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Description of a new species of *Dryomys* (Rodentia, Myoxidae) from Balochistan, Pakistan, including morphological comparisons with *Dryomys laniger* Felten & Storch, 1968, and *D. nitedula* (Pallas, 1778)

Mary Ellen Holden

Abstract. A new species of *Dryomys* (Rodentia, Myoxidae) is described from the Balochistan province of Pakistan. Its morphology is compared with those of *D. laniger* and *D. nitedula*. The new species and *D. laniger* both have greatly inflated auditory bullae, as well as enlarged sphenopterygoid vacuities. This does not necessarily indicate close relationship of the two because *D. laniger* has other unique specializations that suggest the similarities between the species might be convergent. For now the phylogenetic relationships among species of *Dryomys* remain unresolved. Differences in climate and plant associations where the new species and *D. nitedula* occur in Pakistan are also discussed.

Key words. Mammalia, Rodentia, Myoxidae, Leithiinae, *Dryomys*, new species, *Dryomys laniger*, *D. nitedula*, *D. sichuanensis*, taxonomy, nomenclature, Pakistan, Balochistan, vegetation.

Introduction

Forest dormice (genus *Dryomys*) first appear in the fossil record in the early to middle Miocene (Daams 1981; Hartenberger 1994). *Eliomys* is the closest extant relative of *Dryomys* (Wahlert et al. 1993), and together the two genera form the Leithiini, one of two tribes that comprise the myoxid subfamily Leithiinae (Holden 1993; Wahlert et al. 1993). Through personal correspondence some workers have expressed dissatisfaction with the usage of the subfamily name Leithiinae for the phylogenetically related genera *Myomimus*, *Selevinia*, *Eliomys*, and *Dryomys*, because they feel that the extinct giant dormouse *Leithia* is such a derived genus that its name is not appropriate as a group name for the genera listed above. However, the usage of Leithiinae it is not a matter of personal preference, but a consequence of the nomenclatorial history of the subfamily outlined in Holden (1993: 765–766):

"Lydekker (1895) proposed the family Leithiidae to separate the giant Pleistocene dormouse of Malta from other myoxids, and *Leithia* for the type genus. Major (1899) argued that *Leithia* was in fact a myoxid, and Leithiidae a junior synonym of Myoxidae. De Bruijn (1967) proposed Dryomyinae, which included *Leithia*, *Dryomys*, *Eliomys*, and other genera. The International Code of Zoological Nomenclature (1985) mandates that when a nominal taxon is lowered in rank in the family group, its type genus remains the same. Because Dryomyinae de Bruijn contains *Leithia*, the correct name for the subfamily is Leithiinae."

Unless the phylogenetic relationship of *Leithia* with the above genera is disproved, the valid subfamily name is Leithiinae.

Holden (1993) and Wahlert et al. (1993) discuss priority of the family name Myoxidae (type genus *Myoxus* Zimmermann, 1780) over Gliridae (type genus *Glis* Brisson, 1762). There has long been controversy over the validity of Brisson's name,

because they are not Linnaean or binomial. The conservation of 11 of Brisson's mammalian names, including *Glis*, has recently been proposed by Gentry (1994), based on the argument that these names have had historical common usage, and this proposal is currently under consideration by the International Commission on Zoological Nomenclature. The argument of common usage for "over 230 years"(Gentry 1994) is incorrect in the case of *Glis*. As was explained in Wahlert et al. (1993), Gliridae has only been the most commonly used family name for dormice since 1945. The preference for Gliridae over Myoxidae arose with Simpson's (1945) classification of mammals; this work was cited in the Zoological Record for the year 1945, and the change from Myoxidae to Gliridae occurred in that volume (Wahlert et al. 1993). Simpson's (1945) endorsement of Gliridae was based purely on his by no means universally agreed upon opinion that Gliridae was unoccupied, and even if his opinion is accepted, he did not address the unavailability of the type genus name *Glis*. Hopwood (1947) clearly presents the unavailability of *Glis* for dormice. Therefore, whether or not one wishes to conserve Brisson's names is in this case irrelevant. *Glis* can be conserved, but it is not available for dormice. The oldest available name for dormice is *Myoxus* Zimmermann, valid in Linnaeus (1788) for dormice, and the valid family name is therefore Myoxidae (see also Holden 1993; and Wahlert et al. 1993).

Three extant species are currently recognized in the genus *Dryomys*: *D. laniger* Felten & Storch, 1968, *D. nitedula* (Pallas, 1778), and *D. sichuanensis* (Wang, 1985). The purpose of this paper is to describe and diagnose a new species of *Dryomys* from Balochistan, Pakistan, and to provide morphological comparisons by which the new species, *D. laniger* and *D. nitedula* may be distinguished. *Dryomys sichuanensis* was not available for inclusion in this study, but is discussed below and in Holden (1993).

D. laniger is known only from Karst regions in the western and central Toro (Taurus) mountains of Turkey, from 1620 to 2000 meters (Felten & Storch 1968; Spitzenberger 1976). All known specimens (21) were included in this study for comparison with *D. nitedula* and the new species. *D. laniger* and *D. nitedula* have been collected at nearby localities near Çiğlikara, Turkey, but appear to be ecologically and altitudinally separated (Felten & Storch 1968; Spitzenberger 1976).

D. nitedula has a broad distribution ranging from southeastern and central Europe, north and east to Russia, the Caucasus, the Balkans, Turkey, the Middle East, Afghanistan, Pakistan, and Central Asia. Holden (1993) details the distribution of *D. nitedula*, and gives citations of records of the species in each region. Representative samples of *D. nitedula* (total of 85 specimens) from Europe, Russia, the Middle East, the Caucasus, the Balkans, Afghanistan, Pakistan, and Central Asia were included in this study.

Dryomys sichuanensis was originally described as the only member of a new genus, *Chaetocauda*, and was placed in the subfamily Myomiminae (Wang 1985). However, based on Wang's (1985) comparative chart and photograph, the shape and details of the cranium (including proportions of the rostrum, nasals, palate, post-palatal region, and the zygomatic plate) and mandible are very similar to those of *Dryomys*, and the specimen in the photograph is not easily separable from some examples of *D. nitedula* examined for this study. Holden (1993) recognized *sichuanensis* as a distinct species of *Dryomys* pending further information, but the specific status of *D. sichuanensis* needs to be supported by a careful, comparative systematic study that

includes samples of all species of *Dryomys*, as well as *Myomimus*, to test Wang's (1985) assertion that the Sichuan material is more closely related to that genus. An emended description and diagnosis of *D. sichuanensis* would be a valuable first step in assessing the phylogenetic affinities of the sichuan dormouse. *Dryomys sichuanensis* is known only from the type locality, a subalpine deciduous and coniferous forest in the Sichuan highlands (Wang 1985). Comparative material of *D. sichuanensis* was not available for inclusion in this study.

There has been no comprehensive revision of *D. nitedula* throughout its vast range; only a few regional studies are available. Craniodental characters and habitat data were analyzed for the subspecies in the former Republic of Yugoslavia by Kryštufek (1985). Ondrias (1966) discussed the taxonomy of the subspecies in Greece and southeastern Europe. A discussion of geographic variation of pelage color was given by Roesler & Witte (1969). Ognev (1947; 1963) provided a review and diagnoses based on pelage color for the subspecies occurring in the independent republics of the former U. S. S. R.. Rossolimo (1971) revised the subspecies of the independent republics of the former U. S. S. R. using cranial measurements and coat coloration. Of the preceding studies, only Kryštufek's (1985) includes bullar measurements. In this study, relative inflation of the bullae was found to be the most reliable cranial character in distinguishing the new species from *D. nitedula* and *D. laniger.*

Materials

Location of specimens: Specimens examined for this study are housed in the collections of the American Museum of Natural History, New York (AMNH); the Natural History Museum, formerly the British Museum (Natural History), London (BM(NH)); the Field Museum of Natural History, Chicago (FMNH); Naturhistorisches Museum Wien, Wien (NMW); Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt am Main (SMF); the National Museum of Natural History, Smithsonian Institution, Washington, D. C. (USNM); and Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn (ZFMK).

Specimens examined: **New species**, n = 3: Pakistan, Balochistan, 1 mi E of Ziarat, BM(NH) 79.687—88, 2 ♀; Pakistan, Balochistan, Urak, 6500 ft, AMNH 217346 ♀. ***Dryomys laniger***, n = 21: Turkey, Antalya, NMW 20460—62, 1 ♂ and 2 ♀; Turkey, Antalya, 20 km SSE Elmali, Bey Dağlari, Çiğlikara, 2000 m, SMF 33830 ♀; Turkey, Antalya, Bey Dağlari, Çiğlikara, NMW 20459 ♀; Turkey, Konya, Hadim Yayla, NMW 19311 ♀, Turkey, Konya, 25 km S Hadim, Inlice Yayla NMW 14494—95, 14500—01, 1 ♂ and 3 ♀; Turkey, Konya, 2 km W Kaş Yayla, NMW 14477—78, 1 ♂ and 1 ♀; Turkey, Niğde, northern Ala dağlari, Kara göl, NMW 20616 ♀; Turkey, Niğde, northern Ala dağlari, Yayla, NMW 20617 ♀; Turkey, Niğde, Madenköy, NMW 13274—76, 1 ♂ and 2 ♀; Turkey, Niğde, mtns S of Madenköy, NMW 13285—88, 1 ♂, 2 ♀ and 1?. ***Dryomys nitedula***, n = 85: Afghanistan, 17 mi. W. Kabul, Paghman, approx. 2600 m, BM (NH) 47.388—47.390, FMNH 103800—802, 103804—05, ZFMK 94.83, 4 ♂ and 5 ♀; Afghanistan, Salang-Nord, 2550 m, ZFMK 78.151 ♂; Austria, Galicia, BM(NH) 7.7.7.2886 ♀; Austria, Steiermark prov., Kleinalm, AMNH 176461 ♀; Azerbaijan, Zakataly distr., AMNH 176248 ♀; Croatia, Velika Kapela, Šuma Dumanic, 1030 m, BM(NH) 47.1082 ♂; Georgia, Bol'shoy Kavkaz (Caucasus), BM(NH) 75.12.1.1 ?; Greece, Tatoi, BM(NH) 8.10.2.24 ♀; Hungary, Herculesbad, BM(NH) 7.9.16.13—14, 1 ♂ and 1 ♀; Iran, Azarbayjan, Moghan, BM(NH) 77.3018 ?; Iran, Bakhtiari Va Chahar Mahall prov., Zagros mountains, Kuhrang Dam, 2624 m, BM(NH) 66.6740—41 2 ♀; Iran, Elburz mtns, 36 km W Firuz-Kook, USNM 341583 ♀; Iran, Esfahan, FMNH 112328 ♀; Iran, Kordestan, Hezar Darreh (Gezardarreh), FMNH 97682 ?; Iran, Kordestan, Sameleh, FMNH 97678—80, 3 ?; Iran, Lorestan, Khorramabad, AMNH 171194 ♀; Iran, Tehran, BM(NH) 25.9.9.2 ?; Iran, Tehran, 11 km ENE Tasham, USNM 369886 ♀; Iran, Tehran, 4 km N Varangrud, FMNH 97677 ♂; Italy, Cadore reg., Padola, USNM 174695 ♂; Kazakhstan, Alma-Ata, AMNH 245386 ♂; Kazakhstan, Panfilov (Djarkent), BM(NH) 14.5.10.75 ♂; Lebanon, Cedars of Lebanon (Cedres du Liban), BM(NH) 47.344 ?; Pakistan, Dir reg., 16 mi N. Dir, 2756

m, USNM 413716–19, 2 ♂ and 2 ♀; Pakistan, Kurram Valley, BM(NH) 7.6.8.4 ♂; Pakistan, Swat Kohistan, 5 mi. N of Kalam Rest House, USNM 413714–15, 2 ♂; Pakistan, Swat Kohistan, 6 mi. SW Utror, 2920 m, USNM 413720–21, 1 ♂ and 1 ♀; Israel, Jermaq, BM(NH) 51.323 ♀; Poland, Bialowieza forest, 108–215 m, BM(NH) 58.581, 59.283, 2 ♂; Romania, Carpathian mtns., Tatra Mountains, BM(NH) 19.7.7.2753 ♀; Romania, Dobrudscha BM(NH) 12.9.12.14–16, BM(NH) 12.12.17.12, 1 ♂, 2 ♀ and 1 ?; Russian Federation, northern Bol'shoy Kavkaz (Caucasus), Terasouskogo reg., BM(NH) 37.6.12.35 ♀; Russian Federation, Dagestanskaya Respublika, Usherskoye, AMNH 206584 ♀; Switzerland: Graubünden canton, Vulpera, Tarasp, 1000–1500 m BM(NH) 66.2723 ♂; Turkey, FMNH 122600–601, 2 ?; Turkey, Bitlis, Tatvan, FMNH 82164–65, 2 ♂; Turkey, Cilicischer Taurus, Burucek, ZFMK 64.703 ♀; Turkey, Cilicischer Taurus, Pozanti, 1400 m, ZFMK 65.192 ♀; Turkey, Murat Dağı, Ushak, 2461 m, BM(NH) 5.10.6.2 ♀; Turkey, Tatvan, Vansee-Gebiet, 1750m–1850 m, ZFMK 68.297–68.304, 68.306–307, 68.309–310, 6 ♂ and 6 ♀; Turkey, Ulu Dağlari, 1400 m, USNM 327716–718, 2 ♂ and 1 ♀; Turkey, Ulu Dağlari, Bursa, BM(NH) 61.362 ♀; [former Yugoslavia] Republic of Macedonia, Korab Mountains, Cos-Alija, 1500–1550 m, BM(NH) 37.2.22.92–93, 37.3.22.95–97, 3 ♂ and 2 ♀; [former Yugoslavia] Republic of Macedonia, Prilep, Markova, Kula, BM(NH) 34.11.7.21 ♀; [former Yugoslavia] Serbia: Beograd (Belgrade) BM(NH) 75.8.24.4 ?.

Methods

Age criteria: Specimens were assigned to one of four age classes based primarily on stage of tooth eruption and wear, although degree of fusion of cranial sutures and pelage characteristics were also evaluated. Young adults through old adults were included in the principal components analysis and in computation of descriptive statistics and the ratio diagram.

Juvenile:	DP4 still present, or P4 not yet even with molar row.
Young Adult:	P4 level with the molar row, but exhibits little or no wear, and molars show little or no wear.
Adult:	All teeth display moderate wear (lingual and buccal facets worn, transverse ridges worn but not obliterated)
Old Adult:	All teeth very worn and sometimes sharply beveled or eroded buccaly, many or all transverse ridges obliterated or distorted, teeth often flattened almost down to the roots.

Sexual dimorphism: There are not enough examples of the new species, or *D. laniger*, to test whether there is significant sexual dimorphism. Kryštufek (1985) found no statistically significant differences between males and females of *D. nitedula*.

Anatomical terms: Most of the cranial foramina and ossifications referred to are illustrated for dormice in Wahlert et al. (1993), with the exception of the sphenopterygoid vacuities, and mesopterygoid and pterygoid fossae, which are figured in Musser & Holden (1991: 346).

Measurements: Cranial and dental measurements were taken with dial calipers graduated to tenths of millimeters. The limits of each measurement as taken by me are illustrated in figure 1. Skin measurements and body weights are those recorded by collectors on the original skin tags. Measurements are abbreviated in the text as follows:

LHB	length of head and body
LT	length of tail
LHF	length of hind foot
LE	length of ear
WT	weight, in grams
CIL	condylo-incisive length
ZB	zygomatic breadth
IB	interorbital breadth
BBC	breadth of braincase
BR	breadth of rostrum
LN	length of nasals
LD	length of diastema

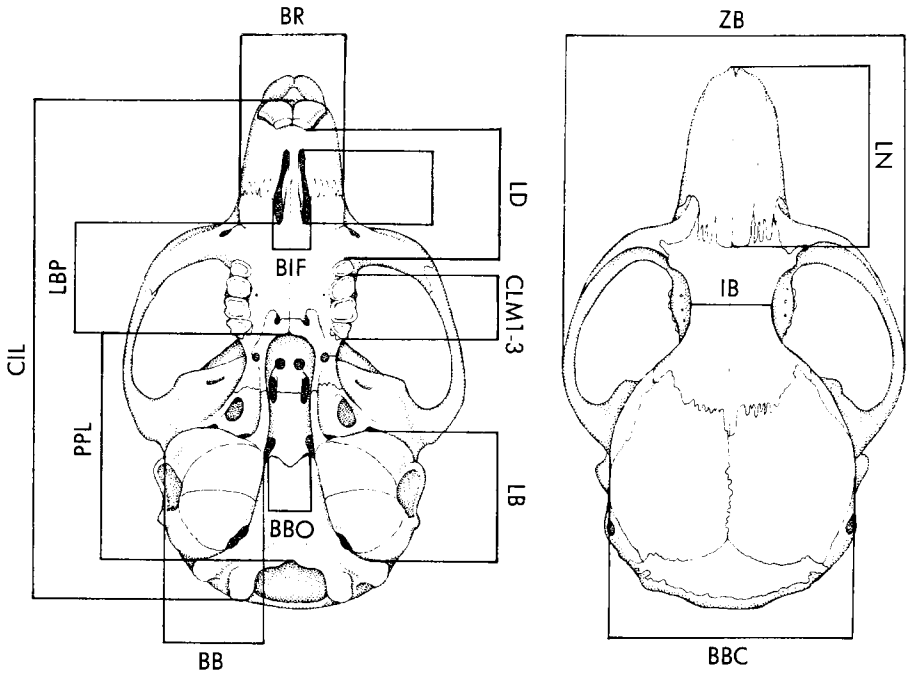

Fig. 1: Dorsal and ventral views of an adult *Dryomys nitedula* showing limits of cranial and dental measurements.

LBP	length of bony palate
LIF	length of incisive foramina
BIF	breadth of incisive foramina
CLM1−3	crown length of M1−M3
PPL	post-palatal length
LB	length of audirory bullae (to the anterior margin of the paraoccipital process)
BB	breadth of auditory bullae
BBO	breadth of the basioccipital.

Statistics: Descriptive statistics were calculated for each species (table 1). The geographically scattered samples of *D. nitedula* were pooled due to the very few numbers of specimens from each locality (often one specimen per locality). In addition, many crania were either broken or of juveniles, and could not yield complete measurement sets. I could not divide the specimens in such a way that reasonable geographic samples would yield enough complete or complimentary measurement sets to estimate means. Large series of the forest dormouse are uncommon, although Rossolimo (1971) did have access to large samples from several of the independent republics of the former U. S. S. R.. All samples of *D. laniger* were pooled due to small sample sizes, but because the species has a very limited geographic range the pooled samples may well represent one population. The three specimens of the new species are from two nearby localities and are considered to exemplify one population.

Differences between two sample means were tested by t-tests, and were considered significant at the $\alpha = 0.05$ level or lower.

Ratio diagram: Proportional craniometric relationships among species are illustrated by a ratio diagram (fig. 9). For each measurement, the absolute value of the mean and plus and minus two standard errors of the mean were converted to logarithms. For each dimension, the logarithm of the mean of the standard (*Dryomys nitedula*) was subtracted from the logarithm of the mean of *D. laniger* and the new species, and the logarithms of plus and minus two standard errors of the mean of the standard were subtracted from the logarithms of plus and

minus two standard errors of the mean of the two comparative species. A species with the same proportions as the standard will be represented by mean values on a line parallel to that of the standard regardless of absolute size. If values for the species being compared with the standard are similar in absolute size, they will be close together on the diagram. Proportional differences will be indicated by deviation from a comparative species' hypothetical parallel line along the horizontal scale.

Principal components analysis: A principal components analysis was performed in SYSTAT 5.0 on a variance-covariance matrix computed from six log-transformed dimensions: length of hind foot, condylo-incisice length, crown length of the upper tooth row, length of bullae, breadth of bullae, and breadth of the basioccipital. These particular dimensions were chosen because they were informative and obtainable from most specimens; other measurements available from the same set of specimens had relatively low scores and did not aid in separation of the samples in multivariate space when included.

Dryomys niethammeri, new species

Holotype: BM(NH) 79.688, an adult female collected by D. G. W. Fulk, Rodent Control Research Center, original number CS958. There is no collecting date recorded on the skin tag, but the specimen was probably collected in 1976 (T. J. Roberts, personal comm.), and was accessioned by the BM(NH) in 1979 (P. D. Jenkins, personal comm.). The preparation consists of a stuffed skin in good condition (fig. 2) and slightly damaged skull (left jugal missing, right jugal broken, posterior margin of bony palate and left hammular process broken) (fig. 3).

Skin measurements recorded by the collector, and craniodental measurements taken by me are listed in table 1.

I verified the usual myoxid count of 8 mammae on the type skin: one pectoral, one post-axillary, one abdominal and one inguinal pair.

Type locality: Pakistan: Balochistan province; 1 mi E of Ziarat (30.25 N, 67.49 E).

Referred specimens: BM(NH) 79.687, collected from the type locality, and AMNH 217346, obtained from Pakistan, Balochistan, Urak (30.16 N, 67.11 E), 6500 ft.

Distribution: The known distribution of *D. niethammeri* includes only the localities at which the three referred specimens were taken, near Ziarat and in the Urak Valley at 6500 feet, in northeastern Balochistan (fig. 5). No additional information is recorded either on the holotype or on a second specimen taken at the type locality, but T. J. Roberts (personal comm.), who was in charge of establishing the Vertebrate Pest Control Center for which George Fulk collected, recalls that these animals were collected at an altitude of approximately 8500 feet. Roberts and colleagues trapped intensively near Ziarat, but collected only 7 dormice, including the holotype and second specimen housed at the BM(NH), plus 5 specimens in the collections of the Vertebrate Pest Control Laboratories of the Pakistan Agricultural Research Council. These additional five specimens are likely representatives of *D. niethammeri*, but unfortunately I was unable to verify their identity, because they could not be loaned for this study due to their fragile condition. Based on many trap nights during 1977–79, Roberts and colleagues (T. J. Roberts, personal comm.) found *D. niethammeri* to be uncommon in Balochistan. The five specimens collected by them were caught in snap traps baited with ripe fruit. Afsar Mian did not obtain *Dryomys* during 940 trap nights spent in Ziarat and Choatair (A. Mian, personal comm.).

A dormouse was seen by Jeremy A. W. Anderson, a keen and reliable naturalist, in Wam (just north of Ziarat), and a dormouse was trapped by him in the Ghishk range near Harboi (T. J. Roberts, personal comm.; also see discussion under *D. nitedula* in Roberts 1977: 249). The AMNH specimen of *D. niethammeri* from Urak was also collected by Anderson. If the specimen from Ghishk was preserved, its whereabouts are unknown. It is possible that the Wam sighting and Ghishk animal represented *D. niethammeri*, as the localities are in the same phytogeographic region as the new species.

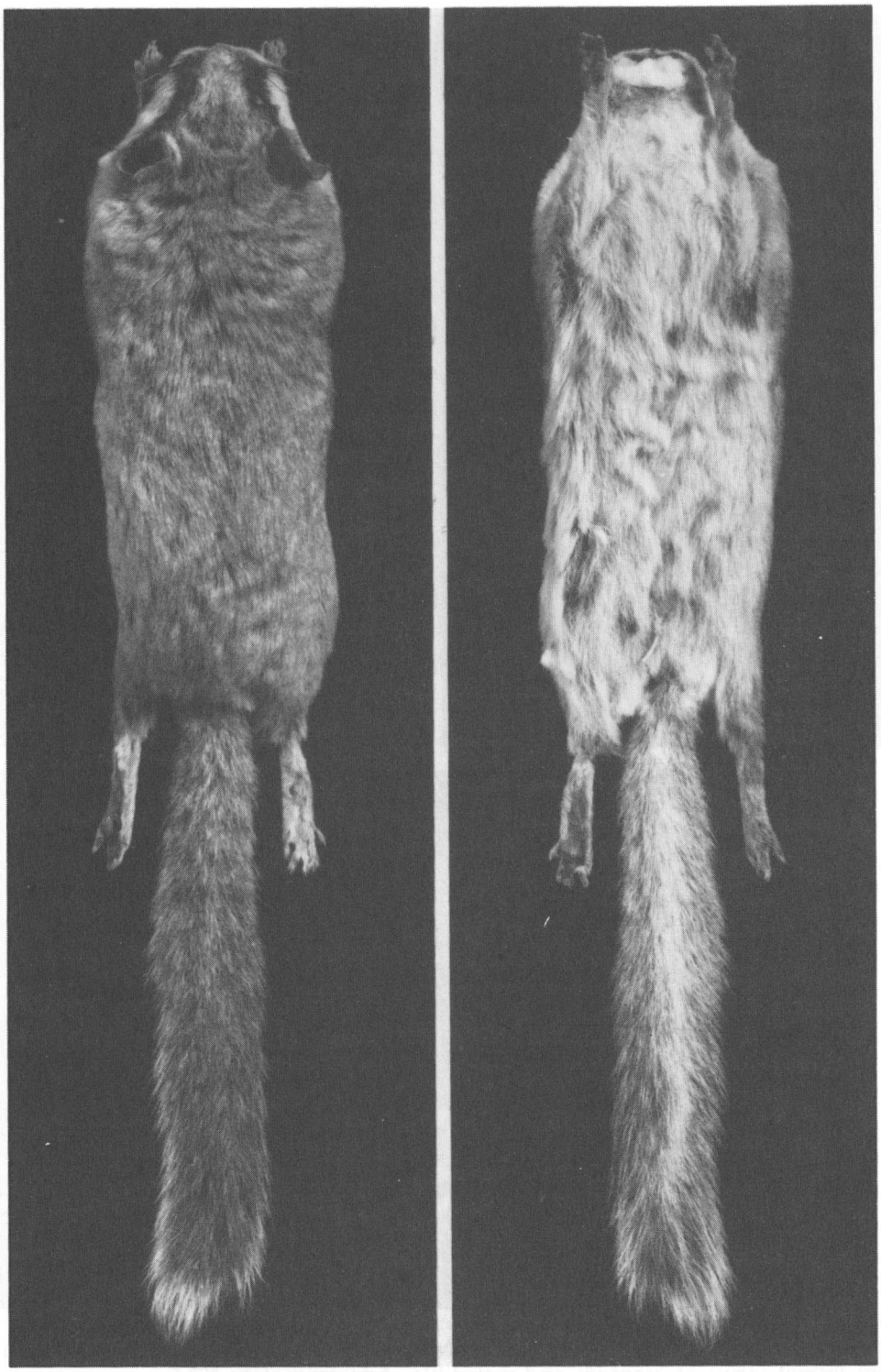

Fig. 2: *Dryomys niethammeri*, holotype (BMNH 1979.688). Dorsal and ventral views of stuffed skin.

Etymology: This species is named for Jochen Niethammer, whose extensive mammalian research encompasses forest dormice and biogeography of the Middle East and adjacent countries.

Fig. 3: *Dryomys niethammeri*, holotype (BMNH 1979.688). Dorsal and ventral views of cranium; lateral views of cranium and mandible. Approximately X2.5.

Diagnosis: *Dryomys niethammeri* is easily distinguished from *D. nitedula* and *D. laniger* by its absolutely and relatively larger bullae in length and breadth (figs. 6—9). The length and breadth of the incisive foramina are also absolutely and proportionally greater than those of the other two species examined (figs. 6, 9).

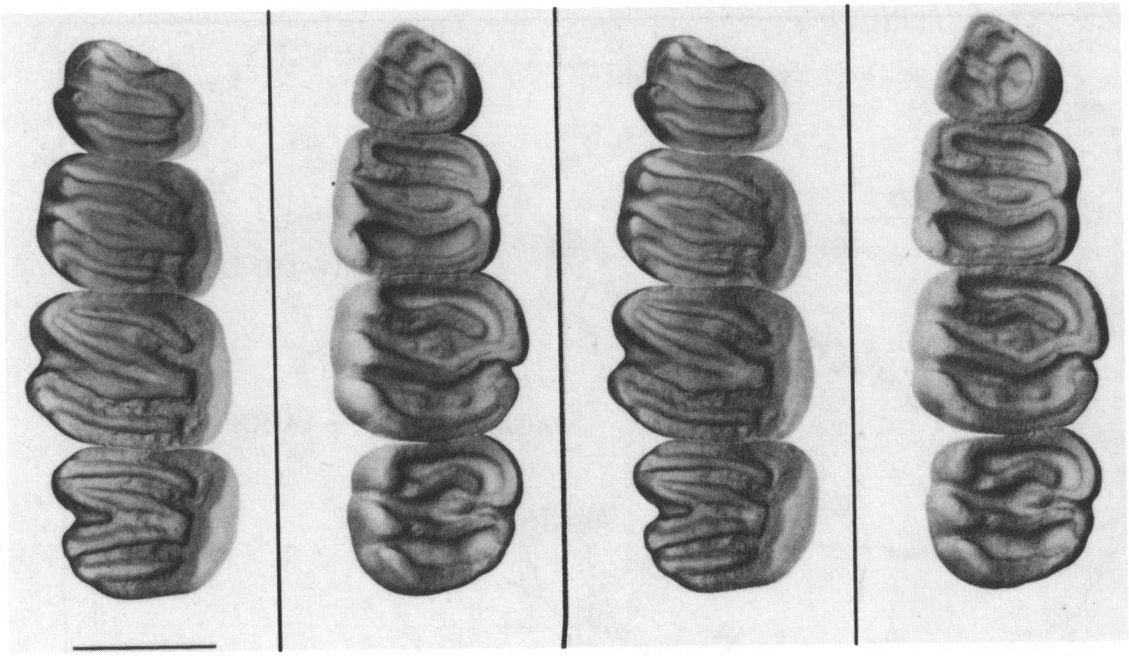

Fig. 4: *Dryomys niethammeri* (AMNH 217346), stereo pair of upper right and lower left dentition. P4 is at the top, left side is labial. Scale bar equals approximately 1 mm. (Reprinted from Wahlert et al. 1993, in which it was labeled *D. nitedula*).

Description of holotype and comparison with other species of *Dryomys*

Description: *Dryomys niethammeri* has pale fur and a tail approximately equal in length to head and body (table 1; fig. 2). The adult dorsal coat is an ashen tawny grey. The individual hairs are dark grey basally, with a broad ochre-cream middle band, and dark brown tips. Dark brown guard hairs are scattered inconspicuously throughout the dorsal fur. The underparts appear uniformly cream; the hairs are pure cream from the base to the tips. Some slightly longer hairs are sparsely distributed throughout the venter and may represent guard hairs; they too are cream from base to apex. The ventral coloration is moderately well demarcated from that of the dorsal pelage. The hairs of the dorsal fur measure 11—13 mm, and the guard hairs reach 15—16 mm. The underfur averages 5 mm, and the scant guard hairs are approximately 7 mm in length. Dorsal surface of the fore and hind feet are cream. A broad, brownish-black face mask begins in the midst of the whiskers, completely encompasses the eye, and terminates just anterior to the front of the ear (fig. 2). The band is broader over the eye, and is reduced to a thin line beneath. The tail appears tawny flecked with grey and cream above, with a conspicuous cream tip (fig. 2). This appearance is due to some of the individual hairs being dark grey at the base, with a broad cream middle band and dark brown tip. Other hairs are cream up to the dark brown apex. The ventral surface of the tail is paler than the upper side (fig. 2), and is mostly cream with some of the dark grey hair bases showing through. The young adult specimen from Urak has a greyer dorsal coat with a dilute tawny wash, and the tail is darker grey above and not as pale below as the two adults from near Ziarat.

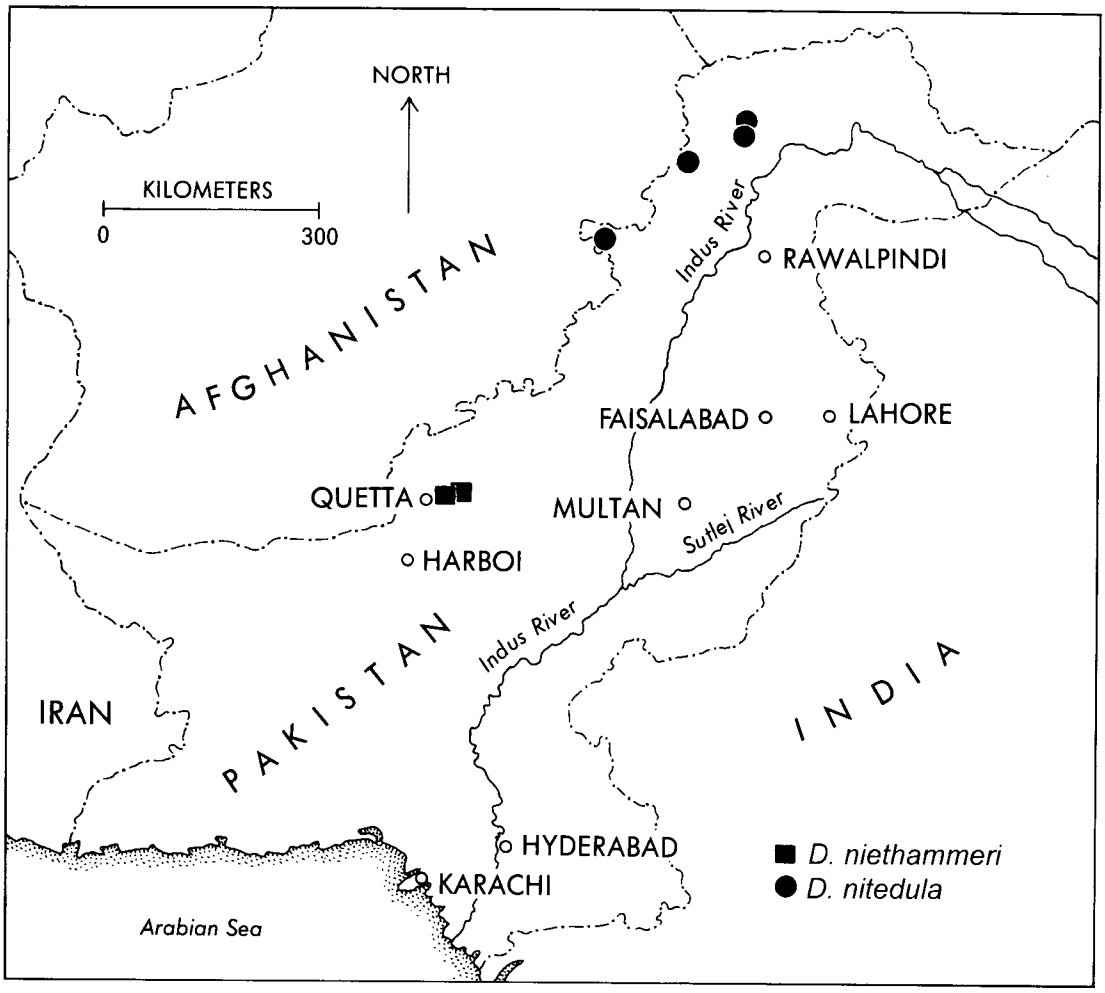

Fig. 5: Geographic distributions of *D. niethammeri* and *D. nitedula* in Pakistan.

The cranium is similar in size to that of *D. nitedula* (table 1; figs. 3, 6, 9). From a dorsal perspective the contours of the skull of the new species resemble those of *D. nitedula*, except that the inflated mastoid region of the auditory bullae results in a wider cranium posteriorly (figs. 4, 6), and the interorbital breadth is narrower relative to condylo-incisive length (fig. 9).

The relatively and absolutely large bullae dominate the basicranium of *D. niethammeri* (figs. 3, 6, 8, 9). The inflation of the bullae is so great that the basioccipital and basisphenoid bones are reduced to thin slivers. Large sphenopterygoid vacuities in the pterygoid fossae merge with the sphenopalatine vacuities dorsal to the palatine and hamular process sutures (fig. 8). The postpalatal region is elongated. The incisive foramina are constricted anteriorly, and are relatively long and broad (figs. 3, 5, 9).

When viewed laterally the distended bullae again are the most distinctive feature (figs. 3, 7). The dilated external auditory meatus is also evident, as is the greatly inflated mastoid region of the bullae.

Table 1: Comparisons of measurements (mm), and weight (g) among species of *Dryomys*. The mean plus or minus one SD, range (in parentheses), and number of specimens are listed for each measurement.

	D. niethammeri		*D. nitedula*	*D. laniger*
	Holo-type	Pakistan (Including holotype)	Europe, Russia, Middle East, Central Asia	Turkey
LHB	99	101.0±2.82	97.2±9.70	89.9±3.96
		(99—103) 2	(72—115) 55	(81—96) 17
LT	93	93±0.0	87.7±11.88	66.9±6.15
		1	(61—119) 44	(51—74) 15
LHF	21	21.0±0.0	21.0±1.51	16.8±1.10
		2	(18—24) 55	(13.8—18.2) 17
LE	18	19.9±1.41	14.9±2.38	14.4±1.38
		(18—20) 2	(10.5—21) 52	(11.3—16.6) 16
WT	33	33.0±0.0	28.9±7.11	22.2±3.73
		1	(20.0—42.1) 11	(13.9—27.9) 17
CIL	25.3	25.2±0.26	23.9±1.15	23.1±0.76
		(24.9—25.4) 3	(21.0—25.7) 56	(21.4—24.8) 17
ZB	15.9	15.9±0.0	15.7±0.85	14.4±0.47
		1	(14.0—17.6) 30	(13.7—15.5) 13
IB	4.1	3.9±0.15	4.1±0.19	4.2±0.16
		(3.8—4.1) 3	(3.8—4.6) 39	(3.9—4.4) 18
BBC	13.3	12.9±0.75	12.8±0.39	12.6±0.26
		(12.0—13.3) 3	(11.9—13.6) 37	(12.2—12.9) 12
BR	—	5.1±0.14	5.1±0.35	4.4±0.16
		(5.0—5.2) 2	(4.5—5.7) 28	(4.2—4.6) 15
LN	9.1	9.3±0.26	9.1±0.44	8.4±0.47
		(9.1—9.6) 3	(7.9—10.0) 36	(7.4—9.3) 13
LD	6.5	6.3±0.20	6.3±0.34	5.8±0.25
		(6.1—6.5) 3	(5.4—6.9) 39	(5.2—6.2) 18
LBP	—	5.2±0.07	5.3±0.31	5.2±0.35
		(5.1—5.2) 2	(4.7—6.0) 37	(4.7—6.0) 15
LIF	4.0	3.9±0.06	3.6±0.29	3.4±0.20
		(3.9—4.0) 3	(2.9—4.2) 39	(2.9—3.6) 17
BIF	2.2	2.2±0.06	2.0±0.19	1.9±0.11
		(2.2—3.3) 3	(1.6—2.3) 39	(1.7—2.1) 18
CLM1—3	2.9	3.0±0.10	3.1±0.19	2.9±0.16
		(2.9—3.1) 3	(2.5—3.5) 59	(2.4—3.1) 18
PPL	—	12.1±0.35	11.1±0.66	10.7±0.35
		(11.8—12.3) 2	(9.4—12.5) 53	(9.9—11.4) 14
LB	8.8	9.0±0.15	7.3±0.45	8.1±0.21
		(8.8—9.1) 3	(6.5—8.3) 60	(7.7—8.6) 18
BB	5.8	5.9±0.15	5.0±0.29	5.3±0.18
		(5.8—6.1) 3	(4.2—5.6) 55	(5.0—5.7) 17
BBO	1.5	1.4±0.10	2.0±0.26	1.4±0.16
		(1.3—1.5) 3	(1.4—2.7) 57	(1.1—1.7) 16

The dentition of *D. niethammeri* is illustrated in figure 4. A detailed description and comparison of its teeth with those of *D. nitedula* and *D. laniger* is beyond the scope of this paper. The variation of dental characters in *D. nitedula* in southeastern Europe, the Middle East and Afghanistan has been documented by Daams (1981). Many of the samples of *D. nitedula* included here were studied at their home institutions and were not available to me for detailed examination under a high-powered microscope. The upper and lower dentition of *D. laniger* were illustrated in Felten & Storch (1968); however, variation of ridge patterns within the species has not been documented. Therefore, any attempted comparisons of dentition among the three species of *Dryomys* included here could be potentially misleading.

Comparison with *D. nitedula:* In overall size, general dorsal conformation of the skull, and relative cranial proportions, *D. niethammeri* and *D. nitedula* appear similar (figs. 6, 9), except for the wider mastoid region of *D. niethammeri*, noted above, and the narrower interorbital breadth relative to condylo-incisive length in *D. niethammeri* (fig. 9).

Viewed ventrally, the greatly swollen bullae of *D. niethammeri* readily distinguish that species from *D. nitedula* (figs. 6, 8). *Dryomys niethammeri* differs significantly from *D. nitedula* in length ($p < 0.0017$ and breadth ($p < 0.01$) of bullae, as well as breadth of the basioccipital ($p < 0.02$). The ratio diagram (fig. 9) shows how each of these dimensions of the new species differs relative to those of *D. nitedula*. Particularly conspicuous is the extremely narrow basioccipital of *D. niethammeri* when compared with *D. nitedula*; it is similar in actual size and proportion to that of *D. laniger*, which is a smaller animal than either the new species or *D. nitedula*. The length and breadth of the incisive foramina, as well as the length and breadth of the bullae are shown to be proportionally greater relative to condylo-incisive length, as compared with *D. nitedula* (fig. 9). In addition the crown length of molars 1—3 is shorter relative to condylo-incisive length in *D. niethammeri* than in *D. nitedula* (fig. 9).

The wide spatial separation of *D. niethammeri* from *D. nitedula* in the plot of the first two pricipal components (fig. 10) is due primarily to its much narrower basioccipital breadth, and greater bullar length along principal component one, and by its greater bullar length and breadth on the second principal component (table 2).

The prominent sphenopterygoid vacuities of *D. niethammeri* strongly contrast with the nearly absent condition of *D. nitedula* in ventral perspective (fig. 8). Only a few specimens of *D. nitedula* were found to have this expansion, and never as marked as in *D. niethammeri*. One of the specimens of *D. nitedula* from northwest Pakistan that displays this slight expansion is shown in figures 6 and 8; the small sphenopterygoid vacuity is barely visible near the medial margin of the left pterygoid fossa.

From a lateral view the expanded bullae and mastoid region readily discriminate *D. niethammeri* from *D. nitedula* fig. 7).

Pelage coloration is not useful in distinguishing *D. niethammeri* from *D. nitedula*. Though the dorsal coat of *D. nitedula* is reddish or yellowish brown, and sometimes dark grey throughout much of its range, Ognev (1947; 1963) and Rossolimo (1971) described some populations of *D. nitedula* from arid regions in the independent

Fig. 6: Dorsal (top) and ventral (bottom) cranial views of *Dryomys*. **Left,** *D. nitedula*, adult, Pakistan (USNM 413715); **center,** *D. niethammeri*, young adult, Urak, Pakistan (AMNH 217346); **right,** *D. laniger*, adult, Turkey (NMW 14477). Approximately X2.5.

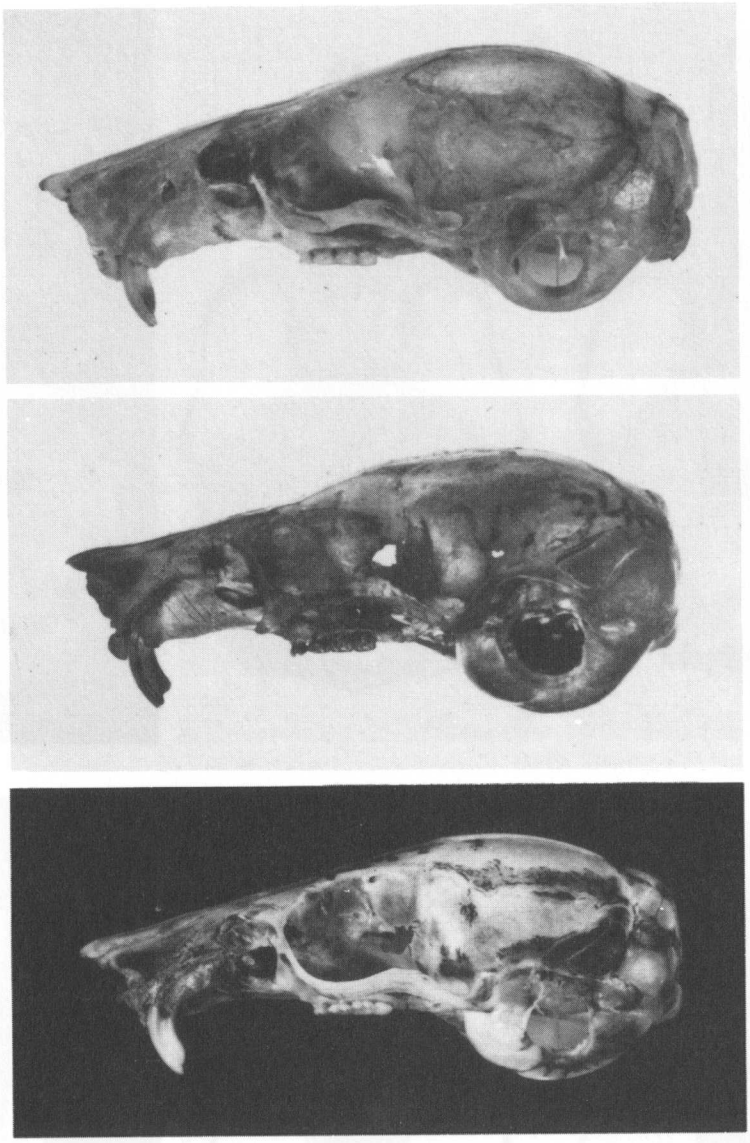

Fig. 7: Lateral cranial views of the same specimens shown in fig. 6. **Top,** *D. nitedula*; **center,** *D. niethammeri*; **bottom,** *D. laniger.*

republics of the former U. S. S. R. that have grey and yellowish grey fur. Most of the specimens from Iran included here are likewise ash or tawny grey above. The populations of *D. nitedula* in Iran need further study, however, as there are some differences in morphology between the paler examples and the more usual reddish brown specimens from that country. Two juveniles housed at the BM(NH) (66.6740—41) from the Zagros Mountains, Kuhrang Dam, have large bullae compared to adult specimens and other juveniles collected at nearby localities.

The striking dark, broad eye mask characteristic of *D. niethammeri* is also a hallmark of *D. nitedula*, and certainly provides no contrast between the two species.

Comparison with *D. laniger: D. laniger* is somewhat smaller in overall size than either *D. niethammeri* or *D. nitedula* (table 1; fig. 9). It also has a more delicate skull.

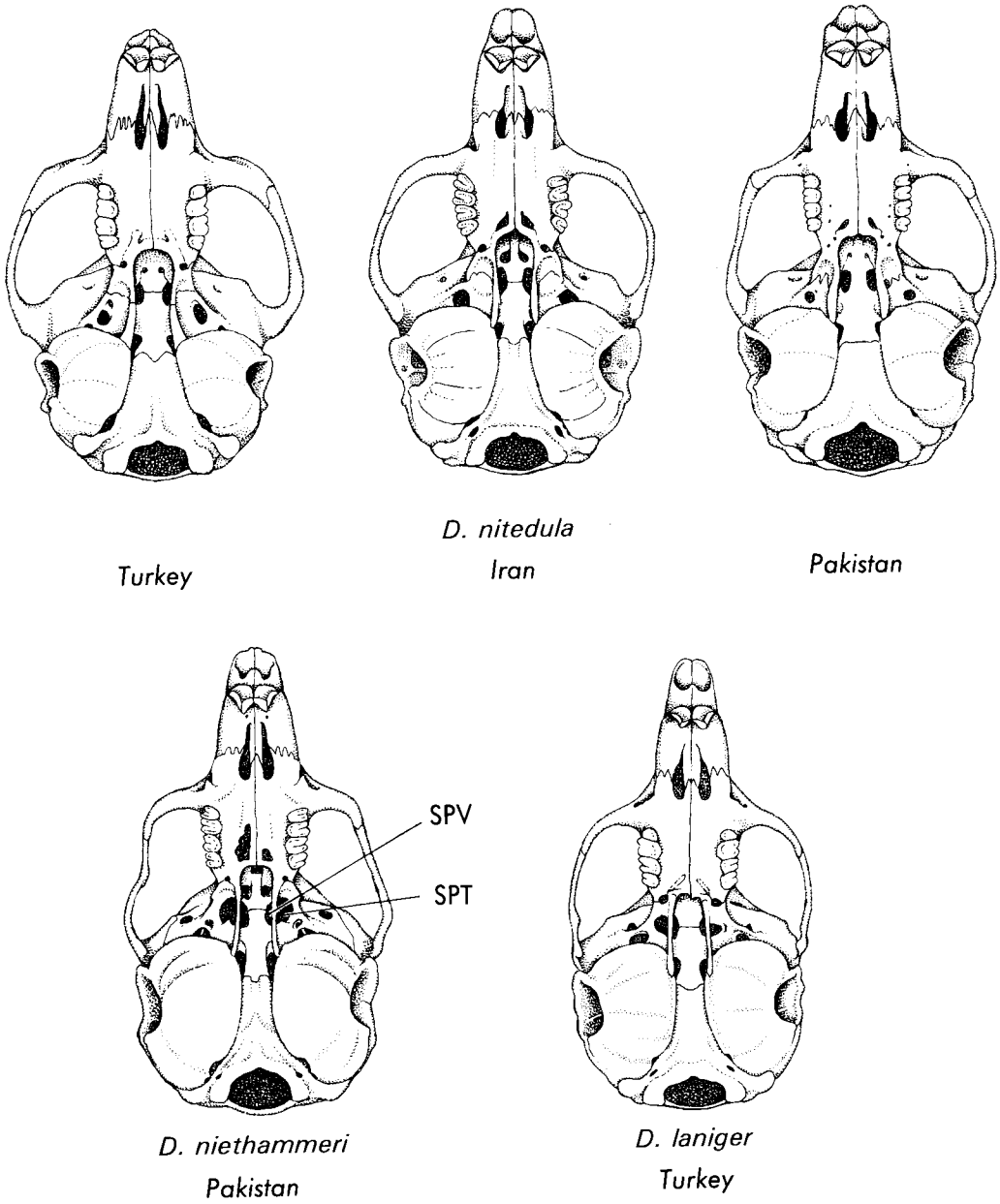

Fig. 8: Ventral proportional views of the three species comparing relative inflation of the auditory bullae, and size and position of the sphenopterygoid vacuities. *D. nitedula*: Turkey (FMNH 82165); Iran (FMNH 112328), Pakistan (USNM 413715). *D. niethammeri*: Pakistan (AMNH 217346). *D. laniger*: Turkey (NMW 20616). Abbreviations: **spt**, sphenopterygoid vacuity; **spv**, sphenopalatine vacuity.

From a dorsal perspective the inflated mastoid region results in a wide cranium posteriorly, as in *D. niethammeri*, but the narrow rostrum of *D. laniger* differentiates this species from both *D. niethammeri* and *D. nitedula* (fig. 6). In rostral breadth *D. laniger* differs significantly from both *D. niethammeri* ($p < 0.001$) and *D. nitedula* ($p < 0.02$), and its rostrum is also narrower relative to condylo-incisive length

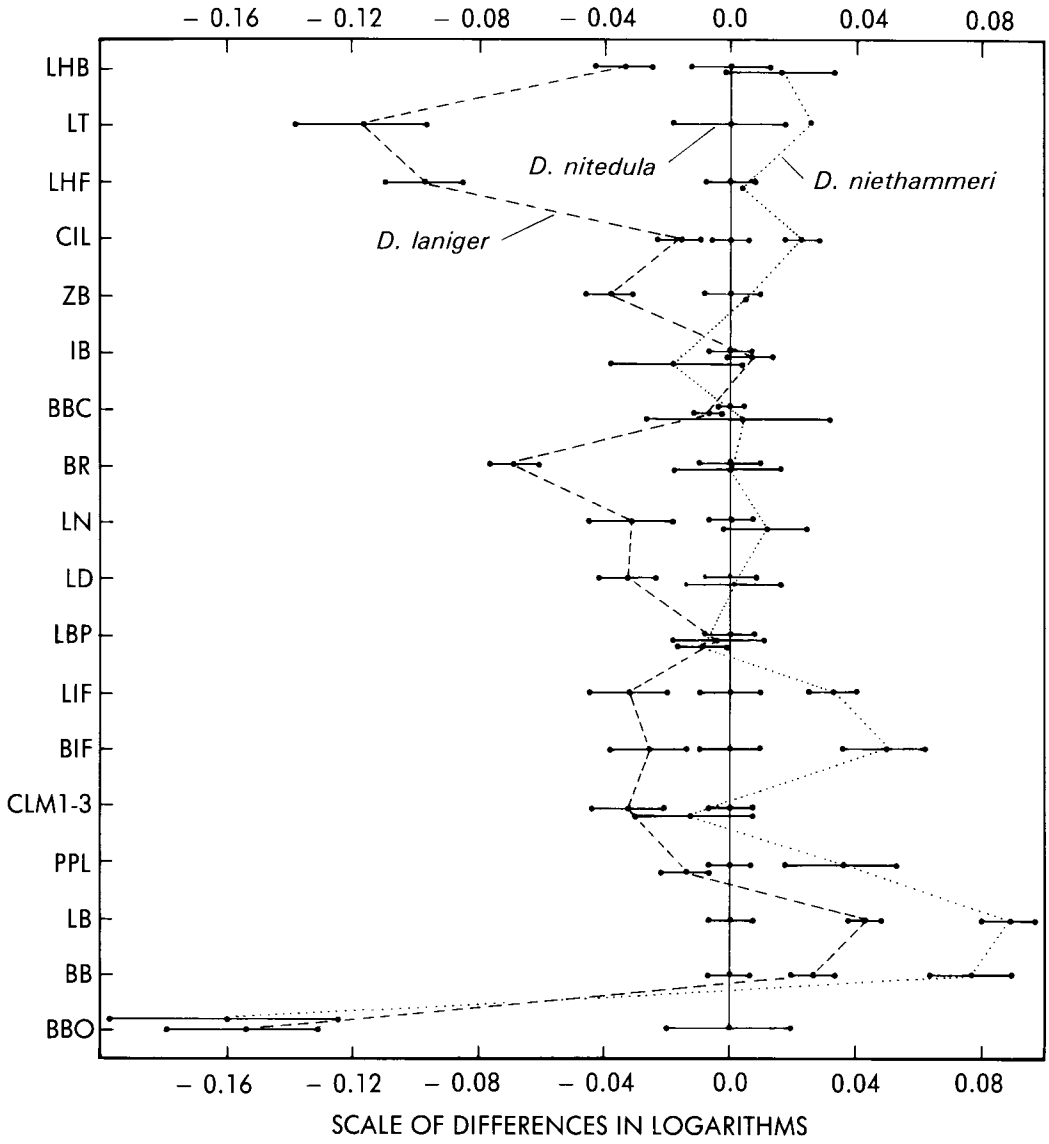

Fig. 9: Ratio Diagram. Proportional differences are compared among *Dryomys nitedula* (the standard), *D. laniger*, and *D. niethammeri*. Construction of the diagram is explained in Methods.

(fig. 9). The zygomatic breadth of *D. laniger* is also narrower than that of the other two species, both absolutely, and relative to condylo-incisive length (figs. 6, 9).

Dryomys laniger and *D. niethammeri* are similar in some features from a ventral perspective (figs. 6, 8). Both species have relatively enlarged bullae, and narrow basioccipital and basisphenoid bones. *Dryomys laniger* differs significantly from *D. nitedula* in basioccipital breadth ($p < 0.02$), as does *D. niethammeri*. The species does not significantly differ from *D. nitedula* in actual bullar length, but proportionally the bullae of *D. laniger* are much larger than those of *D. nitedula*. Though the auditory bullae of *D. laniger* are similar in proportion to *D. niethammeri*, bullar length in *D. laniger* averages significantly shorter than in the new species ($p < 0.001$).

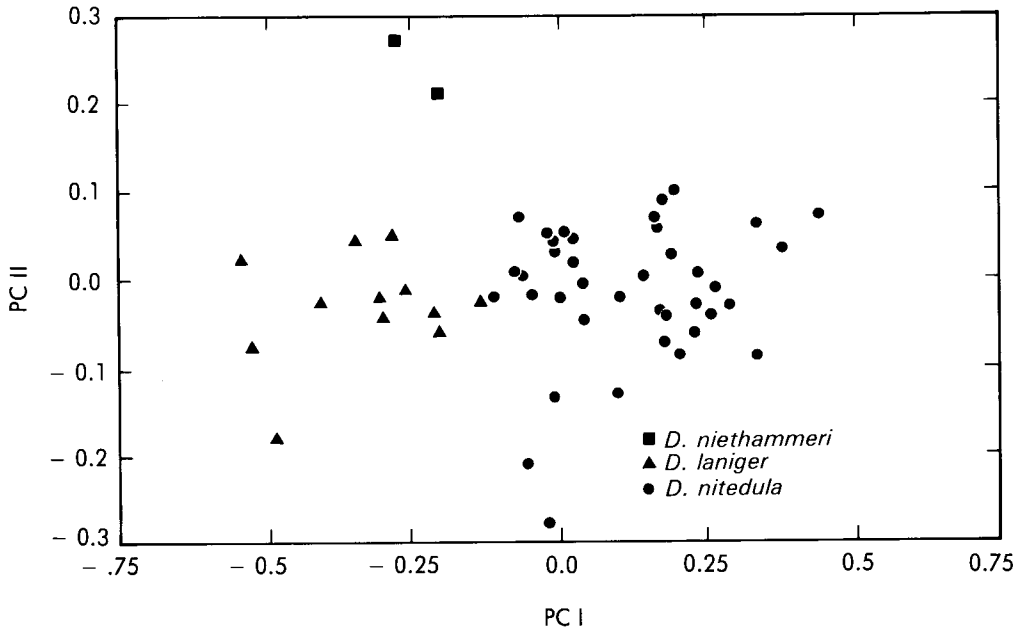

Fig. 10: Principal components scores of young adult through old adult examples of *Dryomys nitedula* (n = 40), *D. laniger* (n = 12), and *D. niethammeri* (n = 2) that yielded complete measurement sets, projected onto principal components one and two. Variables included and loadings are listed in table 2.

The ratio diagram (fig. 9) summarizes the similar proportions of the bullar region of *D. laniger* and *D. niethammeri* relative to *D. nitedula*. As with *D. niethammeri*, sphenopterygoid vacuities are also consistently present in *D. laniger* (figs. 6, 8). The thinner rostrum and smaller general size distinguish *D. laniger* from *D. niethammeri* when viewed from beneath (figs. 6, 8, 9).

Viewed laterally (fig. 7), the greatly inflated bullae and mastoid regions of *D. laniger* and *D. niethammeri* are very similar, except that the overall larger size of *D. niethammeri* separates it from *D. laniger*.

Based on one specimen Felten & Storch (1968) found no difference in length of tooth row between *D. laniger* and *D. nitedula*. The additional 20 specimens included here corroborate their findings, as the mean difference in length of molar row between the two species is not significant ($p < 0.3$).

The pelage coloration of *D. laniger* is ash grey above, and creamy beneath, and is not easily distinguished from *D. niethammeri*. However, *D. laniger* differs from both D. niethammeri and *D. nitedula* in that there is a only a thin brownish-black ring encircling the eyes, not the broad mask found in the other two species. The ventral fur of *D. laniger* is dark grey at the base and white proximally, whereas that of *D. niethammeri* is cream from the base to the apex. A few examples of *D. nitedula* from Iran also have uniformly pale hairs comprising the ventral coat. *D. laniger* exhibits a more distinctly bicolored tail (grey flecked with white above, white beneath) than either *D. niethammeri* or *D. nitedula*, though the undersides of the tails of the latter two species are also paler than the top. Skins of *D. laniger* have been figured in Felten & Storch (1968) and Spitzenberger (1976).

Table 2: Results of Principal Components Analysis. The variable with the lowest loading on PC I is CIL, an index of size. Because there are minimal cranial size differences between the three species, separation along PC's I and II is due mostly to contrasts in shape (see also fig. 10, and discussion in Methods).

Variable	PC I	PC II
CIL	0.019	0.032
CLM1—3	0.045	0.023
LB	— 0.054	0.043
BB	— 0.032	0.043
BBO	0.198	— 0.017
LHF	0.098	0.055
Eigenvalue	0.055	0.006
% Variance	75.26	11.65

Dryomys laniger has significantly shorter hind feet than either *D. nitedula* ($p < 0.05$) or *D. niethammeri* ($p < 0.001$), and appears to have a much shorter tail (table 1). Tail length measurements vary widely according to collector, but the discrepancy between tail length of *D. laniger* and the other two species is great. The hind feet and tail are much shorter relative to length of head and body in *D. laniger* than in *D. nitedula* and *D. niethammeri* (fig. 9).

The segregation of *D. laniger* from the new species and *D. nitedula* in the principal components plot (fig. 10) reflects the differences discussed above. It is separated from *D. nitedula* along principal component one by its narrower basioccipital breadth, relatively longer bullae, and to some degree shorter hind feet. The new species is not separated from *D. laniger* on the first axis, because even though the hind feet of *D. laniger* are shorter than those of *D. niethammeri*, basioccipital breadth loads highest on this component and *D. niethammeri* is even more extreme in the relative constriction of this region, and also has very large bullae (table 1; fig. 9). *Dryomys niethammeri* is separated along the second principal component from *D. laniger* due to the combination of a higher loading of hind foot and bullar length on this component (fig. 10).

Notes on climate, phytogeography and the distribution of *Dryomys* in Pakistan

The distinctions between *D. niethammeri* and *D. nitedula* in morphological characters is paralleled by differences in climate and habitat in Pakistan. The localities from which *D. niethammeri* has been taken is characterized by lower annual mean rainfall, and a drastically lower efficiency of precipitation than the more northern localities where *D. nitedula* occurs (Kureshy 1978). Those who have worked in the vicinity of Ziarat and other parts of Balochistan characterize the environment as being extremely arid and desiccating (T. J. Roberts, personal comm.). *Dryomys niethammeri* occurs in dry steppic juniper forest, and *D. nitedula* (in Pakistan) has been found only in dry steppic oak forest. Each forest type is discussed below. Further data on the distributional limits and ecology of the two species is needed to determine whether or not the differences in climate and plant associations are impor-

tant parameters directly or indirectly influencing the distribution of the two species in Pakistan.

The localities from which *D. niethammeri* was collected are in the Western Irano-Turanian phytogeographic subregion (Ali & Qaiser 1986; T. J. Roberts, personal comm.). Roberts (1977, and personal comm.) and A. Mian (personal comm.) consider Ziarat, Urak, as well as Wam to represent fairly uniform habitats. The vegetation characteristic of Ziarat consists of dry steppic juniper forest of scattered *Juniperus excelsa* (= *macropoda*), with undershrubs of *Sophora griffithii* and *Artemisia maritima*, mixed with scattered *Prunus eburnia* and *Berberis baluchistanica* (Beg 1975: 37, Champion et al. 1965; Roberts 1977: 8, and personal comm.). Champion et al. (1965: plate 30) provide an illustration of dry juniper forest near Ziarat, and Roberts (1977: plate 2b) also figures this forest type at 8500 ft. At higher elevations the Urak valley is ecologically similar to Ziarat, though at 6500 ft there would be less *Juniperus* and more stunted bushes, or small trees, including *Pistacia cabdulica*, *Fraxinus xanthoxyloides*, and *Celtis caucasica*; the understory would be similar to that of Ziarat (Roberts 1977: 8, and personal comm.). The same is true of Wam and the Ghishk range.

Dryomys nitedula has been collected in Pakistan in the North-West Frontier Province from Dir and Swat Kohistan, and the Kurram Valley (fig. 5). All of these localities are in the Sino-Japanese phytogeographic region (Ali & Qaiser 1986), although some workers feel that the Safed Koh range that straddles the Afghanistan/North-West Frontier Province, from which the Kurram Valley specimen was taken, belongs in a third, un-named phytogeographic region that includes North Waziristan at higher elevations, and the Safed Koh range (T. J. Roberts, personal comm.). Each *D. nitedula* specimen was obtained from steppic dry oak forest characterized by the Holly Oak (*Quercus ilex*) and stunted *Pinus wallichiana* or *Pinus geradiana*, with a scattering of *Juniperus excelsa* (Beg 1975: 34; Roberts 1977: 8, and personal comm.). The distribution and detailed floristic characterization of dry oak forests in Pakistan are given by Champion et al. (1965).

Relationships

The relationships of the three species of *Dryomys* included here are unclear. A phylogenetic analysis was not undertaken because the characters documented for the new species thus far are mostly related to an inflated bullar region, except for the greater length and breadth of the incisive foramina, and the combinations of dimensional proportions discussed above. If bullar characters overwhelmed a data set used in phylogenetic analysis, *D. laniger* and *D. niethammeri* would appear to be close relatives. However, *D. laniger* has a very distinctive narrow rostrum, shorter hind foot and tail, and narrower eye ring than the new species; these differences emphasize the possibility that the similarity in ear regions of the two species may well be convergent.

Independent character sets are needed to address the phylogenetic relationships within the genus *Dryomys*. It is possible that details of the dentition (occlusal patterns, for example), male reproductive tract morphology, or molecular data would provide the needed resolution. A much needed revision of *Dryomys nitedula*

throughout its range should include at least some of these characters, and further comparisons of that species with *D. laniger* and *D. niethammeri*, as well as *D. sichuanensis*.

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Zusammenfassung

Eine neue Schläferart, *Dryomys niethammeri* n. sp. (Rodentia, Myoxidae), wird aus Baluchistan, Pakistan, beschrieben. Ihre Morphologie wird mit der von *D. laniger* und *D. nitedula* verglichen. Ähnlich wie *D. laniger* hat die neue Art stark vergrößerte Ohrblasen und vergrößerte Sphenopterygoidgruben. Dies bedeutet nicht zwingend eine enge Verwandschaft zwischen beiden Arten, da *D. laniger* andere Spezialentwicklungen aufweist, die eine konvergente Entstehung der beiden Arten gemeinsamen Merkmale nahelegen. Zum gegenwärtigen Zeitpunkt bleiben die phylogenetischen Beziehungen zwischen den Arten der Gattung *Dryomys* ungelöst. *D. nitedula* und die neue Art kommen in Pakistan offenbar in verschiedenen Pflanzengesellschaften vor, deren Zusammensetzung diskutiert wird.

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Book Review

Filipucci, M. G., Ed. (1995): *Proceedings of the II Conference on Dormice (Rodentia, Myoxidae).* Hystrix N.S., Vol. 6 (1994), 340 pp.

This volume includes 31 papers presented at the second conference on dormice held at Fuscaldo, Italy, from 15–19 May, 1993. Looking at the contents of these papers alone, this must have been a very successful meeting. Five headings form a frame for the contributions. Under "Systematics and Evolution" Daams and de Bruijn propose a classification of the Gliridae on the basis of dental morphology, a comprehensive review which includes information on all the fossil taxa as well. Storch discussed the phylogeny of Palaearctic dormouse genera, and further fourteen authors present new data on chromosomes and biochemical and morphological variation of dormice. Violani and Zava analyze the scientific correspondence of Linnaeus and Scopoli and document that Carolus Linnaeus was totally unacquainted with the edible dormouse which he named *Sciurus Glis*, and that he made mistakes when copying from letters of his Slovenian correspondent Giovanni Antonio Scopoli. As a consequence, they fix the classical type locality in Slovenia, and propose a new name for the subspecies of central Europe. The chapter "Biogeography" contains seven papers on the distribution and status of dormice in Italy, Czech Republic, Latvia, Lithuania, and Croatia. "Morphology and Physiology" contains four papers on thermoregulation, coronary artery anatomy, cranial variation, and a review of phallic and bacular anatomy of the European species. "Ecology and Ethology" contains seven papers on predators, dispersal behaviour, population density, population structure and dynamics, and cave dwelling behaviour. Two papers deal with the biology of non-European species, the Japanese (*Glirulus*) and African (*Graphiurus*) dormice. Under "Conservation and Management" three papers conclude the volume. They deal with conservation aspects in England and Italy, and Carpaneto and Cristaldi present an interesting review of the relations between dormice and humans in the past and present.

The conference also discussed the at that time brandnew conclusion of Mary Ellen Holden, expressed in her chapter on the Myoxidae in the 1993 book "Mammal Species of the World" (Wilson & Reeder eds.), that Myoxidae was the valid name for the group. Except for Daams and de Bruijn, most other authors in this volume now use Myoxidae, and Ernesto Capanna states in his Forword: "Now it is sure. The amusing sleepy-head of our woods can no more be called *Glis glis*; and his relatives can no more be called Gliridae: rules of nomenclature priority impose the names *Myoxus glis* and Myoxidae." It is amusing that a small community of experts on this family can easily accept this change as a kind of routine in living taxonomy, while at the same time a battle is going on in the pages of the "Bulletin of Zoological Nomenclature" in order to save the Gliridae.

Maria Grazia Filipucci, one of the organizers of the meeting and now editor of its proceedings, is to be congratulated for this interesting volume on the dormice family, whatever the scientific community will agree upon to call it in the future.

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