 1986).

REMARKS. The specific epithet for *Rhinolophus landeri* commemorates an early west African explorer, Richard Lander. Some workers have combined the family Hipposideridae with Rhinolophidae (Honacki et al., 1982), but others disagree (Meester et al., 1986). The Hipposideridae differ from the Rhinolophidae in the form of the noseleaf, foot structure, absence of the lower small premolar, and the structure of the shoulder and hip girdles (Nowak and Paradiso, 1983). In the Hipposideridae, the noseleaf complex sometimes has secondary leaflets and an erect transverse leaf that corresponds to the lancet in the noseleaf of Rhinolophidae. The transverse leaf is usually divided into three cell-like parts, the apices of which may produce a point. Hipposiderids lack a sella which is characteristic of rhinolophids. The toes of hipposiderids have only two bones, as opposed to three in the Rhinolophidae (except the first toe—Nowak and Paradiso, 1983).

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