tions of successively increasing length, detail, and taxonomic restriction. In the initial part, the author critically reviews the numerous morphological and behavioral features that have been used to characterize the order Primates and its major subdivisions, provides a classification of the order to generic level, and offers a selective critique of the literature on primate locomotion.

The second part, entitled Evolution and Comparative Morphology of New World Monkeys, is undoubtedly the section that will interest the most readers. As a comparative base Hershkovitz provides a wealth of morphological data on all primates and a variety of other mammals. The numerous illustrations and photographs in this section, including an atlas of primate skulls and dentitions, are alone well worth the price of the book. It is also in this section that Hershkovitz outlines his view of the major patterns of New World monkey evolution as well as the more general rules of mammalian evolution that he believes his studies illustrate.

New World monkeys range in size from the rat-sized pygmy marmoset to large cebids the "size of a setter." Most of the diversity in "diet, locomotor system and to a lesser degree other aspects of primate economy and organization" exhibited by this group can, in Hershkovitz's opinion, be related directly to differences in body size. In partial support of this argument he provides an impressive comparison of parallel dental adaptation in New World monkeys and unrelated primate genera of similar size. In addition, he feels that in almost all instances size evolution among platyrrhines has been from small to large. Thus he argues that among closely related genera, or for New World monkeys as a group, the smaller forms retain the most primitive morphology and the largest are the most specialized. The evidence for this pattern lies in the (size-related?) characteristics that the smallest New World monkeys share with living insectivores and prosimians. At the subspecific level, the differences between taxa, mostly in pelage patterns, are described, if not explained, by the author's principle of metachromism, which he has discussed and defended in earlier publications.

The final, longest section, dealing with the systematics, evolution, and biology of the callitrichids and callimiconids, provided the raison d'être for the volume and is unrivaled as a descriptive treatment of a group of extant mammals. The synoptic histories of each taxon are extraordinarily complete and the distribution maps are unquestionably the most accurate ever produced, being drawn around the plotted locality records from the more than 3100 museum specimens of callitrichids the author examined in preparing the book. Drawings and photographs are provided of each subspecies, and there are more extensive illustrations of skeletal, cranial, and reproductive anatomy for species and genera. The systematic section for each species group is followed by a summary of information on the physiology, behavior, and ecology of that group in the form of excerpts from the literature and notes from the author's own observations. As in previous sections, well-labeled illustrations and tables of raw data abound.

Hershkovitz rejects the opinion of most previous researchers that marmosets and tamarins are derived from cebid-like ancestors and that the primitive-looking features of callitrichids, such as twin births, digital claws, a nonopposable pollex, tritubercular molars, and semiprocumbent incisors, are due to secondary regression. Rather, he thinks that only in their lack of third molars and in certain cranial features do callitrichids appear specialized; otherwise they are the most primitive of all higher primates.

In this volume Hershkovitz has avoided many of the difficulties found in the only comparable book on callitrichids, volume 3 of *Primates* by the late W. C. O. Hill. The illustrations are clear and well labeled. The systematic and distributional information is largely original, internally consistent, and supplemented by an extensive gazetteer. The use of the literature is largely through direct quotation, and includes references from as late as 1975 and 1976. In its mechanics the book is a masterpiece. The corrigenda that were required are mostly late taxonomic revisions. The quality of photographs is high and the large format permits many comparative illustrations. Complete references, including authors' first names, are given in the bibliography, and the volume includes author, systematic, and subject indexes as well as several appendixes of morphological data.

There are, however, aspects of the book that are disappointing. Although the book deals largely with systematics, there is little or no discussion of the philosophy or methods used in determining the relationships of the taxa involved. Even on such critical issues as the identification of primitive and derived morphological features the reader must try to reconstruct Hershkovitz's reasoning from his conclusions. The same problem arises with many statements of fact. For example, Hershkovitz asserts, with no discussion or mention of the numerous authors who state the reverse, that *Plesiadapis* lacked a petrosal bulla. Likewise, a full page of quotations describing the importance of sap in the diet of pygmy marmosets is followed by a statement that the animal "can very likely live and reproduce year round without eating sap." Although many of the author's critical comments are valuable and insightful, the many others that are unsubstantiated, petty, or unnecessarily aggressive detract from the more positive contributions of the volume.

Although the synthesis Hershkovitz presents is a personal view throughout rather than one representative of current opinion, his monograph, appearing amid an endless flood of many-authored volumes and summaries of primate behavior and evolution based on secondary or even tertiary sources, is both a refreshing change and a reminder of how narrow most considerations of mammalian biology really are. As the definitive treatment on the systematics of clawed New World monkeys and an invaluable reference work for comparative anatomists, the book is indispensable for biological libraries and anyone interested in the biology of living mammals. Page for page, the book is a bargain despite the hefty price, and I, for one, am eagerly looking forward to volume 2.

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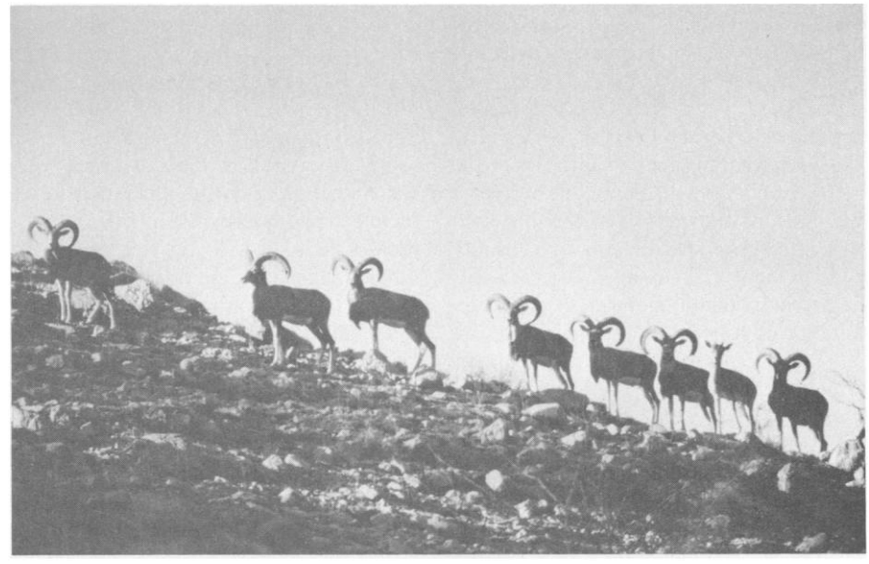
Asiatic Mammals

Mountain Monarchs. Wild Sheep and Goats of the Himalaya. GEORGE B. SCHALLER. University of Chicago Press, Chicago, 1977. xviii, 426 pp., illus., + plates. $25. Wildlife Behavior and Ecology.

How many readers of *Science*, I wonder, can conjure a mental image of a bharal, or a goral, or a serow? Or, for that matter a takin, a tahr, or a tur? All are large mammals of Asia that deserve to be as well known as their popular counterparts in Africa, but knowledge of their distribution and habits, particularly in the Himalaya, has been limited mainly to that collected by hunters. George Schaller has now remedied this deficit by giving us an account of his observations made during arduous expeditions from

1968 to 1975. It was a study in which he had to be versatile and opportunistic, contending among other hazards with an almost continuous state of war between certain of the countries whose borders cross the area. He has drawn his observations together into a comprehensive account of the environment and biology of the Himalayan bovids, particularly those that belong to the subfamily Caprinae, goats and their relatives.

I started the book at the beginning, reading the captivating account of the Himalayan region and learning much from the review of the taxonomy of the bovids and from the account of their distribution. But then, I must confess, I could contain my curiosity no longer and turned to a heading in the last chapter that reads; "Is the bharal a sheep or a goat?" I had an urgent feeling of wanting to know.



Punjab urial rams and one ewe, in December. All rams have conspicuous throat ruffs. [From *Mountain Monarchs*]

The bharal or blue sheep, *Pseudois nayaur*, has physical attributes of both sheep and goats. The horns are rolled, superficially like a sheep's, but are in structure closer to the goat's, being most like those of *Capra cylindricornis*, the Dagestan tur. Like sheep bharal lack beards and have no calluses on the knees, but like goats they have a broad, flat tail with a bare ventral surface. Schaller had hoped, I believe, that studies of behavior might indicate affinities clearly; there emerges, however, a cautionary tale showing that behavioral attributes, like anatomical ones, reflect adaptation to habitat and may also be convergent. In general the behavioral evidence fits the view of most taxonomists that bharal are basically goats. Many sheeplike traits have evolved, the species having settled in a habitat usually occupied by sheep. But Schaller suggests that the precursor from which sheep and goat diverged would have resembled a bharal in many ways. And here is such an animal still surviving in a region that is the probable evolutionary center of the sheep, the goats, and their allies.

The major contributions to new knowledge that are embodied here relate to the behavior and ecology of the caprine species, but Schaller also presents a valuable compilation of data on the physical attributes of the animals. He finds a place, at last, for those embarrassing pieces of biological information provided by record heads and trophies. I found some shortcomings in the presentation of this section, however, in that the units of measurement are not stated for many of the tables and must be inferred from other tables. In the figures in which horn measurements are plotted it is not stated that these are for males only, but I presume that to be the case. The females of many species do carry horns, but it requires some searching in the book to discover just which species.

In a consideration of style of combat and horn shape the tahr and the bharal provide important examples that support a general theory. The tahr has the more primitive, pointed, and potentially lethal horns and fighting is appropriately inhibited; display, using threat gestures and exhibiting the ruff of hair, is the means of attaining dominance. The bharal, on the other hand, engages in exaggerated and frequent clashing of horns, the horns being adapted for bashing and not for wounding. Also in contrast to the tahr, the bharal live in large flocks and exhibit very marked sexual dimorphism.

Reproductive behavior was intensively recorded during the study, and the Punjab urial, the wild goat, and the bharal provided data for analysis. No less valuable, although sometimes too meager to qualify, were observations on tahr and markhor. All species have similar courtship patterns, although they exhibit differences in the frequency with which the elements of display are combined. The differences are possibly too small to serve as reproductive isolating mechanisms. It may be significant, therefore, that contiguous and closely related species differ greatly in appearance. Female selection based on visual characters would then be important in averting hybridization.

The book contains a wealth of unique information that will be extremely useful for making comparisons with other large herbivores, but after a first reading my foremost feeling is one of gratitude that the author has made me familiar with these strange and remote mammals.

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Signaling Systems

The Behavior of Communicating. An Ethological Approach. W. JOHN SMITH. Harvard University Press, Cambridge, Mass., 1977. xii, 546 pp., illus. $20.

In one way or another, the majority of ethological work concerns the study of communication between animals. But, although the last 20 years have seen a lot of data collection on this subject, the amount of theory has, if anything, declined. Many of the neat and simple ideas of early ethologists have got lost in the mass of complexities, species differences, and exceptions that have come to light, and rather few novel ideas have emerged to replace them. But of those that have, the view set forth by W. John Smith has been among the most stimulating and influential.

Rejecting the ethological tradition of attempting to infer the motivation of an animal from the form of its signals and the contexts in which they occur, Smith advocates a more outward-looking, interactional, approach. This draws a useful distinction between messages and