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Pseudois nayaur and Pseudois schaeferi.

By Xiaoming Wang and Robert S. Hoffmann

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Pseudois Hodgson, 1847

Pseudois Hodgson, 1846:343. Type species *Ovis nayaur* Hodgson, 1833.
Pseudovis Gill, 1872:79. Substitute for *Pseudois* Hodgson.

CONTEXT AND CONTENT. Order Artiodactyla, Suborder Ruminantia, Family Bovidae, Subfamily Caprinae, Tribe Caprini. The genus *Pseudois* contains two living species, *Pseudois nayaur* and *Pseudois schaeferi*. Both are included in this account.

Pseudois nayaur (Hodgson, 1833)

Bharal

Ovis nayaur Hodgson, 1833:135. Type locality Tibetan frontier of Nepal (=Kachar region, Nepal).
Ovis nahoor Hodgson, 1835:107. Emendation of *nayaur*.
Ovis burrhel Blyth, 1840:67. Type locality "Boorendo Pass, Nepal" (=Barinda Pass, near Mt. Jumnotri, E of Simla, Nepal).
Ovis nahura Gray, 1843:170. Emendation of *nahoor*.
Ovis barhal Hodgson, 1846:342. Emendation of *burrhel*.
Ovis burhel Gray, 1863:13. Emendation of *burrhel*.

Pseudois schaeferi Haltenorth, 1963

Dwarf Bharal

Pseudois nayaur schaeferi Haltenorth, 1963:126. Type locality Drupalung (Chubalung), S of Batang, Sichuan, China. Raised to specific rank by Groves (1978).

CONTEXT AND CONTENT. Content noted in generic summary above. The species *P. schaeferi* is monotypic; *Pseudois nayaur* Hodgson, 1833 has two subspecies:

P. n. nayaur (Hodgson, 1833), see above.
P. n. szechuanensis Rothschild, 1922:231. Type locality "Shensi Province, China" (*caesia* Howell, 1928 a synonym).

Rothschild's *szechuanensis* was based on a skull (holotype) from Shaanxi (Shensi) and a mounted skin from Sichuan (Szechwan), China. (The current official spellings [Han-yu pin-yin] of Chinese geographic names are employed here, together with their corresponding Wade-Gilles counterparts.) The subspecies was said to differ from *P. n. nayaur* of the Tibetan frontier of Nepal in "the browner rather than blackish-gray summer coat, and in the restriction of the lateral stripe to the middle of the flanks" (Allen, 1930: 2). Unaware of this, Howell (1928) described a "young adult" male from Archuen, Man Shan (mountains), 230 km S Lanzhou (Lanchow), Gansu (Kansu), China, as *Pseudois nayaur caesia*. Allen (1930, 1940) subsequently pointed out that *P. nayaur caesia* Howell was a synonym of *P. nayaur szechuanensis* Rothschild; moreover, Groves (1978) did not recognize the validity of *szechuanensis*.

On their expedition of 1934 to 1936 to western Sichuan (Szechwan) and east Xizang (Tibet), Dolan and Schäfer recognized a population of dwarf bharal in the deep gorge of the upper Chang Jiang (Yangtze River), at the southeastern edge of the range of bharal (Fig. 1). The dwarf population in the lower zone was separated by a forest zone 1,000 m in altitudinal height from the "greater" bharal of the alpine zone. Schäfer (1937) thought that this was a separate species or local race, but Allen (1939, 1940) considered the specimens to be immature, and suggested that food there was not abundant enough for the animals to attain their full size. Conversely, Englemann (1938) gave the dwarf bharal subspecific rank, but failed to name it; Haltenorth (1963) finally named it a subspecies, *Pseudois nayaur schaeferi*. Groves (1978:182) concluded that "the distinctiveness and isolation of the Dwarf Blue Sheep [bharal], together with its geographic approach to the Greater form, suggest that, as a provisional measure at least, it should be classified as a full species," *Pseudois schaeferi* Haltenorth, 1963. The dwarf bharal may represent a peripheral isolate in the process of speciation.

The following text refers to *P. nayaur*, unless otherwise specified.

DIAGNOSIS. Beard absent; no fringe of hair on neck, throat, or on forelegs (Fig. 2). Horns comparatively smooth, without distinct transverse wrinkles, olive-colored and curved first upward, then outward, and finally backward, from the sides of the head (Allen, 1940; Lydekker and Burlace, 1914; Fig. 3). Bharal are distinguished from true sheep by the absence of preorbital (lacrimal) glands (and the pits that house them) and interdigital (pedal) glands, characteristic of true sheep (Pocock, 1910, 1918). The tail is rather long. A clearly defined black band separates the fawn of the back and the white of the underparts, and there are distinct black markings down the whole of the legs (Lydekker, 1898). In addition to smaller body size of *P. schaeferi* compared to *P. nayaur*, horns of male *P. schaeferi* differ from *P. nayaur* in that they are "smaller than would be predicted on a constant body-to-horn ratio, and thinner . . ." and that "The tips are more upturned . . . , and are straighter with no inward curve; and the greatest span is always at the tips, the horns never developing the semicircular form seen in almost all male [*P. nayaur*] . . ." (Groves, 1978:180–182).

GENERAL CHARACTERS. Body mass of *P. nayaur* is 60 to 75 kg for males, and 35 to 55 kg for females; corresponding weights for *P. schaeferi* are 28 to 39 kg, and 25 kg. External dimensions of *P. nayaur* (in cm) are: head and body length 120 to 140, tail length 13 to 20, hindfoot length 70 to 100, and ear length 9.0 to 11.5; linear dimensions of *P. schaeferi* are somewhat less; for example, shoulder height of male *P. nayaur* is 80 to 91.4, whereas that of *P. schaeferi* is 70 to 80. Horns of adult male *P. nayaur* are rounded or subquadrangular in cross section at the base, the surface is smooth compared with that of other wild caprines, and finely striated, having "widely separated sinuous lines of growth" (Lydekker, 1898:232). The tips of the horns are inclined inward in mature males and are situated over the withers (Fig. 3). Horns of adult females of both species are short, curved slightly upward then outward, suboval in cross section, and with the longer axis pointing

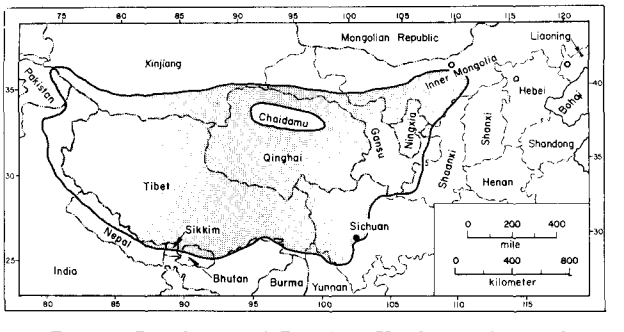

FIG. 1. Distribution of *Pseudois*. Hatching indicates distribution of *P. nayaur*, and solid circle in central Sichuan, of *P. schaeferi*. Open circles indicate Pleistocene fossil localities.

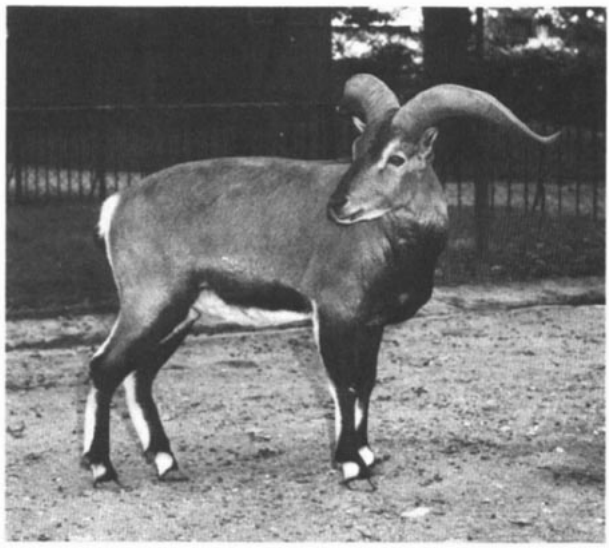

FIG. 2. Captive adult male bharal (*Pseudois nayaur*), Berlin Zoological Park. Courtesy L. Schlawe.

laterally. Ranges in cranial measurements (in mm) of male and female *P. nayaur*, respectively (Allen, 1939, 1940; Groves, 1978), are as follows: greatest length of skull, 246 to 250, 215 to 220; palatal length, 133, 120 to 122; zygomatic breadth, 120 to 137, 109 to 114; mastoid breadth, 87 to 93, 77 to 78; labial molar breadth, 60 to 65, 58 to 58.5; length of upper toothrow, 64 to 72, 66 to 67; nasal length, 65 to 91, 62 to 79; nasal breadth, 22 to 24, (no data); basal diameter of horn core, 83 to 94, 44. Comparable measurements for male *P. schaeferi* (Groves, 1978) are: 208 to 247; 113 to 121; 125 to 138; 74 to 85; 61.5 to 64; 65 to 68; 75 (mean of 8 individuals); 28; 73.7 (mean of 7 individuals). No measurements of female *P. schaeferi* are available. The hair is short, thick, and smooth. The color of bharal is grayish-buff on the upper parts of the body, "with a tinge of the slaty-blue" (Lydekker, 1898:233), and with a tendency to brownish in summer and to grayish in winter. *P. schaeferi* is said to be more drab, with a silvery sheen to the pelage (Groves, 1978). The belly, rump, inside and back of limbs, base of the tail, and "bands down the sides of the face" (Sowerby, 1923:158) are white (Fig. 2). Adult rams lack beard or long hair on the neck, and the face between the white bands, the throat, and the whole front of the legs are black, except the knees are white. A black band along the lower part of the flanks borders the white of the underparts; about two-thirds of the tail is black. The black markings on the face, chest, and flanks of males are absent in ewes. In summer, the underwool is shed in ragged patches and the faded reddish-gray pelage feels harsh and springy, but in winter, the bharal grows thick underwool (Roberts, 1977); Schaller (1977), however, remarked that there is little wool. The orbit projects laterally (Fig. 3). The lacrimals are situated almost on the upper part of the face, and the ventral edge of the lacrimal forms a raised ledge, bounding an excavation just beneath for muscle attachment. There is no lacrimal pit. The premaxillaries are rather delicate and tapering, and are connected proximally with nasal bones that are wide at the proximal ends and taper forward to a point, instead of being the same width throughout as in other caprines (Allen, 1940).

Milne-Edwards (1868–1874) provided comprehensive cranial and dental measurements. Detailed horn measurements on several dozen specimens of *P. nayaur* were made by Rowland Ward and published by Lydekker (1898), and by Lydekker and Burlace (1914).

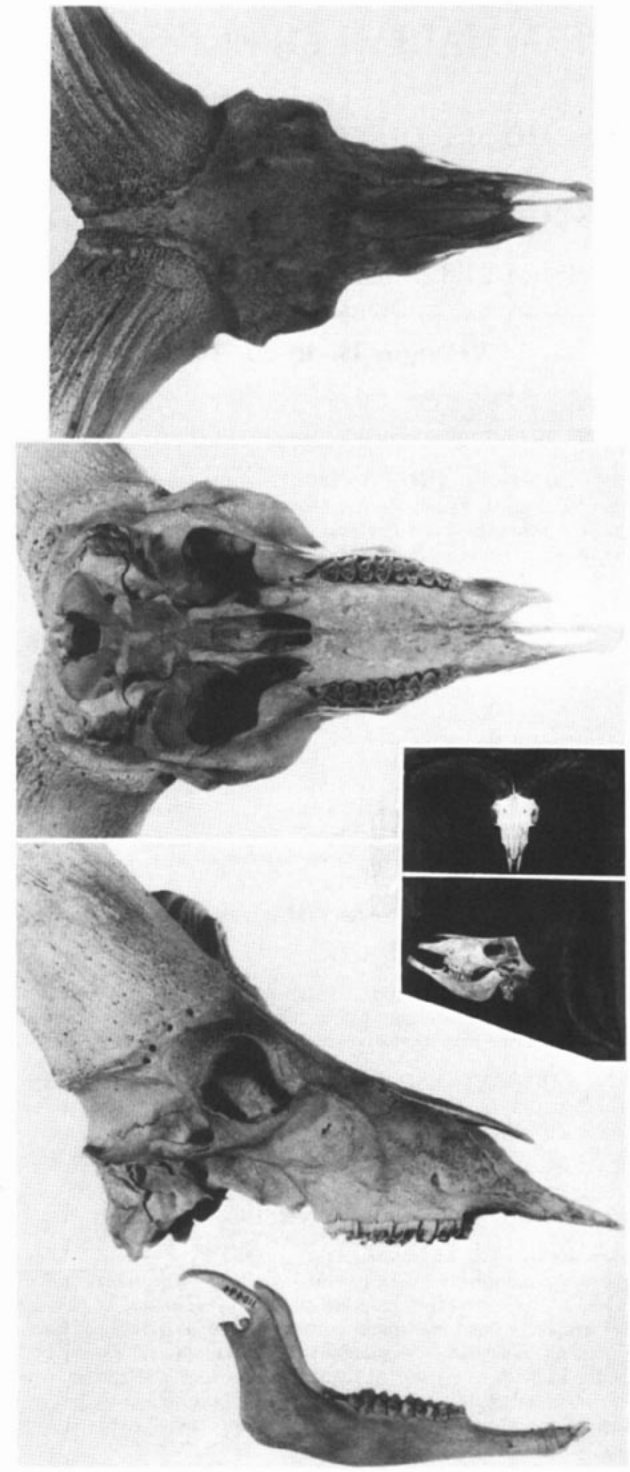

FIG. 3. Dorsal, ventral, and lateral views of skull and mandible of adult male *Pseudois nayaur* (AMNH 110494) from Qionglai Shan, China. Courtesy G. G. Musser. Insets illustrate horn shape of adult male (Inst. Zool., Beijing 17365). Courtesy Wang Sung.

DISTRIBUTION. Because of the inaccessibility of the areas where the bharal lives, the distribution remains poorly known. Recently, after several scientific expeditions to the Tibetan Plateau by the Chinese Academy of Sciences, the bharal was found to be distributed over almost the entire Qinghai (Tsinghai)-Xizang (Tibet) Plateau which includes high montane regions of Quinghai (Tsinghai) Province and Xizang Zizhiqu (Tibetan Autonomous Region) of the People's Republic of China (Cai, 1982; Feng et al., 1980; Zheng, 1979; Zhu, 1979). In addition, four countries adjoining the southern Tibet border also are inhabited by bharal (Fig. 1): the northeastern corner of Pakistan (Roberts, 1977); the mountains of northwestern Nepal (Mitchell, 1977); Bhutan (Kinloch, 1892); and the Indian sector bordering China (Burrard, 1925); these are geographically part of the Qinghai-Xizang Plateau. From this main area of distribution, bharal extend eastward and northward to western and central China, including western Sichuan, central and eastern Qinghai, southern Gansu and Shaanxi provinces (Chang and Wang, 1963; Shen, 1963). Other places from which bharal were reported occasionally include Ningxia Huizu Zizhiqu (Ningsia Autonomous Region) and Nei Monggol (Inner Mongolia) Zizhiqu (Allen, 1940; Shou, 1964).

Wang et al. (1963) placed the altitudinal range of bharal as

from 2,400 to 6,000 m above sea level, the lower limit of which is the winter range, whereas 3,500 to 6,000 m is the summer range. *P. nayaur* never goes below the upper forest lines, but *P. schaeferi* occurs below the forest belt in its restricted range in the Yangtze Gorge. Roberts (1977) placed the upper limit at 6,500 m [sic] in summer where human intervention is rare. The lower limit was put at about 3,000 m by Lydekker (1898).

FOSSIL RECORD. A middle to late Pleistocene skull fragment with partial horn cores from Gezidong (Pigeon Cave), Song Ling, Liaoning Province, China was identified as *Pseudois* cf. *nayaur* ("Archaeological Team," 1975). This locality is more than 800 km east of the present range. However, the horn cores as figured (Editorial Committee, 1979: fig. 587) suggest that the specimen may be misidentified. There also are Chinese reports of "*Ovis nahoor*" from late Pleistocene localities at Xuanhua, Hebei (Hopeh) Province, about 140 km northwest of Beijing, and at Salawusu (Sjara-osso), Nei Monggol (Inner Mongolia) Aut. Reg. (Editorial Committee, 1979). The first locality lies approximately midway between the Gezidong Cave site and the northeast corner of the present range, whereas the second is only slightly north of modern occurrences in the Yin Shan (mountains). The late Pleistocene and early Holocene distribution of *Pseudois* may have encompassed most of the mountains of Shanxi (Shansi), Shaanxi (Shensi), Ningxia, Nei Monggol, northwestern Hebei (Hopeh) and western Liaoning.

FORM AND FUNCTION. Bharal resemble other cliff-climbing caprines (*Ammotragus, Capra, Hemitragus,* and pachycerine *Ovis*) in possessing a stocky body and stout legs, with massive shoulders and broad chest. Hooves have a hard rim surrounding a softer pad, and accessory hooves (dew claws) are relatively large; these features are interpreted as adaptations for cliff-climbing (Schaller, 1977). The bharal's tail is longer than that of typical wild sheep (*Ovis*), but not as long as that of typical goats (*Capra*). The ears are said to be distinctly goatlike, dark on the outside, fringed with white, and light-grey on the inside (Sowerby, 1923). The "blue tint" of bharal makes them almost invisible against the background of blue-greyish rock so typical of their habitat (Burrard, 1925). The dental formula, as in other caprines, is i 0/3, c 0/1, p 3/3, m 3/3, total 32. There has been no account of dental morphology. The vertebral formula, as in other caprines except for the caudal number, is: C 7, T 13, L 6, S 4, Ca 10, total 40 (Lydekker, 1913).

The frontal sinuses are relatively small, comparable to those of *Capra sibirica* and *Hemitragus jemlahicus,* and smaller than those of *Ammotragus* or *Ovis*. The associated cornual sinuses of male *Pseudois* are relatively larger than in *Capra,* but smaller than in other caprine genera (Schaffer and Reed, 1972). These sinuses probably serve a dual function, in absorbing the shock of horn clashing and in thermoregulation (Taylor, 1966).

Bharal lack preorbital glands, as do other caprines except *Ovis*. Interdigital glands are well developed in both forefeet and hind feet of *Ovis,* but are absent on hind feet of *Capra,* which, however, possess interdigital glands on the forefeet in some species. In *Pseudois, Ammotragus,* and *Hemitragus* these gland are absent or at most rudimentary (Pocock, 1910). Inguinal glands also are absent in *Capra, Ammotragus,* and *Hemitragus,* but present in *Ovis*; they have been reported in *Pseudois* (Hodgson, 1847; Ward, 1924), but this was denied by Pocock (1910). Among caprids, *Ammotragus, Capra, Hemitragus,* and *Pseudois* have subcaudal glands (Pocock, 1910, 1918). There is one pair of mammae as in other caprids. The glans penis is large and blunt, and bears a long filiform process as in *Ovis*; in *Capra, Ammotragus,* and *Hemitragus* the glans is smaller and flatter, and the filiform process shorter (Pocock, 1918).

No studies of the physiology of bharal have been reported. Field observers note that they are heavy with fat in September and October, before the rut (Jerdon, 1874). The single annual molt occurs in spring and summer (Roberts, 1977).

ONTOGENY AND REPRODUCTION. Little is known about reproduction of bharal. Estrus in Nepal takes place in late November to January: Schaller (1973, 1977) reported the rutting season was from mid-November to early December; Wilson (1984: 41) reported a longer, later rut, from 15 December to 28 January, which "suggested adaptation to climatic conditions peculiar to the study area." After a gestation period of about 160 days (Wilson, 1984) the young are born between mid-May and mid-June (Schaller, 1977) or between late May and early July (Wilson, 1984), which coincides with new growth of grasses (Roberts, 1977; Wilson, 1984). Crandall (1964) gave the gestation period as 150 days but Roberts (1977) suggested it might be longer. In a captive herd in London, 50% of births were in June (Zuckerman, 1953). Jerdon (1874), Sterndale (1884), and Bailey (1911) all claimed that most young in the Indian Himalayas were born in June and July, and that twinning was common. Wegge (1979) claimed that yearlings bred; this was supported by Wilson (1981) but denied by Schaller (1973, 1977). Ewes were reported usually to give birth to a single young in rock crevices; no twins were observed (Qian et al., 1974). Frequency of twinning and yearling breeding probably depend upon nutritional status of the ewes.

Young males (<1 year old) have straight horns about 5 cm long, and a woolly cap of hair, also seen in some females, covers their crown (Schaller, 1973). Yearling males (almost 2 years old) are about two-thirds the size of adult females, lack a flank stripe, and have horns about 15 cm long. Subadult males (almost 3 years old) are about the size of adult females, still lack a flank stripe, and have horns about 25 cm long; the horns do not yet flare back. As 4-year-olds, males begin to show the flank stripe; their horns are about 35 cm long. In the fifth to seventh years, males approach full growth, but are slightly less heavy in build than a full-grown ram; their horns are about 45 to 55 cm long. Horn growth is slower, particularly in the first year, than in other caprines (Schaller, 1977: figs. 20 to 22).

ECOLOGY AND BEHAVIOR. Wilson (1981) estimated that 800 to 900 bharal were living in the 960 km² Dhorpatan Shikar hunting reserve southwest of the Dhaulagiri Range, Nepal. By calculating the surface area of observed bharal habitat, he estimated a density of 2.6 to 2.7 animals/km² as compared with 1.9 to 2.7 animals/km² reported previously by Wegge (1976). Schaller (1977) reported even lower densities (0.9 to 1.4/km²), but also noted that winter concentrations reached densities of 8.8 to 10.0/km².

Wilson (1981) reported a yearling sex ratio of 1:1.05 in favor of females. He further speculated that the sex ratio of adult bharal was as low as 1:1.45 in favor of females caused by selective hunting by trophy hunters and village poachers. In remote areas where populations are not significantly affected by human activities, a higher ratio of adult males to adult females was observed. Wegge (1979) observed that survivorship and mortality of bharal compared reasonably well with that of true mountain sheep, but that mortality was higher in more accessible areas. In Pakistan, bharal were said to occur in "considerable numbers" in the Hunza region and Karakoram range (Roberts, 1977:201), but no more precise estimate was made.

Bharal generally inhabit extremely high mountains inhabited by few other animals, and rarely frequented by humans. The climate in the Dhorpatan Shikar Reserve is usually arid and cold; occasional heavy snowfalls force the animals to lower altitudes. Estimates of annual precipitation range from 100 to 1,400 mm. The weather pattern is monsoonal with about 60% to 65% of the annual precipitation falling within the monsoon month of July. The mean daily temperature ranges from −7.8°C to 6.7°C in December, and 3.9°C to 11.7°C in June (Wilson, 1981).

Roberts (1977:201) described bharal habitat in Pakistan as "relatively arid mountain steppe country beyond the monsoon influence and above the limit of tree growth . . . typically associated with broad stony valleys and shale ridges at the foot of higher mountain peaks, in regions characterized by extreme cold in winter and aridity throughout the year." Wilson (1981) suggested that bharal show no change in seasonal use of habitat type or slope steepness and use gently sloping, grass-covered basins year-round. They strictly avoid forested habitat (Kinloch, 1892), but usually are found near cliffs and similar escape cover (Schaller, 1977). The Asian caprine with the most similar habitat preference is the ibex, *Capra sibirica*; it is perhaps significant that ranges of the two species are largely allopatric (Schaller, 1977). A small area of sympatry occurs in Ladakh, but habitat relationships there have not been described.

Schaller (1977) suggested that bharal in winter mainly feed on dry grasses (*Arundinella, Danthonia*) that composed about 98% by volume of the rumen contents of a bharal killed by a snow leopard (*Panthera uncia*). He also listed grasses such as *Festuca* sp. and *Trisetum* sp. as food plants, in addition to forbs (*Anaphalis, Polygonum, Thermopsis*) and shrubs (*Berberis, Caragana, Cotoneaster, Ephedra, Juniperus, Lonicera*; Schaller, 1977, 1980).

FIG. 4. Young male bharal rearing in threat before adult male on right. Juvenile in foreground, and group of adult males on far right. (Courtesy G. B. Schaller).

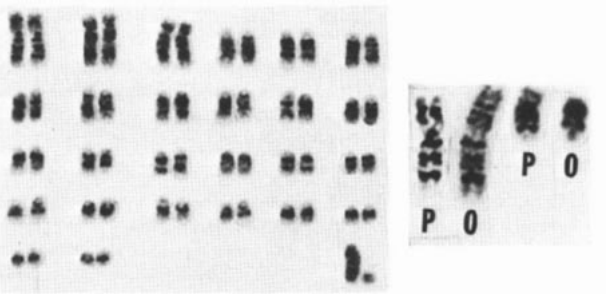

FIG. 5. Karyotype of male bharal (2n = 54, FNa = 58) with three pairs of biarmed and 23 pairs of acrocentric autosomes, large acrocentric X and small biarmed Y sex chromosomes. Inset: Two Giemsa-banded chromosomes of *Pseudois* (right chromosome of pair—P) and *Ovis* (left chromosome of pair—O), showing nonhomology of chromosomal arms. From Bunch et al. (1978).

Summer alpine grasses (such as *Poa alpina* and *Poa pratensis*), watered by springs from melting snow, are common species in Karakoram Mountains and probably provide an important part of the bharal diet (Roberts, 1977). In winter, bharal rely on browsing the thorny clumps of *Astragalus* sp. and may supplement their diet with "twigs of Alpine willow or even lichens and mosses" when snow is heavy (Roberts, 1977:203).

Bharal feed during the day; in the Kang Chu valley, eastern Nepal, Schaller (1973:530) showed that feeding had no diurnal schedule, but "at least 40% of the sheep were moving or feeding at any time between 6:30 am and 5:30 pm," with activity concentrated before 0930, between 1130 and 1300, and after 1430. However, according to local hunters in Chaidamu Pendi (Basin), Qinghai Province, China, bharal descend twice a day, once early in the morning, and again after midday, to feed in grasslands, and spend the rest of the day resting at higher elevations, on rocky mountain slopes (Wang et al., 1963). This corroborates reports by Burrard (1925), Schäfer (1937), and Wilson (1984).

Bharal are gregarious; group size is usually about 10 to 40 individuals (Qian et al., 1974; Roberts, 1977; Schaller, 1973) for *P. nayaur*. Occasionally groups range from 2 to 400 individuals (Schaller, 1980; Stockley, 1928); solitary individuals rarely were seen (Schäfer, 1937), although "the oldest rams . . . were almost invariably seen alone or in partnership" (Allen, 1939:291). The latter author reported that *P. schaeferi* formed smaller herds, of only 3 to 10 animals, and solitary animals were common. The apparent difference in social organization may be related to the smaller size and lesser degree of sexual dimorphism exhibited by *P. schaeferi* (Groves, 1978). Herd composition changes constantly as single individuals and groups join and part (Schaller, 1973). Except for the rutting season, associations between adult males and adult females are not common, and mature rams associate in small bands of five to six individuals close to the snowline (Roberts, 1977; Stockley, 1936). Therefore, groups generally consist either of adult and subadult males or adult females, young, and yearlings (Schaller, 1973). However, Sheldon (1975) claimed to have observed flocks containing both sexes and all age classes in late September. Kinloch (1892:213) stated that "the males for the most part separate from the females during the summer months, but mixed herds may be seen at all seasons of the year." Recently, Wilson (1984:40–41) suggested that food or other habitat characteristics, such as "available forage, spring 'green-up,' and temperature," may affect social organization of bharal. Apparently, there may be much seasonal and geographic variation in social behavior.

Herd composition also varies with population density and range condition. Of two Nepalese populations studied by Schaller (1977), one (Lapche) was small and occupied good winter range, but the other (Shey) inhabited an overgrazed winter range. Nine of 10 adult females at Lapche were accompanied by young, survival to yearling age was high, more than 67% of the males were less than 5 years old, and only 9% were in the oldest age classes. In contrast, at Shey only about 40% of adult females had offspring at heel, mortality to yearling age was high, only a quarter of the males were less than 5 years old, and 59% of them were in the oldest age classes.

Schaller (1973) considered bharal to be shy and difficult to approach (except where protected; Schaller, 1980), but was able to make some behavioral observations. Rams have the usual ungulate behaviors such as lip-curl, low-stretch twist, kick, penis mouthing, and mount. Wilson (1984) also reported hornpull and neck-fight. Lip-curl (flehmen) in the vicinity of the anal area of a female is employed by the male to detect whether the female is in estrus. Low-stretch is used by a male to approach a female. Other aggressive caprine behaviors such as broadside display, horning vegetation, jerk and lunge, head-shake, jump, butt, and clash also were seen in bharal, with slight variation from those of other caprines. Females also behave aggressively toward other females, and Schaller (1977) reported that they were the only caprine he had observed in which females bit one another. Lydekker (1898:239) remarked that in the London Zoological Gardens it was observed that "the male bharal . . . , when charging each other, rise on their hindlegs previous to the impact"—after the manner of goats (Fig. 4). This was first noted by Hodgson (1835), and has been confirmed by Schaller (1973) and Roberts (1977).

Bharal exhibit two antipredator strategies: they always stay near precipitous cliffs, ready to dash to rugged slopes when threatened, thus demonstrating an ability to climb slopes that "would try the most skilled and active mountaineer to ascend" (Lydekker 1898: 237). Usually, an adult female leads the retreat of the herd. Roberts (1977), Schaller (1973, 1980), and Wilson (1981) corroborate these observations. Bharal also give sharp calls ("*chit-chit*, slurred *chirrt*") to warn fellow herd members (Schaller, 1973, 1980). Fergusson (1911) was told that, when feeding, bharal always post a sentry standing high on rocks whence a good view of the surroundings could be obtained. The story was quoted by Allen (1940), but other investigators have failed to observe this behavior. However, Fergusson (1911) gave the name "Panyang" to this animal (which he never saw), that is also applied to the argali, *Ovis ammon*. Therefore, it is possible that it was the sheep referred to. Group defense, such as that used by North American bighorn sheep (*Ovis canadensis*), has not been reported in bharal.

The snow leopard was reported to kill bharal in Nepal (Schaller, 1973; Wegge, 1976). Jackson (1979) and Schaller (1980) found that the wolf (*Canis lupus*) also hunts bharal. The common leopard (*Panthera pardus*) occasionally includes bharal in its diet (Wegge, 1976). In addition, Wilson (1981) listed steppe eagle (*Aquila nepalensis*) and red fox (*Vulpes vulpes montana*) as two potential predators, both of which were observed to pursue bharal. Information about predators in China is lacking.

A mallophagan louse (*Bovicola multispinosa*) was collected from a bharal in Nepal (Emerson and Price, 1979), and Mitchell (1977) reported a tick (*Dermacentor everestianus*). In Nepal, domestic sheep often were seen to feed together with bharal, and some of the parasites of domestic sheep might be transmitted to them (Schaller, 1977).

A captive female *P. nayaur* lived for 16 years (Dover, 1933), and another (sex not specified) for over 20 years (Nowak and Paradiso, 1983).

GENETICS. The karyotype of a male bharal from the Himalayas was reported by Hard (1969:228): "The diploid number is 54 (NF = 60) represented by six submetacentrics and 48 acrocentrics. The X chromosome is not identified but seemingly must be an acrocentric . . . . The Y chromosome is considered to be the

very minute acrocentric . . ." (Fig. 5). Later comparative work on chromosomal relationships between bharal and other caprines based on G-band patterns (Bunch et al., 1978; Bunch and Nadler, 1980) has shown that, although both *Pseudois* and some species of *Ovis* share 2n=54, the biarmed chromosomes of the bharal are formed from fusion of different acrocentric elements than those of any species of true sheep. Bunch and Nadler (1980) concluded that bharal represented the lineage that diverged first from the ancestral caprine (2n=60), and that both true goats (*Capra*) and other caprine genera are independent lineages.

Darskus and Gillespie (1971:521) analysed high-sulphur hair proteins of four genera of caprines and showed that "some important differences" can be seen in the patterns of electrophoresis. Although two species of wild *Ovis* and domestic sheep exhibited the same banding patterns, *Capra* differed from *Ovis*, and also from *Ammotragus* and *Pseudois*; the latter two seem to be more similar to each other than to either *Ovis* or *Capra*.

REMARKS. The evolutionary relationships of bharal are not well established. It was often termed (Lydekker, 1880) to be "intermediate" between true goats (*Capra*) and true sheep (*Ovis*). Because of its superficial similarities to true sheep, some workers tended to believe that it was closer to sheep (Hodgson 1833, 1835, 1846; Sowerby, 1923). However, others claimed that the bharal was an aberrant goat with sheeplike affinities (Pocock, 1910). Evidence cited includes similarities of horn structure and color, shape of basioccipital (Lydekker, 1880), the fact that bharal lack or possess only vestigial preorbital glands and interdigital glands, and modern behavioral, genetic, and biochemical evidences (Bunch and Nadler, 1980; Darskus and Gillespie, 1971; Pocock, 1918). Schaller (1977) discussed the evidence and concluded that *Pseudois* probably was a primitive goat, with some convergent, sheeplike characters. Little is known about the comparative anatomy and osteology of bharal and until more work is done, their systematic position will remain unsettled.

Pseudois also is commonly called blue sheep in the western world. Other colloquial names for this species are: Yanyang (Cliff Sheep; Chinese), Banyang (Half Sheep; Chinese); Burrhel (Hindi); Myatu (Kulu); Na, Nawa, Napu (Tibetan), Naur, Nahoor, Nahur, (Nepali), Nervati, Sna, and Ngai Yang.

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Editors of this account were B. J. VERTS and SYDNEY ANDERSON. Managing editor was CARLETON J. PHILLIPS.

XIAOMING WANG AND ROBERT S. HOFFMANN, MUSEUM OF NATURAL HISTORY AND DEPARTMENT OF SYSTEMATICS AND ECOLOGY, UNIVERSITY OF KANSAS, LAWRENCE, 66045. PRESENT ADDRESS OF HOFFMANN: NATIONAL MUSEUM OF NATURAL HISTORY, SMITHSONIAN INSTITUTION, WASHINGTON, D.C. 20560.