

MAMMALS of

EASTERN ASIA

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MAMMALS OF EASTERN ASIA

THE PACIFIC WORLD SERIES

Under the Auspices of The American Committee
for International Wild Life Protection

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MAMMALS of the PACIFIC WORLD

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MAMMALS of EASTERN ASIA

by G. H. H. TATE

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MAMMALS
OF EASTERN ASIA

by G. H. H. TATE

ASSOCIATE CURATOR OF MAMMALS
THE AMERICAN MUSEUM
OF NATURAL HISTORY

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1947

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First printing.



Foreword

IN this comprehensive volume Dr. Tate describes the varied mammalian life that stretches southward from the bleak tundra of the Arctic to the steaming jungles of Burma and Malaysia, and from Lake Baikal, the Gobi desert and Tibetan plateau in the west, eastward to the shores of the Pacific. It was from the deserts, forests, mountains and plains of this vast region that the mammals of the islands of the Asiatic continental shelf—Java, Sumatra, Borneo, Palawan, Formosa and Japan—were originally derived. The present volume therefore forms an important supplement to the Handbooks of the Pacific World Series sponsored by the American Committee for International Wild Life Protection and devoted to the natural history of the Pacific's far-flung island archipelagos. The great majority of Asiatic creatures herein described are strangers to the American public. A few spectacular species are known through mounted specimens in museum habitat groups, or living examples in zoological parks—the gibbon and panda, as well as the familiar tiger, Indian rhinoceros and elephant. Singular as it may seem, forms allied to the Asiatic elephant, camel and Saiga antelope were among the contemporaries of man in pre-glacial America.

The book's carefully prepared chapters and fine original pen sketches will bring to lovers of wild life, layman and zoologist, much of interest regarding the habitats, relationships, life histories and idiosyncrasies of the still surviving members of eastern Asia's widely diversified faunas. The distribution of many of these species through the pressure of human populations is ever becoming more circumscribed. The volume is authoritatively and entertainingly written by one of America's widely travelled

and foremost students of mammals, a co-author of "Mammals of the Pacific World" and Associate Curator of the Department of Mammals in the American Museum of Natural History.

Exploration for and study of mammals, living and extinct, is still only in its rugged youth. We believe that the present informative pages will result in awakening in many a desire to further the protection and conservation of Asia's wild life heritage, that these riches from long ages past may be preserved for the study and enjoyment of future generations.

CHILDS FRICK,
*Chairman, American Committee,
International Wild Life Protection.*

Contents

	PAGE
FOREWORD	v
LIST OF ILLUSTRATIONS	ix
INTRODUCTION	xiii
I. WHAT IS A MAMMAL?	1
Special Adaptations in Mammals	1
Limbs	2
Teeth	4
Common Names and Scientific Names	7
II. THE HOME TERRITORIES OF EASTERN ASIATIC MAMMALS	10
Mountain Systems and River Systems	10
Swamps, Lakes, and Deserts	16
The Climates of Eastern Asia	17
Animal Environments and Faunal Areas in Eastern Asia	20
The Tundra	22
The Northern Forest Belt	22
The Northeast China Faunal Area	23
The Gobi Desert Faunal Area	24
The South China Faunal Area	24
The Western Highlands Faunal Area	25
The Tibetan Plateau Faunal Area	25

	PAGE
The Subtropical Faunal Area	25
The Tropical or Malay Faunal Area	26
An Ancient East Asian Faunal Area	27
III. DESCRIPTIONS OF EAST ASIATIC MAMMALS	30
Insectivores. Order Insectivora	30
Bats. Order Chiroptera	66
Pangolins. Order Nomarthra	112
Flying Lemurs. Order Dermoptera	116
Lemurs, Monkeys, Apes. Order Primates	118
Flesh-eaters. Order Carnivora	142
Whales, Dolphins, Porpoises, Order Cetacea	195
Rabbits, Hares, Pikas. Order Lagomorpha	201
Gnawing Mammals or Rodents. Order Rodentia	210
Elephants. Order Proboscidea	305
Dugongs and Manatees. Order Sirenia	308
Even-toed Ungulates. Order Artiodactyla	309
Odd-toed Ungulates. Order Perissodactyla	349
GLOSSARY	355
INDEX OF COMMON NAMES	359
INDEX OF SCIENTIFIC NAMES	363

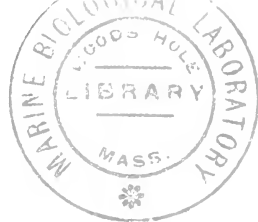


Illustrations

FIGURE	PAGE
1. Political Map of Eastern Asia	11
2. Physiography of Eastern Asia	13
3. Faunal Areas of Eastern Asia	21
4. Tree-shrew, <i>Tupaia</i>	33
5. Moonrat, <i>Echino-sorex</i>	36
6. Hedgehog, <i>Erinaceus</i>	39
7. Hands of True Mole, <i>Talpa</i> , and Shrew Mole, <i>Rhynchonax</i>	40
8. Web-footed Water Shrew, <i>Nectogale</i>	65
9. Flying Fox, <i>Pteropus</i>	72
10. Mouse-eared Bat, <i>Myotis</i>	82
11. Head of Long-eared Bat, <i>Plecotus</i>	85
12. Head of Barbastelle, <i>Barbastella</i>	85
13. Wing of Bent-winged Bat, <i>Miniopterus</i>	93
14. Head of Tube-nosed Insectivorous Bat, <i>Murina</i>	94
15. Ear of Trumpet-eared Bat, <i>Kerivoula</i>	94
16. Head of Naked Bulldog Bat, <i>Cheiromeles</i>	94
17. Head of Wrinkled-lipped Bat, <i>Chaerephon</i>	97
18. Tail of Sheath-tailed Bat, <i>Emballonura</i>	97
19. Head of False Vampire Bat, <i>Megaderma</i>	101
20. Head of Hollow-faced Bat, <i>Nycteris</i>	102
21. Head of Horseshoe Bat, <i>Rhinolophus</i>	102
22. Head of Round-leaf Horseshoe Bat, <i>Hipposideros</i>	102

FIGURE	PAGE
23. Pangolin, <i>Manis</i>	114
24. Flying Lemur, <i>Cynocephalus</i>	116
25. Slow Loris, <i>Nycticebus</i>	121
26. Dusky Langur Monkey, <i>Trachypithecus</i>	125
27. Snub-nosed Langur, <i>Rhinopithecus</i>	129
28. Rhesus Macaque, <i>Macaca</i>	133
29. Japanese Macaque, <i>Lyssodes</i>	136
30. White-handed Gibbon, <i>Hylobates</i>	140
31. Yellow-throated Marten, <i>Charronia</i>	147
32. Ferret Badger, <i>Helictis</i>	152
33. Common Old World Badger, <i>Meles</i>	154
34. Otter, <i>Lutra</i>	156
35. Raccoon Dog, <i>Nyctereutes</i>	162
36. Lesser Panda, <i>Ailurus</i>	164
37. Giant Panda, <i>Ailuropoda</i>	165
38. Asiatic Black Bear, <i>Selenarctos</i>	169
39. Banded Linsang, <i>Prionodon</i>	172
40. Malay Civet, <i>Viverra</i>	175
41. Palm Civet, <i>Paradoxurus</i>	177
42. Binturong, <i>Arctictis</i>	179
43. Owston's Banded Civet, <i>Chrotogale</i>	182
44. Head of Lowe's Otter Civet, <i>Cynogale</i>	183
45. Javan Mongoose, <i>Herpestes</i>	186
46. Asiatic Lynx, <i>Lynx</i>	192
47. Snow Leopard, <i>Uncia</i>	195
48. Asiatic Pika, <i>Ochotona</i>	209
49. Multi-striped Palm Squirrel, <i>Menetes</i>	215
50. Giant Tree Squirrel, <i>Ratufa</i>	216
51. Sladen's Tree Squirrel, <i>Callosciurus</i>	222

FIGURE		PAGE
52.	Long-nosed Tree Squirrel, <i>Dremomys</i>	232
53.	Asiatic Chipmunk, <i>Eutamias</i>	235
54.	Suslik or Ground Squirrel, <i>Citellus</i>	237
55.	Giant Flying Squirrel, <i>Petaurista</i>	240
56.	Beaver, <i>Castor</i>	252
57.	Teeth of Cricetine, Murine, and Microtine Rats	255
58.	Cricetine Mole Rat, <i>Myospalax</i>	258
59.	Bamboo Rat, <i>Rhizomys</i>	270
60.	Japanese Dormouse, <i>Glirulus</i>	297
61.	Szechwan Jumping Mouse, <i>Zapus</i>	300
62.	Five-toed Jerboa, <i>Allactaga</i>	301
63.	Brush-tailed Porcupine, <i>Atherurus</i>	303
64.	Old World Porcupine, <i>Hystrix</i>	304
65.	Mouse Deer, <i>Tragulus</i>	316
66.	Gaur, <i>Bibos</i>	319
67.	Banting, <i>Bibos</i>	320
68.	Musk Deer, <i>Moschus</i>	329
69.	Muntjak, <i>Muntiacus</i>	333
70.	Roe Deer, <i>Capreolus</i>	336
71.	Hog Deer, <i>Cervus (Hyelaphus)</i>	338
72.	Indian Sambar, <i>Cervus (Rusa)</i>	340
73.	Eld's Deer, <i>Cervus (Rucervus)</i>	343
74.	Red Deer, <i>Cervus (Cervus)</i>	345
75.	Asiatic Moose, <i>Alces</i>	347
76.	Reindeer, <i>Rangifer</i>	348
77.	Malay Tapir, <i>Tapirus</i>	350
78.	Sumatran Rhinoceros, <i>Rhinoceros</i>	352
79.	Javan Rhinoceros, <i>Rhinoceros</i>	354



Introduction

THE eyes of the world are fixed upon the western shores of the Pacific Ocean where millions of men have been locked in a struggle to free, or dominate, those lands and the peoples who inhabit them. Many people whose sons write home from a Pacific A.P.O., to whom Burma, China, Formosa, Japan, and Siberia were scarcely more than names on a map, wish to know the kinds of territories and climates, the manner of peoples, the various sorts of animal and plant life that may be encountered in eastern Asia. In a book¹ recently published, my colleagues and I told about the animals to be found on the islands from Australia to the Kurile and Aleutian Islands. The present volume has been prepared in order to offer the same service in considerably fuller detail for the mammals of the mainland of eastern Asia. Books and articles relating to the mammals of limited portions of the Asiatic margin of the Pacific exist, but are usually either out of print, too technical, written in a foreign language, or for some reason are not usable by the public. The geographical scope of the present work covers some 6000 miles of the Pacific coast of Asia, from northeastern Siberia through Manchuria, China, Burma and Indo-China, to the Malay Peninsula. The mammals of Sakhalin, Japan, and Formosa are included.

In preparing this work, museum specimens of the various mammals described have been examined whenever practicable. But of necessity, much of the information has been taken from the literature. I have not hesitated to borrow from all sources in order to gather the habit notes, often pitifully meager, on the various genera and species. Although it is not possible to

¹ Carter, T. D., Hill, J. E., and Tate, G. H. H., *Mammals of the Pacific World*. Macmillan Co., 1945.

acknowledge indebtedness to all authors, I wish to single out for special appreciation the extraordinarily valuable works of G. M. Allen,² F. N. Chasen,³ S. I. Ognev,⁴ and R. I. Pocock.⁵

The art work has been done under the supervision of the Illustration Department of The American Museum of Natural History. For the many excellent drawings, some of which were made from photographs, I am indebted to the following artists: Miss Paula Hutchison, Miss Barbara Kurtz, Miss Dorothy Kay, Mr. George F. Mason, Mr. Fred F. Scherer. The three maps are the work of Miss D. F. L. Bradley.

I am also very grateful to Dr. Lee S. Crandall of the New York Zoological Society and to Dr. William M. Mann and Mr. Ernest P. Walker of the National Zoological Park, Washington, D. C., for sending me the photographs from which certain of the drawings were made.

This volume is a supplemental work in the Pacific Handbook Series, prepared under the auspices of the International Committee for Wild Life Protection, an organization of persons keenly interested in the conservation of wild life in general and the protection of many species that are in grave danger of extinction in the near future. The committee has, in fact, recently published two important books dealing with this very subject,⁶ that should be required reading for every farmer, hunter, sportsman, sealer and whaler.

² G. M. Allen, *The Mammals of China and Mongolia*, 2 volumes. The American Museum of Natural History, 1938, 1940.

³ F. N. Chasen, *A Handlist of Malaysian Mammals*. Bulletin Raffles Museum, Singapore, No. 15, 1940.

⁴ S. I. Ognev, *The Mammals of Eastern Europe and Northern Asia*. Moscow, 4 volumes, 1928, 1931, 1935, 1940.

⁵ R. I. Pocock, *The Fauna of British India, including Ceylon and Burma*. Mammalia, 2 volumes, London, 1939, 1941. Also other valuable monographs.

⁶ Allen, G. M., *Extinct and Vanishing Mammals of the Western Hemisphere with the Marine Species of All the Oceans*. Special Publication of the American Committee for International Wild Life Protection, No. XII, Lancaster, Pa., 1942. Harper, F., *Extinct and Vanishing Mammals of the Old World*. Special Publication of the American Committee for International Wild Life Protection, No. XII, New York, 1945.

MAMMALS OF EASTERN ASIA

1

What Is a Mammal?

WHEN visitors at the zoo or the natural history museum ask to see the "animals," they almost always mean the mammals. If they want to see birds, snakes, crocodiles, or insects, they say so. Mammals, whether the visitors realize it or not, are those animals that feed their young with milk. The word comes from the Latin, *mamma*, meaning "a nipple."

Besides employing this basic method of rearing their young, most mammals give birth to their babies alive, have four legs, a more or less complete coat of fur, and a number of unique features in their internal anatomy. Exceptions to the foregoing include the Duckbill that lays eggs, the Monkeys that have hands instead of paws, the Whales, Dugongs, and Seals that have more or less converted their limbs into paddles, the Bats that have their hands made into wings, the Pangolins that develop large scales mixed with only a few hairs, and the Dugongs and Whales that have almost completely ceased to grow a hairy covering but have developed instead a dense layer of insulating fat beneath their skins. All these exceptions conform to the basic fact stated above: they give milk to their young.

SPECIAL ADAPTATIONS IN MAMMALS

The nearest relatives of the mammals are the reptiles, the birds, and the amphibia (frogs and salamanders). All have the same type of skeletal system—a framework of bones centered

upon a dorsal axis or backbone, from which muscles move the extremities. The entire association of organisms with this kind of skeletal arrangement, in contrast to the external hard skeleton of crabs and insects, is termed the vertebrates, from the Latin, *vertebra*, "backbone."

The methods by which vertebrate animals obtain their food and grow, by which they make sensory contact with their surroundings, by which they protect themselves from unfavorable conditions, and by which they perpetuate their kinds, provide further basic facts for their classification. Their classification is based upon the forms and functions of their physical parts, of their nervous, respiratory, digestive, glandular, excretory, and reproductive systems. It involves their methods of locomotion, their senses, and their instincts.

The most easily observed of these in the mammals are those that pertain to their shape and external structure and to movement. The kind of food eaten can often be determined by the forms of the teeth. The climatic habitat of an animal may be indicated by qualities of its fur and skin. The degree of acuity of its senses of smell, hearing, and sight may be suggested by the characters of the muzzle, ears, and eyes. Whether it runs, hops, climbs, digs, swims, or flies can usually be deduced from the form of its limbs and tail. The limbs, tail, and teeth probably furnish the most reliable and simple index for preliminary broad classification into orders and families.

LIMBS. The characters of the limbs of a mammal bear a definite relationship to its way of moving from place to place and its method of seizing food. Probably the most generalized type of limb may be seen in the Common Shrew. Shrews' limbs are moderately tapered structures that hold the body off the ground, permit the animal to walk or run, and have five toes on both front and hind feet, each toe provided with a moderately sharp claw. The generalized pattern of Shrews' limbs becomes altered in a variety of ways. To function as digging tools, the limbs,

especially the forelimbs, become short, thick, heavily muscled, with the hand broad and the claws lengthened, broadened, and flattened. Examples of this include the Badgers, the Moles, the Mole Rats. Ability in climbing comes about either by development of grasping, hand-like organs as in Tarsiers and Monkeys, in which the unused claws become nails, or by alteration of the normal claws into short, sharp, strong, hook-like structures as in the Martens, Cats, Squirrels, Dormice, Marmosets, and some Civets. Claws become modified for food-getting also, as in the great enlargement to be seen in Anteaters and Pangolins, used for tearing open termite nests, or the special device for retracting the claws into sheaths seen in Cats and Linsangs, both of which use their claws for seizing living prey as well as for climbing.

Ability to run well leads to a tapered form of limb as in the Rabbits, and to a tendency to reduction of the number of digits as seen in the Dogs and many even-toed and odd-toed ungulates. But the evolution of the claws in these groups differs radically. In Rabbits and Dogs the claws remain essentially claw-like; they are blunt but still effective scratching organs. In the ungulates, the claws have become thickened, shortened, and hoof-like.

The Elephants, in response to their enormous body weight, have grown pillar-like legs that are centered over a single axis and lack the ability to spring and flex that the legs of Dogs, Horses, and Rabbits show. Although the five toes in Elephants are retained, they are shortened and tipped with small thick hoofs, while the short, rounded foot rests on a thick, elastic, fatty sole.

From the spring-like, narrowed, few-toed foot of the Dogs and rat-like rodents it is a rather short step to the hopping type of foot found in Jerboas, Jumping Mice, and Kangaroos. Considerable lengthening of the foot takes place, and at the same time a tendency appears for only one or two of the toes of the

hind feet to carry the weight of the body, while the little-used outer hind toes and the forelimbs become proportionately smaller.

Aquatic life has had either moderate or profound effects upon the limbs. The amphibious existence of Water Rats, Water Shrews, Otter Civets, Otters, and Water Opossums produces only minor changes in the feet. The soles and tactile surfaces of the toes may become soft, naked, and rubbery and the pads blend together. Fringes of stiff hairs that become erect and firm during the swimming stroke may be developed. The skin web between the fingers may be enlarged or the claws may be reduced as in the Small-clawed Otter. But in mammals as fully aquatic as the Seals, Whales, and Dugongs, much greater changes have taken place. Partial or total obsolescence has occurred in the hind limbs, and the forelimbs have been altered into paddles.

To permit travel for considerable distances through the air, modification of the limbs has taken two distinct courses; one is the development of gliding membranes attached to the arms and legs, and the other is the development of real wings and the power of true flight. Gliding membranes have developed in four distinct groups of mammals: the Flying Squirrels, the Flying Lemurs, the Phalangerine Flying Marsupials, and the Phascolarctine Flying Marsupials. But the problem of true flight has been solved only by the Bats, through enormous enlargement of the arm, hand, and fingers, and expansion of the skin covering them.

TEETH. The teeth, quite as variously modified as the limbs, have two associated functions—getting the food into the mouth, and cutting, crushing, or grinding it in preparation for swallowing. It is logical that the food-grasping teeth are at the front of the mouth and the food-treating teeth behind them.

The generalized type of mammalian dentition is not to be sought among the Shrews, where we saw the generalized foot.

Instead, we look at the American Opossums, the Australian Dasyures and Bandicoots, and (not so generalized) at some of the tree-shrews, the Flying Lemur, some carnivores and Bats.

The theoretically basic plan of the teeth of living mammals includes four classes of upper and lower teeth. Across the front of the mouth is a row of fairly simple single-rooted incisor teeth, the ones with which you bite a mouthful out of a slice of bread. At the front outer corners of each jaw stands a single, large, pointed tooth, the canine tooth. These are exceptionally large in most mammals and are used in seizing live prey and in fighting. Just behind the canine and extending back to about the angle of the lips are some three small, pointed, compressed, blade-like teeth, the premolars (bicuspid to dentists), which may act as supplementary canines or as supplementary grinding teeth. Behind them again stand four or less broadened, multicuspid cheek teeth, which do most of the chewing of the food—the molars. The incisors, canines, and premolars are represented by sets of temporary teeth during babyhood and the period of active growth; they are replaced by a second, permanent set. The molars come into place later, usually from front to back, and are not replaced by others.

In the different orders of mammals this basic pattern has become considerably or profoundly altered, probably in response to changes in food-getting habits, in the kind of food eaten, and in the animals' general mode of life. So long as mammals remain meat-eaters or insect-eaters, their teeth tend to keep the patterns described above, although some teeth may exchange functions with others and the total number of teeth may decrease. But when vegetable matter is added in quantity to the diet or replaces meat altogether, very great changes in the teeth take place.

A change of shape in the incisive and canine teeth that has taken place in certain still highly insectivorous mammals seems to indicate an alteration in their killing procedure to a kind of

stabbing or nipping technique. The central lower incisors become enlarged and point forward from the front of the jaw, while the usually large canines remain rather small or become very small. This condition appears in the Shrews and the South American *Cænolestids*. It is possible that the ancestral Rabbits, rodents, Phalangers, and Kangaroos used their centrally placed incisors in this way before they became so highly vegetarian.

When carnivorous animals took to living permanently in the water, wholly new things happened to their teeth. In some, the Seals and Whales, a tendency toward uniformity of shape plus simplification of structure in the premolars and molars appeared. The cheek teeth, especially in the Toothed Whales, became peglike. Although the number of the cheek teeth in some of the Toothed Whales tended to increase, in some Ziphioid Toothed Whales and all Whalebone Whales the teeth tended toward or achieved obsolescence.

In mammals with omnivorous diets, such as some Primates, Bears, Raccoons, Pigs, Murinæ, certain Squirrels, and certain of the Marsupial Phalangers, the cheek teeth may become enlarged and bear on their crown surfaces mound-like cusps that both crush and grind.

An almost completely vegetarian diet, especially if it consists chiefly of leaves of trees and grasses, requires an elaborate mechanism for chopping and grinding the relatively resistant cellulose. This is provided by more or less complicated folding of the lateral walls of the teeth to produce raised surface plates or meandering patterns of hard enamel on the crowns, interspersed by depressed softer areas of cement. The different degrees of wear in these two substances maintain the sharp, file-like surface seen in the molars of many ungulates, Kangaroos, and Langur Monkeys. In the ungulates the canines become similar to the incisors or disappear, and the premolars take the form and function of the molars and act with them.

The folded molar pattern in browsing and leaf-eating mam-

mals assumes one of two rather distinct patterns. It may form a series of crescent-shaped ridges lengthwise in the jaw and with two or four crescents to each molar. Mammals which have developed such "selenodont" molars include the Phascolarctine Marsupials, the Colobid Monkeys, the majority of the Artiodactyla (Cattle, Deer, Camels, etc.), some of the Philippine Complex-toothed Rats, some Flying Squirrels, and the Rabbits (a special type). The second pattern consists of a series of plate-like ridges one behind another, crossing the tooth from side to side. Those mammals that have adopted the plate-like or rigid pattern of crown surface include the Kangaroos, the Artiodactyla (with the Rhinoceroses and Horses showing complex foldings), and to an extreme degree the living Elephants.

Degeneration and obsolescence of the teeth in mammals, other than the Whales already mentioned, is initiated when diets of extremely soft and easily digested matter are habitually consumed. The South African Aard-wolf, a hyænid which eats chiefly grubs and termites, has small, weak teeth. The same is true of the Banded Civet, *Chrotogale*, which, according to Dr. Delacour, a scientist who has for many years lived in Indo-China, feeds on earthworms. The Armadillos, chiefly termite-eaters, and the Platypus, eater of water grubs, are approaching toothlessness. The Anteaters, Spiny Anteaters, and Pangolins, eaters of termites and other soft-bodied invertebrates, have no teeth at all. In view of this last, it may behoove our present generation of ice-cream lovers to watch their dental welfare closely.

COMMON NAMES AND SCIENTIFIC NAMES

When we speak of a Siberian Tiger, a Short-tailed Mongoose, a Pen-tailed Tree-shrew or a Black Rat we indicate with a relatively high degree of precision a certain kind of Tiger, Mongoose, Tree-shrew, or Rat. But if we talk of a House Cat, a

Spotted Cat, and a Civet Cat, we indicate widely diverse animals; the first is a member of the Cat family, but the second and third are animals related respectively to the Kangaroo and the Civet. This sort of misnaming took place in the early days of exploration, when travelers saw animals that reminded them slightly of familiar kinds at home and often invented unsuitable names for them. The Cat Bear is not a Bear; the Mouse Deer is not a Deer; the Tree-shrew is not a Shrew. Native names like Binturong, Pangolin, and Mongoose, which locally signify rather distinct types of mammals, are fairly satisfactory but still lack precision.

To provide a more exact terminology, the biologist Linnæus in 1758 invented a system of paired Latin or Greek names for all animals and plants. Each species of animal received two names—a first name, written with a capital letter, indicating the genus or general group to which the animal belonged, and a second name, written without a capital, showing the species or exact kind of animal. The generic name *Canis* includes both the Dogs and the Wolves, but *Canis familiaris* is the Linnæan name for the Dog alone, while *Canis lupus* applies only to the Wolf.

Much later, when Wolves from widely separated geographical regions were found to differ by minute but recognizable characters, a third name was added to so indicate. The typical European Wolf becomes *Canis lupus lupus*; the Chinese Wolf becomes *Canis lupus chanco*. In the text of this book the frequent use of the expressions “subspecies,” “forms,” and “races” (identical for present purposes) will be found invariably to refer to the last name of such a group of three. Unfortunately, many technical names are long and hard to pronounce, but apart from that handicap they serve to indicate thousands of kinds of animals with great accuracy. Many subspecies may go to make a species, many species a genus. On the other hand, an animal may be unique. Such a one is the Giant Panda, *Ailuropoda*

melanoleucus; no subspecies of this animal are known, nor is there a second living species in the genus *Ailuropoda*.

Depending upon their relationships to one another, genera are gathered together in subfamilies, and subfamilies into families. Families in turn are bundled up into suborders, and these into orders. The orders of mammals are grouped into the few subclasses of the class mammalia, which includes all mammals. Depending upon the complexity or simplicity of an order, the "sub" divisions, subgenera, subfamilies, or suborders, may be in use or may be omitted. Illustrating the major steps of this system, our Dogs and Wolves of the genus *Canis* combine with several other genera of dog-like animals to form the family Canidæ. The Canidæ, with the Bear family, the Cat family, and others, compose the Order Carnivora (flesh-eaters). In conclusion, when any single species has to be referred to, its family and ordinal relationships are left aside. The Wolf is alluded to simply as *Canis lupus*; that and nothing more is its scientific name.

2

The Home Territories of Eastern Asiatic Mammals

A geographical region as vast as the eastern face of Asia can be described in this work only in barest outline. Discussion here is confined to coast-line, mountain and river systems, swamps and lakes, and deserts. It is useful to learn from the accompanying map (fig. 1) the names of some of the political areas, countries and provinces, though they have no direct bearing on natural history. The differences between those parts of the coast that are low and flat and those that meet the sea as cliffs are not brought out in maps. Moreover, in a work of this nature, no coast of such enormous length can be described point by point. Wherever the coast is seen on the map to be closely backed by ranges of hills, coastal cliffs are likely to be numerous. On the contrary, the coast may be low and even marshy at the mouths of large rivers, or where no hills appear nearby.

MOUNTAIN SYSTEMS AND RIVER SYSTEMS in a large continental area that are intertwined and interdependent should be considered together (fig. 2). Divides or heights of land, the bounding features of river basins, may rise so slightly as to be scarcely perceptible; they may be sufficiently prominent to be called hills; or they may tower up to snow-capped summits.

From the northeast of Siberia the central hills of the Bering Peninsula, after giving off a spur that runs down the Kamchatka Peninsula, rapidly increase westward to mountain proportions, the Stanovoi Mountains. This great range, turning



FIG. 1. Introduced for purposes of general orientation and to be compared with Physical and Life Zone Maps (figures 2 and 3).

south close to the Sea of Okhotsk, runs at a distance of about 100 miles more or less parallel to its shores. At the southwest corner of that sea, where the coast-line turns abruptly east, the Stanovoi Range, continuing westsouthwest, merges into the Yablonoi Mountains (east of Lake Baikal), which in turn unite through a vast complexity of ranges with the great Altai Mountain system of central Asia. This huge elevated axis, stretching some 4000 miles from northeast to southwest, separates the large river systems of the Omolon, the Indigurka, the Lena, the Yenisei, all emptying into the Arctic Ocean, from the southern and eastern rivers.

East of the Altai Mountains and south of the Yablonoi, a virtually land-locked 4000-foot plateau extends into the Gobi Desert of Mongolia. The eastern edge of the Gobi is marked by the Hsing-an (Khingan) Mountains, 5000 feet, running north-south, the northern tip of which thrusts up into Manchuria and is separated from the combined Stanovoi and Yablonoi Mountains only by the valley of the Amur River.

To the south the Gobi and its subsidiary the Ordos Desert, south of the bend of the Yellow River, give place gradually to less arid country built of wind-deposited dust, called loess, that also stands several thousand feet above sea-level.

The Hsing-an (Khingan) Range, east of the Gobi, is connected by a low divide running east to the isolated eastern mountain system of the Maritime Province. These coastal mountains, named the Sikhota Mountains, reach as high as 8000 feet, and extend from the south shore of the Sea of Okhotsk to north Korea, with a break at Vladivostok. The mountains of the Shantung Peninsula, rising from 3000 to 4000 (one, 5000) feet above sea-level, are to be regarded as a southwest continuation of that east Manchurian system, part of which has foundered and lies beneath the waters of the Gulf of Pechili.

In the northern part of Manchuria the Amur River, rising in the northern Gobi and among the east slopes of the Yablonoi

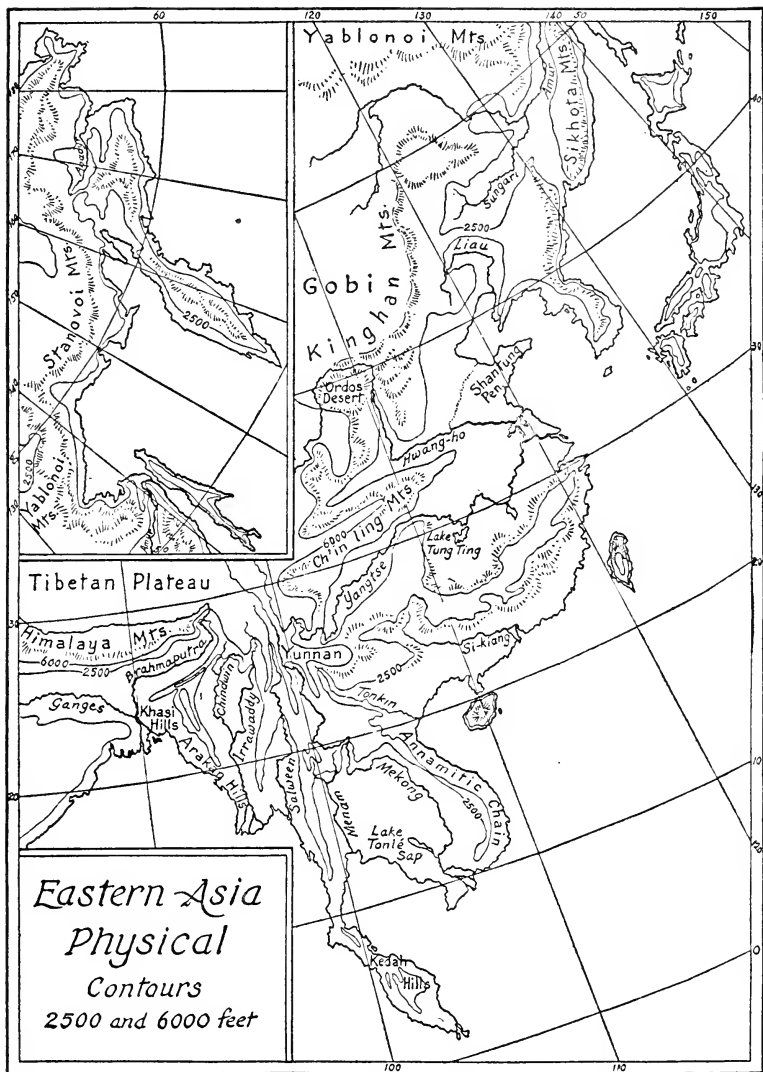


FIG. 2. The interrelationships of the principal mountain masses and river basins appear. Their influence upon the positions of the life zones are apparent by comparison with figure 3.

Mountains, passes around the northern tip of the Hsing-an (Khing-an) Mountains, then southeast among the Manchurian portions of the coastal system, where it is joined by the Sungari and the Ussuri Rivers, and again turning north, finds its way through the coastal mountains to the sea at the northern end of the Gulf of Tatory (separating the Island of Sakhalin from the Siberian coast). The smaller Liao-ho River that enters the Pechili Gulf below Mukden, originates in the southern part of the Hsing-an (Khing-an) Mountains.

South of Inner Mongolia and the Sinkiang Desert the land surface abruptly rises to the Altyn Tagh and Nan Shan Ranges on the northern edge of the Tibetan Plateau, the latter a high plain averaging 12,000 feet above sea-level, carrying on its surface many large mountain ranges and extending southward for almost 1000 miles to the Himalaya Mountains. In the far west, Tibet is connected with the mountains of Afghanistan, the Pamir and the Tien Shan, though only incompletely with the Altai, for the Tarim and Sinkiang depressions form an extensive low gap between the Tibetan region and the Altai Mountains. The eastern part of the Tibetan Plateau, peaks of which rise to 20,000 feet, becomes greatly dissected by huge, nearly parallel valleys running east, southeast, and south, through which flow great rivers, such as the Salween of Burma, the Mekong of Indo-China, the Yangtse (Long River) of China.

From the northern part of its eastern margin, the plateau sends forth a long mountain finger, the Ch'in-ling (Tsing-ling) Range, which, gradually dwindling from 10,000 or 12,000 feet to mere hills north of Nanking, serves as the southern boundary of the Yellow River or Hwang-ho.

The Hwang-ho or Yellow River, rising in the northeastern part of the Tibetan Plateau, swings north, east, and south again around the Ordos Desert. The southern arm of this loop is contained on the east by spurs of the Hsing-an (Khing-an) Mountains until the river reaches the Ch'in-ling (Tsing-ling)

Range. There it turns east, squeezing between the two ranges to reach the plains of Shantung Province from 200 to 400 feet above sea-level. In Shantung this remarkable river by depositing silt has gradually raised its own bed above the surrounding country, with the result that every few years disastrous floods drown thousands of people and bring about frequent changes of the river's course. In 1938 it abandoned a channel carrying it past Tsinan to the Gulf of Pechili for a new course that reaches the sea south of the Shantung hills and peninsula, nearly 300 miles away.

The Yangtse or Long River, which first flows southeast or south from the Tibetan Plateau, is turned to the northeast by the mountains of Yunnan; it then pursues a winding but generally easterly course to the East China Sea near Shanghai. This east-west river reinforces the barrier-like effect of the Ch'in-ling Mountains. For half of its 2000-mile course it is closely beset by encroaching mountains; and 1000 miles from the sea it forms the famous Yangtse Gorges. Its delta is criss-crossed by thousands of miles of canals. Its upper course passes through the red rocks of Szechwan.

The Tibetan highlands are connected with the Yunnan Mountains by the Likiang Range, which separates the valleys of the Mekong and the Yangtse Rivers. These send extensive offshoots eastward between the Yangtse and the Si-kiang or West River (which reaches the South China Sea at Canton) as far as Fukien and Chekiang Provinces. Those rather low mountains, reaching 5000 to 6000 feet in their central section and 4000 feet in Fukien, fill almost the whole of that vast area of south-eastern China.

The mountains of Yunnan also send off arms to the southeast and east-southeast. The ranges to the southeast extend between the Mekong River and the South China Sea through Indo-China to the Langbian Peaks in southern Annam. They are relatively low, in the southern part rarely reaching to 6000 feet. The

mountains thrusting eastsoutheast from Yunnan are even lower, falling from 6000 feet in western Kweichow to 1000 or less in the east of that province. They separate the West or Si-kiang River from the South China Sea. A low spur of this system, interrupted by the Hainan Strait, is continued as the 6000-foot mountains on Hainan Island.

At least three more systems of mountains originate from the southward-projecting spurs of the east Tibetan Mountains where four huge rivers, some in canyons 2 miles deep, flow through an area only some 200 miles across. The great divide between the Mekong and Salween Rivers expands at its southern end into the high hill country, 6000 to 8000 feet, of extreme northern Siam. These ranges continue through Tenasserim into the hilly northern Malay Peninsula and reappear in the lower peninsula as the isolated hills of Kedah and Perak. From the Tibetan Plateau just west of the upper Chindwin the Namkiu Range forks about the source of the Irrawaddy River, the eastern fork extending as gradually lowering ridges, 3000 to 4000 feet, south through the Shan States almost to Pegu and Rangoon. The west fork expands greatly into the Kachin Hills, the Lushai Hills, the Chin Hills, and Arakan Yoma Range, of eastern Bengal, Assam, and Arakan. This last great mass of hills—particularly the Patkoi, Naga, Jaintia, the Khasi Hills, from 8000 to 12,000 feet high—forms the southern edge of the valley of the mighty Brahmaputra River south of its point of emergence from the interior of the Himalayas.

The Tibetan Plateau in combination with the Himalayas can be compared to the handle of a gigantic fan, with radial mountain systems and the great rivers between them diverging to the east and south like the ribs.

SWAMPS, LAKES, AND DESERTS. Swampy areas of large size are absent except about the courses and deltas of some of the rivers. The most important areas of swamp are along the Ningpo and the Yangtse Rivers in China, the lower portions of the

Mekong in Cochin-China, and the delta of the Irrawaddy in Burma. Innumerable local regions of swampland exist also.

There are a number of important lakes in the region. One very interesting one, Lake Baikal of south central Siberia, draining into the Yenesei River, is important zoologically because it contains a species of Seal, *Phoca sibirica*. Another lake, lying 100 miles north of Vladivostok, empties through the River Ussuri into the Amur, and several more exist west of the lower course of that river. At least three large lakes lie along the course of the Yangtse River: Lake Tung Ting, 600 miles from the sea, contains the peculiar White Dolphin *Lipotes*; Lake Poyang is some 300 miles inland, and Lake T'ai is less than 100 miles from the mouth of the river. Other lakes are known in Yunnan and Szechwan. A large lake in Cambodia named Tonle Sap, located about 120 miles from the South China Sea, is drained by a tributary of the Mekong River. In Burma there are only two rather small lakes, Indawgi near Mogaung in northeast Burma, and Inle in the Southern Shan States. Bodies of water as large as these may well harbor unique faunal elements.

Deserts are chiefly represented in Asia by the great central wastes, the Gobi, the Ordos, and the Tarim, and other deserts of Mongolia and Sin-kiang. The fauna of such huge desert areas is specialized to a considerable degree. Only the extreme eastern portion of the Gobi can by any stretch of the imagination be included in this book. It is better to mark the inner limit of our area at the Hsing-an (Khing-an) Mountains.

THE CLIMATES OF EASTERN ASIA. The broad strip of land extending from the northeastern tip of Siberia to the Malay Peninsula, of which the physical form has just been pictured, is nearly 6000 miles in length, or about one-fourth the circumference of the earth. An aeroplane flying through its length must traverse successively arctic, temperate, subtropical, and tropical climatic zones. Except near the coast the average annual

climates in the northern parts are controlled by temperature, which is mainly related to latitude and is little influenced by rainfall; those climates at the southern parts, including part of Japan, are governed chiefly by the amount of rainfall modified by the direction and humidity of prevailing winds, while comparatively slight changes of average daily temperature occur during the year. The climates of the intervening areas, compounded from all of these factors, show moderate annual fluctuations of temperature together with varying developed wet and dry seasons.

Such generalizations as the above are profoundly modified by such local influences as the presence and orientation of mountain ranges, or the nearness to large bodies of water. The interplay of these and other factors in varying intensities produces the annual climate of any given area.

Hopei, eastern Manchuria, the Maritime Provinces of Siberia, and Kamtschatka experience winter temperatures as low as 25° below zero, with an annual rainfall of from 25 to 40 inches. Only June, July, and August are free from frost. In western Manchuria and the interior of the Okhotsk area the rainfall is less—only 10 to 20 inches.

Around Peking, in the Province of Hopei, extreme temperatures ranging from zero to 100° are experienced. The slight rainfall, 20 inches, comes mostly during the summer months. The nearby Shantung Hills of the Shantung Peninsula receive 30 inches of rain and likewise have extremely cold winters. The Khingan Mountains receive 50 to 60 inches of rain.

South of Ch'in-ling Range and in the lower part of the Yangtse valley the climatic picture changes. The rainfall, averaging 45 inches annually, occurs mostly in June. Summer temperatures reach nearly 100° , and winters are mild, with some 12° of frost, and of short duration.

The coastal region of Fukien, Chekiang, and eastern Kwangtung varies in temperature from 95° in the summer to 50° in

the winter (in the interior hilly lands south of the Yangtse, winters bring frosts). Rainfall amounts to 60 inches on the coast and 72 in the interior. Typhoons occur in the summer months. The driest period comes during the winter. Heavy rains, from 60 to 120 inches, occur in Formosa and south Japan. As far west of Kwangtung as Tonkin and as far south as 15° , the coastal climate is subtropical to tropical. The climate, much like the last, varies from 40° to 100° , and the rainfall from 45 to 70 inches, most of which falls between April and September. In Hanoi, Tonkin, and Laos the February temperature averages as low as 62° and may fall to 40° ; in June it may reach as high as 110° . Hainan belongs in this belt.

Southern Indo-China, southern Laos below 15° , and from Cochin-China west through Cambodia and Siam to lower Burma are regions subject to the typical monsoon climate of that part of southern Asia. The prevailing winds blow from April to October from the southwest and from October to April from the northeast. There are three "seasons"—the hot season from February to April, the rainy season from May to October, and the cold season lasting through the remainder of the year. Eastern Siam undergoes great heat through the day but may become very cool at night. The rainfall of lower French Indo-China may exceed 100 inches locally. Most of Siam is somewhat drier, 40 to 60 inches.

In the upper part of the Malay Peninsula the temperature is relatively mild and equable. Hot, fairly dry weather prevails from February to August, and cooler, very rainy weather from September to January, with maximum rainfall in December. The annual precipitation varies from 60 to 120 inches there and in the lower peninsula.

Most of Burma is tropical except high on the mountains, where cold weather and in winter even snow are known. The amount of rain that falls is very varied, depending upon the part of the country considered. The rain-bringing monsoon

blows from the southwest from May to October. Most of this moisture is deposited upon the coastal mountains of Arakan and the highlands of Assam, with relatively little falling in the interior of the country north of Prome. Parts of Arakan receive as much as 200 inches of rain annually, while the interior "dry zone" has only about 50 inches, though the mountains beyond along the Yunnan frontier receive nearly as much rain as the Arakan Hills. At sea-level, in the deltas of the Irrawaddy and the Salween Rivers where the protecting influence of the Arakan Hills is not felt, the rainfall is also abundant, about 100 inches.

ANIMAL ENVIRONMENTS AND FAUNAL AREAS IN EASTERN ASIA (fig. 3). The sum total of the conditions under which an animal lives constitutes its environment. Although environment is more comprehensive than climate, local climate is always an integral factor of environment. Environment is influenced also by the physical and chemical character of the land and soil, whether the locale is mountainous, rocky, swampy, sandy, acid or alkaline. If an organism is aquatic, the character of the water is important, whether a lake, a sluggish river, a mountain torrent, sweet or brackish, hard or soft. Another factor that plays an important part in an animal's environment is the character of the local vegetation. Is the land forested, grass-covered, or semi-desert? If forested, is it composed of stands dominated by one or a few species of trees, like pine, spruce, oak? Or is it a mixed hardwood forest of oaks, hickories, beeches? Depending upon its relationship to climate and soil, the forest may be tall and luxuriant, or low and seemingly starved.

Forests of the tropics differ completely from temperate forests. One of the many reasons for this, and possibly the most important of them, is the ability of temperate and arctic plants to tolerate the extreme changes of temperature, compared with the intolerance of such by tropical plants. Accompanying those varying tolerances of temperature go other more local tolerances: Both the tropical and the temperate zones contain certain

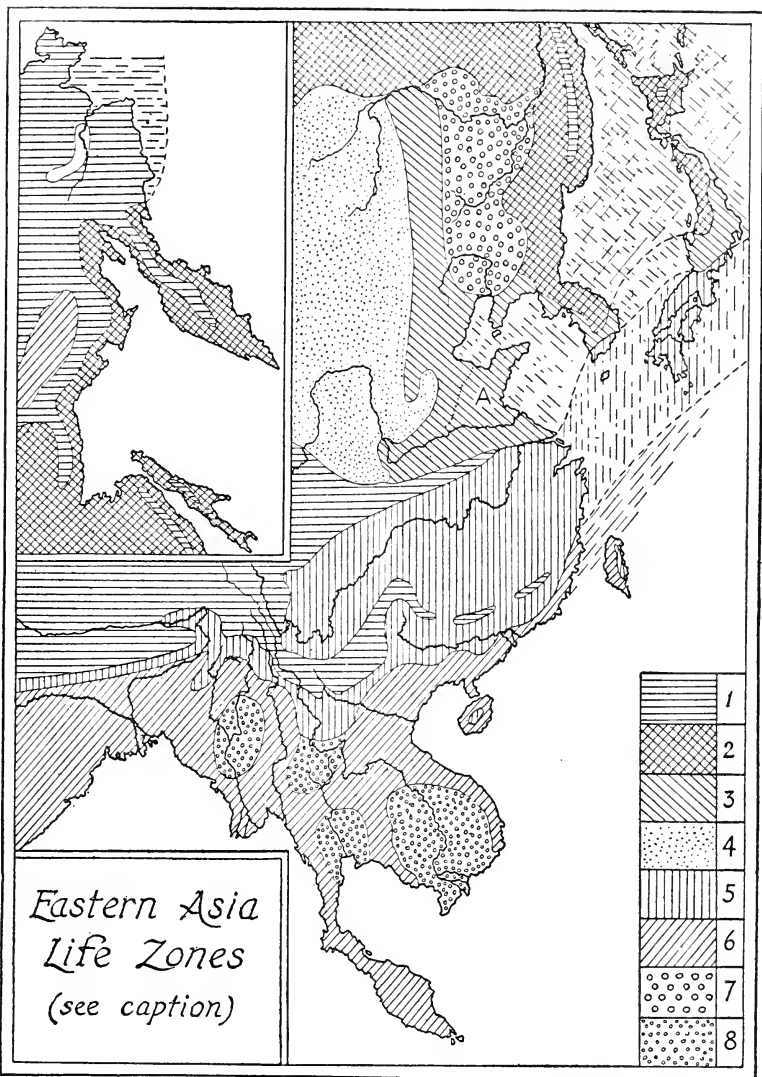


FIG. 3. 1. Tundra and High Plateau; 2. Northern Coniferous Forest; 3. Northern Mixed Forest; 4. Desert and Semi-desert; 5. Subtropical Zone; 6. Humid Tropics; 7. Temperate Areas of reduced Rainfall; 8. Tropical Areas of reduced Rainfall. A. Almost all of the southern portion of the Northern Mixed Forest Zone is deforested, presumably by man.

kinds of plants that grow well or even best under special conditions, such as aridity, swamp, soil acidity or alkalinity, intense light or shade. This interplay of very different responses in many sorts of plants to multitudes of stimuli results in the production of the local patches of forest, pasture, and bog that in turn provide the vegetational element in an animal's environment.

Even these environmental factors—climate, land and vegetation—are not all. There are many others of importance, such as the abundance of predators, the state of the food supply, and the incidence of parasitic and other diseases, but those just discussed are three of the most important elements that affect the lives of most free-living animals. The interaction on the individuals of a species of all its environmental elements determines whether it can continue to live where it is, whether it can increase in numbers or, on the contrary, is fated to become extinct.

It is neither possible nor suitable in this book to try to give descriptions of the very numerous and complex local environments present through the coastal areas of eastern Asia. On the other hand, a series of brief vignettes of larger divisions, known as "faunal areas," may help readers to visualize some of the local conditions among which Asiatic mammals live.

THE TUNDRA, generally frozen throughout the year, with the exception of a few inches of the surface soil in summer, is the treeless, rather arid circumpolar belt lying between the Northern Forest belt and the Arctic Ocean. Most of the plants that grow there are either dwarf perennials or annuals of quick growth. The equivalent of tundra develops on the tops of the highest mountains just below snow-line. The mammals present include Shrews, Bears, Wolves, Arctic Foxes, Weasels, Pikas, Arctic Hares, Ground Squirrels, Woodchucks, Red-backed Mice, Beaver, Lemmings and Lemming Mice, Caribou, Moose, Sheep, Reindeer.

THE NORTHERN FOREST BELT is also circumpolar. In Siberia

it begins as scrub forest at the southern margin of the tundra at about the latitude of the Yablonoi and southern Stanovoi Mountains, and it extends southward into Mongolia and north China, to terminate at a line that roughly follows the northern edge of Mongolia to the Khingan Mountains, across central Hopei to the coast. To it belong Sakhalin, and parts of Korea and of northern Japan. Its more northern portions are composed of coniferous forest; its southern parts contain mixed conifers and hardwoods such as pines, firs, larches, oaks, and birches.

Its mammal fauna consists of northern forest dwellers: species of Shrews, Moles, Hedgehogs, several genera of Vespertilionid Bats, Brown Bear, Red Fox, Wolf, Old World Badger, several Weasels, Otter, Lynx, Siberian Tiger, European Squirrel, Ground Squirrel, Eurasian Flying Squirrel, several kinds of Voles and Mice, Birch Mice, Pikas, northern Hares, Wild Pig, various kinds of northern Deer. Goral and Serow occur high on the mountains.

South of latitude 40°, due to marked differences between coastal and interior climates, the zonal pattern of the faunal areas becomes interrupted. There are at least four coastal areas and three internal areas south of the Northern Forest belt in China.

THE NORTHEAST CHINA FAUNAL AREA extends from the southern foothills of the Khingan Mountains east to the coast, to the Siberian Maritime Province, southern Korea, and northern Honshu, and southward in China to a poorly defined region of transition with the South China area, roughly at the latitudes of the Ch'in-ling Mountains and the northern edge of the lower Yangtse valley. The vegetation is chiefly a mixture of deciduous and coniferous woods. According to Cressy, the original vegetation of much of this country has been destroyed.

The mammals of northern China include invaders from adjoining areas as well as widespread species and a few endemics.

Northern types are Birch Mice, *Sicista*, *Apodemus*, Red-backed Vole, *Microtus*, and Eurasian Flying Squirrel. Southern animals include White-cheeked Tree Squirrel, Yellow-bellied Rat, White-toothed Shrews, *Pipistrellus abramus*, *Rhinolophus*, *Chrysopteron*, *Murina*, *Nyctinomus*, Stump-tailed Macaques (Japan and South China). Gerbils enter from the Gobi Desert area. Animals with wider distribution comprise several carnivores and ungulates, and the Tolai Hare. As endemics one may list River Deer (*Hydropotes*), David's Deer, the Grooved-toothed Flying Squirrel, and the Japanese Dormouse.

THE GOBI DESERT FAUNAL AREA is properly beyond the scope of this book. Offshoots of its mammal fauna such as Gerbils just reach the western edge of the North China area under consideration.

THE SOUTH CHINA FAUNAL AREA, if its area of overlap with the North China area is neglected, reaches its northern limit approximately at the Yangtse River, on the 34th parallel. Farther west the boundary approximates the Ch'in-ling Range and it extends southward throughout the hill country of southern China almost to the seacoast; it includes part of Formosa, southern Honshu, and Kiushu, Japan. To the west it passes imperceptibly into the Western Highlands. The higher parts of its mountain ranges may be occupied by faunal outposts of the same Western Highlands. It should be pictured as continued as a narrow belt around the mountain sides of Tonkin, northern Laos, northern Siam, and Burma to the Himalayas, at altitudes between 3000 and 6000 feet. The vegetation is subtropical mixed evergreen and coniferous forest.

Of the mammals listed below few are completely restricted to this area, but they do not extend far beyond its limits. They include the Moles of genus *Euroscaptor*, some White-toothed Shrews, the Harlequin Bat (*Scotomanes*), several Horseshoe Bats (*Rhinolophus macrotis* group and *R. rex*) and Roundleaf Horseshoe Bats (*Hipposideros armiger* and *pratti*), the Snub-

nosed Langurs (*Rhinopithecus*), some Macaques, the Spotted Linsang (*Prionodon pardicolor*), the Coarse-haired Hares (*Lepus sinensis*), two Squirrel groups (*Tamiops* and *Dremomys*), and the Bamboo Rats. A number of other mammals with headquarters in south China have much wider ranges. Such include the Ferret Badgers, the Crab-eating Mongoose, the Goat-antelopes.

THE WESTERN HIGHLANDS FAUNAL AREA represents an altitudinal belt of tremendously dissected country placed between the Tibetan Plateau and South China faunal area. There is indirect contact with the Himalayas, across the valley of the Brahmaputra River; to the south the Western Highlands area extends into northern Burma and western Annam. The altitude of this zone varies from 6000 to 13,000 feet. The forests contain spruce and fir, with rhododendron and certain bamboos.

The fauna of the Western Highlands contains a number of distinctive mammals, as well as invaders from the Tibetan Highlands and from the lower zone. Examples are the Chinese Gymnure (*Neotetrachus*), a number of Shrew Moles and Talpine Moles, the Asiatic Short-tailed Shrews (*Anourosorex*) and the Himalayan Water Shrews (*Chimarrogale himalaica*), the chipmunk-like *Rupestes* and some other Squirrels, some species of Voles of the genus *Eothenomys*, the Rats of the *R. bowersi*, *R. andersoni*, and *R. eha* groups, the Chinese Jumping Mouse (*Zapus*), the Takin and the Goral, the Giant Panda and the Snub-nosed Monkeys.

THE TIBETAN PLATEAU FAUNAL AREA is mentioned chiefly for the sake of completeness. The high Himalayas, separated in their eastern part from the Tibetan Plateau by the eastward-flowing Brahmaputra, are faunally a subdivision of Tibet. Both are beyond the scope of the present work. The fauna includes Himalayan Brown Bear, Red-eared Pika, Tibetan Hare, Himalayan Woodchuck, Blue Sheep, Yak, and Snow Leopard.

THE SUBTROPICAL FAUNAL AREA begins at the southern

edge of the South China faunal area and extends through Indo-China, Laos, Burma, and Assam, along a foothills zone just above the tropical area. In China it is represented intermittently as a narrow strip along the south coast. It is present on Hainan. In Annam it follows the Annamitic Chain south to the Langbian Peaks and the Bolovens Plateau. A small "island" of this zone appears on the Perak and Kedah Hills of the lower Malay Peninsula. The vegetation is modified tropical, with a mixture of conifers.

The mammals more or less characteristic of the area include: some of the Tree-shrews (*Tupaia*), the Lesser Gymnure (*Hylomys*), several species of Tube-nosed Bats (*Murina*), the Harlequin Bat, and Pratt's Horseshoe Bat (also in the hills of Perak), some Langurs (*Trachypithecus*), the *Callosciurus sladeni* and *quinquestriatus* groups of Squirrels (in part), the Spotted and other Giant Flying Squirrels, some Bamboo Rats, the Marmoset Mice (*Hapalomys*), the *Acanthion* Porcupines, Fea's Muntjak, and the Roosevelt Muntjak. The foregoing are in addition to a large number of tropical species that extend southward to the Sunda Islands.

In Annam, Laos, and Tonkin there is a small group of restricted species typified by the Douc Langurs and the Crested Gibbons that reappear in Hainan.

THE TROPICAL OR MALAY FAUNAL AREA, including all of the remainder of our territory and represented southeast across the equator almost to northern Australia, has been divided into several subareas of which we need regard only those of the mainland. Those divisions are relatively weak and inconclusive because they depend upon imperfect barriers based chiefly on low hills and comparatively small differences of temperature and rainfall.

Faunistic subdivisions of the tropical area of Burma, Indo-China, and Malaya include: the Annamitic Chain of Annam; the coastal Elephant Chain of Cambodia; the swampy savanna-

like, or scrub-covered lowlands of Cambodia and Cochin-China bordering the lower course of the Mekong River; the barren Korat Plateau of Eastern Siam drained through the Nam Si River to the Mekong River; central Siam, watered by the Menam Chao Praya; peninsular Siam together with Tenasserim, forming the upper part of the Malay Peninsula; the lower Malay Peninsula (excluding the hill country of Perak); the rainy Salween and Irrawaddy delta country; and finally the "dry zone" of central Burma.

Characteristic mammals of the Malayan tropics include the Moonrat (*Echinosorex*), some White-toothed Shrews (*Suncus* and *Crocidura*), most of the Fruit Bats, and among insectivorous Bats many *Pipistrellus*, Disk-footed Bats, and other Vespertilionid Bats of the genera *Hesperoptenus*, *Eptesicus*, *Scotophilus*, and *Kerivoula*; most of the Free-tailed Bats and many species of *Rhinolophus* and *Hipposideros*, also the Hairy-faced Horseshoe Bats *Coelops*. Other representative mammals are Pangolins, Flying Lemur, Langur Monkeys, Macaques and Gibbons, tropical Weasels and Otters, Malay Bear, Banded Linsang, most of the species of Civets and Mongooses, several Cats, certain Hares, the Giant Squirrels, many groups of Tree Squirrels, the Sunda Long-nosed Squirrel, the Black Flying Squirrel, and several Dwarf Flying Squirrels. In addition, there are several genera of Mice with the great toes of the hind feet opposable, a wealth of the species groups of *Rattus*, Long-tailed Porcupines, the Elephant, the Crested, Banded, and Bearded Pigs, Mouse Deer, Wild Cattle, Muntjaks, Hog Deer, Sambar Deer, Eld's and Schomburgk's Deer, Tapir, and Rhinoceros.

AN ANCIENT EAST ASIAN FAUNAL AREA. There is, further, a pattern of distribution in southeastern Asia that disregards and transgresses many of the faunal areas just described. No less than sixty-seven thoroughly distinct species groups of the mammals dealt with in this work have distribution patterns that run to a greater or less extent from the general Burma-South

China region to the general Siberia-Japan region. Some of these are continuously represented throughout the region; others are represented in the south and in the north but not in the intermediate areas.

Of those sixty-seven distinct types, the northeast-southwest contacts of 53 are made by following the contours of the land, usually remote from the sea, through various fairly uniform altitudinal zones. Another ten species appear to have a coastal pattern of distribution, through eastern China and Formosa to Korea, the Maritime Province of Siberia, and Japan. Among these the Tree Squirrels, *Callosciurus*, the Shrews *Suncus*, and the Bats *Myotis* (*Chrysopteron*), *Pipistrellus*, *Rhinolophus* are essentially Indo-Malaysian (some also African) tropical groups, while the Mole *Mogera*, the Macaque *Lyssodes*, the Pig *Sus leucomystax*, the Goat-antelope *Capricornis crispus*, and the Deer *Sika* apparently evolved right in coastal eastern Asia. *Capricornis crispus*, in view of its relationship to the continental *C. sumatrensis*, may be regarded as also continental; or else either the Japanese or the Formosan *crispus* may have been transported in some way. All of these ten groups show substantial discontinuities in their patterns of distribution.

There remain four more groups—the Bats *Myotis* (*Leuconoë*), the Marten *Charronia*, the Bear *Selenarctos*, and *Rattus rattus*—that may have spread either by the littoral route or by the hillside route, or by both. The *rattus* Rats are primarily tropical; like *Callosciurus*, they are represented in Japan by a single species. To this fauna, which may have originated in rather remote times in the east Asiatic littoral, may be added several local northern elements: two Japanese Moles *Dymecodon* and *Urotrichus*, the Hamster *Phodopus*, and the Dormouse *Glirulus japonicus*.

Types of environment such as the valleys of rivers may successively penetrate two or three nearby faunal areas. River valleys like the Yangtse, the Mekong, and the Salween may act

as thoroughfares to bring lowland species far into the otherwise mountainous hinterlands. The ultimate limiting factor in such cases is probably temperature; wherever the bed of a river rises so high above sea-level that night temperatures fall below some critical point, the tropical fauna will be excluded. Conversely, mountain chains projecting from extensive upland areas will often permit faunas characteristic of elevated plateaus to extend along their crests far into regions otherwise distinct.

Descriptions of East Asiatic Mammals

THE INSECT-EATING MAMMALS OR INSECTIVORES (ORDER INSECTIVORA)

THE separate families that compose the insectivores in Asia are perhaps more easily visualized than is the entire order. They are the Shrews, the Moles, the Hedgehogs, and the Tree-shrews. The Shrews and the Moles are familiar to many people. The Hedgehogs, unknown in America but common in the Old World, are typically small animals 8 or 9 inches in length, covered with short, straight spines. Farther south, in the Asiatic tropics, occur dissimilar relatives of the Hedgehogs commonly called Gymnures, clad in hair instead of the distinctive spines. The Tree-shrews, also unknown in America, are poorly named and not shrew-like; their appearance instead suggests squirrels, and their usually bushy tails, climbing habits, and activity during the daylight hours add to the resemblance. Furthermore, their relationships to other families of insectivores are exceptionally remote. They are held to be most nearly allied to the Elephant Shrews of Africa and have been considered related to an extinct line of primitive animals which gave rise to the Primates (apes, monkeys, lemurs).

Perhaps if the Order Insectivora were endowed with a single short, popular name like monkeys, whales, or bats—words that promptly bring distinct pictures to the minds of most people—its significance would be more easily grasped.

It is probably true that all of the Insectivora actually eat insects and to that extent merit their name. But the name is not exclusive; the habit of eating insects turns up in many other orders. In mammalogy, the order of insectivores signifies not a type of behavior but a certain group of interrelated mammals.

THE TREE-SHREWS (FAMILY TUPAIIDÆ)

Although the Tree-shrews are so much like small squirrels in external appearance, the long, slender snout will show their distinctness from all of those except the long-nosed squirrels of southern Asia. Their numerous sharp front teeth distinguish them from the squirrels, which have paired upper and lower gnawing teeth like other rodents. In most of the species the tail is hairy, with most of the hairs growing out from the sides. The animals are active tree-climbers during the day.

Two subfamilies are recognized: the True Tree-shrews, Tupaiinæ, and the Pen-tailed Tree-shrews, Ptilocercinæ. The former is composed of several genera; the later of one genus only, *Ptilocercus*.

The Pen-tailed Tree-shrew, *Ptilocercus*, may be at once distinguished from other Tree-shrews by the fact that its tail bears a large terminal tuft of hairs arranged distichously, or like the webs of a bird's feather. The ears also are large and membranous instead of small and cartilaginous. The color of the fur is pale brown, with shades of drab and gray. A black mark runs through each eye. The body color extends nearly to the base of the tail, beyond which it changes; the basal part of the "feather" is black and the end part white or cream. The length of the head and body is from 5 to 6 inches, tail $6\frac{1}{2}$ to $6\frac{3}{4}$ inches, hind foot $1\frac{1}{4}$ inches. The only known species is *P. lowi*, with a race *continentis*. The original *P. lowi* lives on the island of Borneo; the mainland race is known from the lower half of the Malay Peninsula.

TRUE TREE-SHREWS (SUBFAMILY TUPAIINÆ)

The continental members of this subfamily present in our area belong to the genera *Tupaia* and *Dendrogale*, which can be recognized by the following characters:

- Tail squirrel-like in character, clothed uniformly with
 long hairs *Tupaia*
 Tail rounded, with appressed hairs throughout
Dendrogale

The Pigmy or Bridled Tree-shrew. *Dendrogale*, a very small genus, contains but one mainland species, *D. frenata*, of southeastern Indo-China, Cambodia, and Annam. Other species occur on Borneo. The color in general is grizzled, a mixture of black and yellowish hairs, with the underparts pale buff. The "bridle" is formed by a strong blackish line beginning at the whiskers and running back across the eyes to the ears. This dark line is margined above and below by similar lines. The tail is slender and the hairs on it, unlike those of *Tupaia*, lie nearly flat. Head and body 5 to 5½ inches, tail 4 to 4¼ inches, hind foot 1 to 1⅙ inches.

True Tree-shrews, genus *Tupaia*, are the most squirrel-like of any members of the family. The great authority on these animals, Dr. M. W. Lyon, divided the genus into seven sections, all but one of which live on the islands of the Sunda region and so do not concern us. His fourth section, with which we are concerned, was subdivided into eight groups; only two of those, the *T. belangeri* and *T. glis* groups, are continental.

Notes on a Javan species give some idea of the behavior of these interesting little creatures. "A confiding, simple little animal, always in motion, seeking its food at one time among dry leaves and moss on the ground, again on the stems and branches of trees, poking its nose into every crevice. Its nest is formed of moss at some height from the ground."

Another author writes of *Tupaia* in Malaya, "In a state of nature it lives singly or in pairs, fiercely attacking intruders of its own species. When several are confined together they fight each other, or jointly attack and destroy the weakest. . . . A short, peculiar, tremulous whistling sound . . . marks their pleasurable emotions, while the contrary is expressed by shrill, protesting cries. . . . They will sit on their haunches, holding their food between their forepaws, and after feeding they smooth the



FIG. 4. Tree-shrew, *Tupaia ferruginea*.

head and face with both forepaws and lick the lips and palms. They are fond of water, both to drink and to bathe in."

The Tree-shrews of the *T. belangeri* group are colored grayish or olive, and the number of nipples in females is generally 3 pairs on the chest and 3 more pairs on the belly. The one species contained in this group includes a number of geographical races. Belanger's Tree-shrew, of southern Burma and northern Malay Peninsula, is colored a grizzled mixture of yellow and black, becoming reddish on the rump, with the underparts cream to buffy yellow. The length of head and body is $7\frac{1}{2}$ inches, tail $6\frac{1}{2}$ inches. The Chinese Tree-shrew, *T. b. chinensis*, is colored olive-gray with a faint whitish shoulder stripe. It lacks the reddish rump of *belangeri*, and has the underparts from whitish to buff, the hairs with gray bases. The size is about the same as that of *belangeri*. This race is found in Yunnan; westward it extends to Nepal, southward into middle Burma at about 6000 feet and to northern Siam from 1500 to 8000 feet. The longer-haired *T. b. vesuræ* of the Mishmi Hills

is reported also from Burma; this form is contrasted with the shorter-haired *T. b. assamensis* from Assam. A slightly browner form, which was formerly separated as *T. b. yunalis*, is the same as *modesta*, the former being in winter pelage, the latter in summer pelage. The broadly light-colored underparts seen in summer are said in winter to become much narrowed, and gray-based hairs become more numerous on either side of the narrowed strip of self-colored hairs. The Concolored Tree-shrew, *T. concolor*, is colored much as the Chinese animal but is larger, with the length of the head and body attaining 8 to 9 inches, tail 6½ inches. This form is found in southern Annam and northern Cochin-China.

The *T. glis* group is colored deep reddish. The number of nipples in females never exceeds 8. In the Red Tree-shrew, *T. glis ferruginea*, the color is composed of a mixture of red and blackish hairs and the tail is yellowish black above, blackish yellow beneath. The underparts of the body are buff, often with the gray bases of the hairs showing through. The length of head and body is 7 to 8 inches, of the tail 6 to 7 inches. This common Tree-shrew occurs on the lower third of Malay Peninsula. Numerous local races are known from adjoining islands. *T. glis cambodiana* from the southeastern parts of the Siamese-Annamese Peninsula must be carefully distinguished from *T. belangeri modesta* from the same general region.

Wilkinson's Tree-shrew, *T. lacernata wilkinsoni*, which to some extent is intermediate between *belangeri* and *glis* both in its color and geographically, dwells in the middle part of the Malay Peninsula, north of *glis* and south of *belangeri*.

THE HEDGEHOGS AND GYMNURES (FAMILY ERINACEIDÆ)

Although the Hedgehog family includes the largest Asiatic members of the Order Insectivora, none of its members is as large as a house cat. The Hedgehogs may reach a total length

of 9 inches and the rat-like *Gymnures* may slightly exceed this.

Fossil relatives of the Hedgehog family and of their nearest allies, the Elephant Shrews of Africa, are known far back in the geological record. This total assemblage, known as the Menotyphla, if traced back far enough, will be found to converge with another evolutionary stream, the Lipotyphla, which produced the Shrews and Moles.

The family Erinaceidæ divides naturally into subfamilies, the primitive Moonrats and *Gymnures*, *Gymnurinæ*, and the specialized, spine-bearing Hedgehogs, *Erinaceinæ*.

SUBFAMILY GYMNURINÆ

The *Gymnures*, though they have a rat-like appearance, nearly bare tail, and are clothed with hair instead of the spines of the Hedgehogs, exhibit nevertheless the distinctive pointed front teeth of the insectivores and the squarish molar teeth of the Hedgehog family. They comprise three genera: *Hylomys*, *Neotetrachus*, and *Echino-sorex*. The last of these is commonly called the Moonrat or Raffle's *Gymnure*. The first two genera may be designated respectively the Lesser *Gymnure* and the Chinese *Gymnure*.

The Moonrat or Raffle's *Gymnure*, *Echino-sorex gymnura*, is colored white and black; the head, neck, and back between the shoulder blades are white or brownish white, the rest of the body blackish; there is a black streak above each eye uniting with a median black line on the crown of the head. The underfur of the back of the neck is also black. The distal half of the tail is white. The length of the head and body is about 12 inches, of the tail 8 inches.

Moonrats, with their almost naked, scaly tails look like pied rats with very pointed noses. They give off a peculiarly offensive, onion-like smell. They are creatures of the night, hiding

by day under the roots of trees and among rocks where these occur in forest. The contents of the stomachs of dead *Gymnures* prove them to feed upon roaches, termites, and other insects.

The geographical range includes Burma, Indo-China, and the Malay Peninsula. An allied species having much more white in its coat occurs in Borneo. The representative of *E. gymnura*



FIG. 5. Moonrat, *Echinosorex gymnura*.

in Siam and Burma (the northern part the total range) has been distinguished as *E. g. birmannicus*, the Burmese Moonrat.

The Lesser Gymnures, *Hylomys suillus*, are small insectivores about the size of Moles. Their generic name means "forest mouse" (another poorly chosen name); their specific name, "little pig," was probably inspired by the facial contours. The color is a grizzle of finely mixed black and ochre-yellowish hairs which combine to make a rusty brown; the underparts are grayish white or yellowish. The length of the head and body is about 5 inches, of the tail only $\frac{3}{4}$ inch. The animals have long snouts which make the head occupy a proportionately very large amount of the head and body length; externally they look like long-nosed Meadow Mice. Kloss gives the measurements of

H. siamensis as head and body $6\frac{1}{2}$ inches, tail 1 inch, and hind foot $1\frac{1}{12}$ inch.

Lesser Gymnures were first discovered on the island of Java. Continental races have been distinguished as follows: *H. s. peguensis* from Tenasserim and southern Burma, north to Yunnan, China; *H. s. siamensis* from northern and eastern Siam, the isthmus of Kra and Annam, a close relative of *peguensis*; and *H. s. microtinus* (meaning "like a meadow mouse") from Tonkin, Laos, and Annam. *H. s. siamensis* has been trapped under logs in wild banana groves in northern Siam at 4300 feet.

The Chinese Gymnure, genus *Neotetrachus*, is closely related to *Hylomys*. The length of its tail amounts to half of the length of its head and body, instead of being only as long as the hind foot. The snout is not quite so long in proportion, and there are fewer teeth. The only known species, *N. sinensis*, is colored dull olive-brown above, buffy gray beneath, with the sides of the head slightly tinged with russet. The length of the head and body is 4 or 5 inches, the tail 2 to $2\frac{1}{2}$ inches, the hind foot about 1 inch. This animal is best known from Hsikiang, Szechwan, and Yunnan, all provinces of China. It is present in the basin of the Salween River between 7000 and 8000 feet. A race, *N. s. cuttingi*, which occurs in northeastern Burma between 7000 and 9000 feet, occurs in cool damp forest where it uses the same runways as many other small mammals of the region. Another race, *N. s. fulvescens*, found in Tonkin, has the underparts conspicuously more reddish than the animals from Yunnan.

THE HEDGEHOGS (SUBFAMILY ERINACEINÆ)

The Hedgehogs of China include two genera, *Hemiechinus* and *Erinaceus*. *Hemiechinus*, meaning "half spiny," has the ears long ($1\frac{1}{2}$ inches), and the spines on the crown of the head

parted along the middle. *Erinaceus* (the Latin word for a Hedgehog), on the contrary, has short ears (1 inch) and no parting of the spines on the crown. Both genera have the tail very short, about one-ninth of the length of the head and body. A Hedgehog can roll itself into a ball when disturbed, like an armadillo, at which time it erects all its spines for protection. The spines, though sharp, are not barbed as in North American Porcupines.

The length of the body is not easily estimated on account of the spines. But 7 to 8 inches is approximately the distance from the nose to the base of the tail, including the spines.

In the province of Hopei, China, the Hedgehogs are regarded as sacred. In Europe they were once believed to suck cows, much as milk snakes are said to do in the United States, and to be immune against poisons—particularly snake-bites. Their digestive powers must be great, for they are stated to be able to eat hundreds of blister beetles with apparent impunity. The normal food appears to be insects, frogs, mice, and worms. But in confinement Hedgehogs eat almost any animal matter or soft vegetable matter they may be given. Near Peiping they feed extensively upon the maggots of flies. The number of young is 4 or 5.

The Long-eared Hedgehogs, genus *Hemiechinus*, are represented in eastern Asia by the single species, *H. dauricus*, although others are known from central and western Asia, southeastern Europe, and northwestern Africa. *H. dauricus*, named after the Daurian region of northeastern Mongolia, is found from 300 to 600 miles inland (northwest) from Tientsin on the Gulf of Chihli. It therefore barely enters the area we have to consider. A second race, *alaskanicus*, is found in the Gobi Desert, twice as far away to the west.

The True Hedgehogs, genus *Erinaceus*, are by far the better known, since they are common in northern Europe and England, where they have been studied intensively. The species of

the Old World temperate zone is *E. europæus*. Several races of this species have been described. Two of them, the Chinese Hedgehog, *E. e. dealbatus* and *E. e. miodon*, live in China. The former is widely distributed in Shantung, Hopei, Hupeh, and Kiangsu, the latter in a restricted area in Shensi. Besides the foregoing, there are other races in western China. Farther north a race, *E. e. amurensis*, of the Amur region of Siberia probably



FIG. 6. True Hedgehog, *Erinaceus europæus*.

extends to Vladivostok and through Manchuria into the Khingan Mountains area of China; and a second race, *E. e. koreanus*, is known in Korea.

THE MOLES (FAMILY TALPIDÆ)

Moles are ordinarily thought of as "varmints" that make raised ridges through our finest lawns by tunneling in the sod and pushing up the surface as they go. The culprits include the European True Moles of the subfamily Talpinæ and the American Moles, Scalopinæ, which have their front feet altered into powerful, paddle-like organs with which they "swim" through

the soil, using a kind of breast stroke, while the hind feet thrust the loosened earth straight behind them. One of our Moles of the western United States, a member of the latter group, is sometimes accused of eating choice bulbs.

The value of Moles as destroyers of pests was recognized by very few people until recent times. Yet as long ago as 1876 a dairy farmer appreciated them: "The moles are of great service. They eat up the worms that eat the grass, and wherever the moles have been, afterwards the grass grows there very luxuriantly. . . . The grass where the moles have been is always best for cows."



FIG. 7. Hands of True Mole, *Talpa*, and Shrew Mole, *Rhynchonax* to show digging adaptation in the former.

There are also Moles in which the peculiarity of the hands has not yet developed, and which, in consequence, look much like large Shrews. All Moles can be distinguished from Shrews, which belong in a different family, by the fact that they have complete though very slender cheek arches, while Shrews lack them.

The Shrew-like Moles and the True Moles of eastern Asia form two natural subfamilies, the primitive *Uropsilinæ* and the specialized *Talpinæ*. There is also present in eastern Asia a single member of the American Moles, the genus *Scapanulus*. A few of the Shrew Moles are somewhat intermediate as regards the form of their hands, having them slightly broadened.

THE SHREW MOLES (SUBFAMILY UROPSILINÆ)

The Shrew Moles include a number of Asiatic genera, ranging from *Uropsilus*, which still has traces of external ears and has absolutely unmodified hands, to *Scaptonyx*, in which a slight broadening of the hands is present. Most are local or very scarce. *Uropsilus*, *Rhynchonax*, and *Nasillus* are found only in Yunnan and Szechwan.

The Furry-snouted Shrew Mole, *Dymecodon pilirostris*, a long-snouted Mole with long, strong, pointed claws, has the snout covered with short, dark velvety hairs like the body. The tail is comparatively long, with scattered long hairs. The total number of teeth is 38, this being more than any other Asiatic member of the group except *Scaptonyx*, which has 42 teeth. The color of the fur is dark brown with a metallic sheen. The length of the head and body measures $2\frac{1}{2}$ inches. This Mole is found in Japan.

The Chinese Eared Shrew Mole, *Uropsilus soricipes*, has the external ear better developed than has *Urotrichus*, the next genus; it extends beyond the fur of the head. The forefeet are simple like those of Shrews, the claws curved and weak; and the tail is almost as long as the head and body, which together measure from $2\frac{1}{2}$ to 3 inches. The number of teeth varies from 34 to 38. This Mole is known only from Szechwan. It has sometimes been separated in a distinct subfamily.

The two subgenera *Rhynchonax* and *Nasillus*, which are found at great altitudes, are indifferently distinguished from *Uropsilus* by having extra teeth; they have been considered distinct genera. Anderson's Shrew Mole, *R. andersoni*, is a slate-colored animal with a touch of hazel at the tips of the hairs. The length of head and body is $2\frac{1}{2}$ inches, of the tail $2\frac{1}{4}$ inches. It is found in Kachin, Burma, and Yunnan between 6000 and 12,000 feet above sea-level. In Burma it has been taken under logs and rocks in moist forest between 7500 and 10,000 feet. *Nasillus gracilis* of Szechwan and *N. investigator* of Yunnan are probably northern and southern races of a single species (*gracilis*). They are almost indistinguishable externally from *Uropsilus*.

The Japanese Eared Shrew Mole, *Urotrichus talpoides*, is one of the genera retaining a small external ear conch. The fur is gray-brown with strong greenish reflections. The tail is clothed with long coarse hairs, which form a brush extending beyond its tip. The length of the head and body is a shade more

than 3 inches, of the tail $1\frac{1}{4}$ inches, of the hind foot (with claws) a little more than $\frac{1}{2}$ inch. This Mole is found in the hilly parts of Japan, on Tsu-Shima, and on Oki Island in the Japan Sea.

The Spindle-tailed Shrew Mole, *Scaptonyx fusicaudatus*, is more like a typical Mole than the other Chinese Shrew Moles. The hands are slightly broadened and the claws are stout, compressed, and straight, much as in the Japanese Shrew Mole. The tail is thick; its length, $1\frac{1}{4}$ inches, is one-third of the length of the head and body. The color is dark slate, touched with brown at the tips of the hairs. This Mole is found in Yunnan between 8000 and 13,000 feet. A race, *affinis*, from southwest Yunnan and northeast Burma, has smaller teeth. Its external dimensions are about the same as those of *fusicaudatus*. The foot measures $\frac{3}{5}$ inch.

SUBFAMILY TALPINÆ

The True Moles are all burrowing animals, with close-set, nearly erect, velvety fur, shorter snouts than most Urotrichinæ, hands and feet broadened, and front claws enlarged for digging. The genera include the typical Moles, *Talpa* (Latin for "mole"), Temminck's Moles, *Mogera*, the White-tailed Mole, *Parascaptor*, and the Musk Mole, *Scaptochirus*.

The True Moles, *Talpa*, are represented in eastern Asia by several species: the Common Mole, *Talpa europea*, is present in the temperate zone of the Old World from England and France to Japan. In eastern Asia it extends from Siberia south to Nepal (race *macrura*). Its habits have been more studied than those of almost any other kind of Mole.

The erect, velvety fur of the European Mole is black, sometimes tipped with grayish. Underneath a narrow streak of orange occasionally extends from the throat to the chest. Rarely, pied or even white specimens have been observed. It has 44 teeth. The length of the head and body is $5\frac{1}{2}$ inches, tail $1\frac{1}{3}$ inches.

The Big-tailed Mole, *Talpa macrura*, of Nepal and Sikkim, may be a close relative of *T. europea*. In northeastern Asia the genus is represented by *T. suschkini* of the Yenisei basin, Siberia, and *T. mizura* of Japan.

A special subgroup of moles, *Euroscaptor*, has been proposed to contain those forms in which the tail is thickened near the tip or club-shaped (except in *longirostris*) and the nostrils open to the sides. It includes *micrura*, *klossi*, *malayana*, *grandis*, *longirostris*, and *parvidens*.

The Long-nosed Mole, *Euroscaptor longirostris*, is an oriental member of the genus, known from Tibet and Szechwan, China. It is rather smaller than the European Mole. The color is nearly black. The length of head and body is $4\frac{1}{4}$ inches, of the tail less than 1 inch, hind foot $\frac{3}{5}$ to $\frac{3}{4}$ inch. The muzzle is elongate and slender.

The Short-tailed Mole, *Euroscaptor micrura*, is about the size of the foregoing, although its tail is very much shorter. It is found among the southern foothills of the Himalayas in Kashmir, Sikkim, Nepal, and Assam. It is not rare about Darjiling. The length of head and body is $4\frac{3}{4}$ inches, of the tail only $\frac{1}{4}$ inch, hind foot $\frac{2}{3}$ inch. In Sikkim the hands of these Moles are dried and used for charms.

The Siamese Mole, *Euroscaptor klossi*, found in northern and western Siam and Tonkin and Hainan Island, has the club-shaped tail of *Parascaptor leucurus* but the teeth as in *Talpa*. The head and body measure $5\frac{1}{2}$ inches, the tail $\frac{2}{5}$ inch, the hind foot $\frac{3}{5}$ inch. In northern Siam one was dug out of a garden at about 4000 feet. The great similarity of the skull of *E. klossi* to that of *P. leucurus* with the exception of the tooth formula has been pointed out by Osgood.

The Malay Mole, *Euroscaptor k. malayana*, is a representative of the Siamese Mole found in the Cameron Highlands of the Malay Peninsula, in the Province of Pahang. It is darker-colored than *klossi*—iron-gray instead of the paler brownish color of *klossi*.

Miller's Mole, *Euroscaptor grandis*, from Szechwan (Mount Omei), 5000 feet, is much like *klossi* but is larger. The length of the head and body is 6 inches, tail $\frac{2}{5}$ inch, hind foot $\frac{7}{10}$ inch.

The Small-toothed Mole, *Euroscaptor parvidens*, from Annam is distinguished from *klossi* and *micrura* by its slender skull and small teeth and from *longirostris* by its much shorter tail. The length of the head and body is $5\frac{2}{3}$ inches, of the tail $\frac{1}{4}$ inch, of the hind foot $\frac{2}{3}$ inch.

Temminck's Mole, *Mogera wogura*, differs from the Common Moles by having one less tooth in each upper toothrow. The missing tooth is the canine. The color is somewhat variable—usually grayish brown above, yellowish brown beneath. The eyes are covered with skin. These Moles are inhabitants of Japan, and in Korea a race, *M. w. coreana*, is found. A slightly smaller race, *insularis*, found on Formosa, has been collected at 6500 feet above sea-level. Two different species of *Mogera* are found in China, *M. latouchei*, which has an enormous range stretching from Fukien and northern Kwangtung westward to western Kwangsi and western Kweichow; and *M. hainana* on the Island of Hainan. The measurements of *M. latouchei* are head and body $3\frac{1}{2}$ to $4\frac{1}{2}$ inches, tail $\frac{3}{5}$ to $\frac{4}{5}$ inch. *M. hainana* is larger, with shorter tail, the same dimensions being head and body $4\frac{3}{4}$ to $5\frac{1}{2}$ inches and tail $\frac{2}{5}$ to $\frac{3}{5}$ inch. A still larger species, *M. robusta*, occurs in Manchuria.

The White-tailed Mole, *Parascaptor*, has gone a step farther than *Mogera* in reducing the number of its teeth; it has discarded an upper premolar on each side. *P. leucurus*, a native of the Khasia Hills (eastern Bengal), northern Burma, Yunnan, Shan States, Laos, and Tenasserim, is smaller than the European Mole, the length of its head and body being about $4\frac{1}{4}$ inches. The tail is shorter, $\frac{3}{8}$ inch, although not so short as in *Euroscaptor micrura*, and is thickened or club-shaped at the end. The color of the front three-quarters of the body is blue-black, of the hind quarters brownish. The tail is thinly clad with

whitish hairs. The White-tailed Mole must sometimes leave its tunnels, because in northern Burma one was trapped under a log.

The Musk Mole, *Scaptochirus moschatus*, is about the size of the European Mole, the head and body measuring $5\frac{1}{2}$ inches; but its tail is shorter, $\frac{2}{5}$ inch. The hands are even broader and stronger than those of the Common Mole. The color of the fur is grayish brown with a yellowish wash. This animal has one less premolar in both upper and lower jaws than *Talpa*. The Musk Mole is found in Siberia, and in northeastern China in the provinces Hopei, Jehol, and Shantung. A closely allied race, *S. m. gilliesi*, known from Shansi, is smaller than *moschatus*.

SUBFAMILY SCALOPINÆ

This third subfamily of Moles is represented in the Orient only by the genus *Scapanulus*, the name meaning "little *Scapanus*," which latter is an American genus. It was not discovered in Asia until 1912. The family is distinguished by its enlarged incisors and reduced canine in the upper jaw.

Owen's Mole, *Scapanulus oweni*, which has only 36 teeth, is drab gray above, with silvery reflections in certain lights. The stout tail is densely clothed with rather long black hairs, the tip paler. The length of the head and body is as much as 5 inches, the tail $1\frac{1}{2}$ inches, the hind foot $\frac{3}{5}$ inch. This Mole is known from Kansu, Shensi, and Szechwan, where it is reported to live in fir forests.

THE SHREWS (FAMILY SORICIDÆ)

Some of the world's smallest mammals belong in this family. *Sorex ussuriensis* of Siberia and its relatives are even smaller than Hoy's Shrew, *Microsorex hoyi*, the smallest American mammal. On the other hand, some of the tropical species, especially those of the genus *Suncus*, become as large as a small rat.

Many people who live in the country have at some time or other seen our Long-tailed and Short-tailed Shrews, tiny, tireless bundles of energy and ferocity. Some Shrews have been found to devour their own weight in worms and insects daily. Their consumption of energy is so great that deprivation of sufficient food, even for quite a short space of time, may cause them to die. It has not been proved, however, that such rapid deaths are due to starvation. They may be induced by the shock of capture.

Shrews are distinguished by the fact that their enlarged front upper incisor teeth have two sharp cusps, placed one behind the other. The front cusp is curved forward and downward, the hind one downward. Against these operate the strong, dagger-like front lower incisors. The whole constitutes a stabbing, nipping apparatus deadly to the living prey constantly being attacked by Shrews. Behind the first incisors are several much smaller, pointed teeth (the unicuspid teeth) whose number varies in different genera, and behind these again a series of broader, sharp-cusped grinders or crushing teeth. In most Shrews the head is moderately narrowed and the snout very long and slender. The ears may be well developed externally or in some burrowing and swimming types may be as nearly obsolete as in many of the Moles.

The Shrews are believed to be descendants from the same ancestral stock as the Moles. Unlike typical Moles, their feet are not especially adapted for digging; and they are distinguished from even the non-digging Moles by having open, incomplete cheek arches. Two subfamilies of Shrews are recognized: the White-toothed Shrews, Crocidurinae, and the Red- (or blackish red) toothed Shrews, Soricinae.

THE RED-TOOTHED SHREWS (SUBFAMILY SORICINÆ)

These Shrews, which occur in both hemispheres, are largely characteristic of the temperate zone. They are absent from

Africa. One North American genus, *Cryptotis*, has reached the northwest corner of South America. In eastern Asia five genera are present: the Long-tailed Shrews, *Sorex*, the Southern Long-tailed Shrews, *Soriculus*, Kastaschenko's Shrews, *Chodsigoa*, the Oriental Short-tailed Shrews, *Blarinella*, and the Old World Water Shrews, *Neomys*.

Red-toothed or Brown-toothed Shrews are so called because the tips of their teeth are coated with brownish red, sometimes blackish red pigment. In general, the tails are rather smooth-haired or at least lack the scattered, very long guard hairs to be seen in *Suncus* and *Crocidura* of the Crocidurinae.

The True or Long-tailed Shrews, genus *Sorex*, form the largest genus of the red-toothed division of the Soricidae. They need to be distinguished carefully from the Southern Long-tailed Shrews and Kastschenko's Shrews, which closely resemble them. Certain of the tiniest of the True Shrews as well as certain species of *Suncus* are called Pygmy Shrews.

The body in *Sorex* is rather slender. The delicate front and hind feet are armed with sharp claws on the five well-developed digits. The snout is long, slender, and tapering. The tail may be as long as head and body or considerably less. There are 32 teeth (less in some of the other genera given above).

The Common Shrew of Europe, *Sorex araneus*, is by far the best-known species. The color of the fur may be slightly different in different molts. Winter pelage may not only differ in color but may be fully twice as long as summer pelage. The food of Shrews, while chiefly made up of insects, spiders, and other invertebrates, undoubtedly includes meat at times, because Shrews readily kill and eat mice larger than themselves if they can corner them. The habits given for the Common Shrews are doubtless shared in large measure by the many other species, of which we know much less.

Mating, in this species, takes place from March onward, and gestation is said to last about 4 weeks. The nests, placed in cavi-

ties in the ground or in banks, are made of fine grass and any soft material available. Litters of from 4 to 10 young are said to be produced. The young are born hairless, blind, and entirely helpless. Six weeks later they can forage for themselves. Shrews do not hibernate; winter nests for shelter in the north may often be found under the snow. *Sorex araneus* is said to molt three times a year—from April to May, from the end of July to August, and from the end of September to October.

In Russia the skins of Shrews were once placed in chests containing clothing in order to keep moths away. The musky odor was thought to act as a repellent; and perhaps it did! In by-gone days Shrews bore bad reputations. Their bites were feared by country folk more than those of spiders; in England they were more dreaded than adders or vipers. One sixteenth-century naturalist wrote of the shrew: "It is a ravenous beast, feigning itself gentle and tame, but being touched, it biteth deep, and poisoneth deadly. It beareth a cruel mind, desiring to hurt anything, neither is there any creature that it loveth, or it loveth him, because it is feared by all . . ." Strange to relate, this fear of the bites of Shrews is also prevalent in Bengal and southern India. In that case it relates to the genera *Suncus* and *Croci-dura*.

Until a year or so ago it was agreed that Shrews were harmless. Recently evidence has been produced to show that the bite of the American Short-tailed Shrew may really be poisonous to small animals. Preparations from the submaxillary gland injected into mice and rabbits were found to be lethal.

The many sorts of Shrews of the genus *Sorex* found in America are divided into two chief sections. Those two sections depend upon whether the third unicuspid tooth is larger or smaller than the fourth. Only about one-third of American species belong to the first of these sections. The species of the Old World, apparently without exception, belong also to this first section. There seems to exist no representative of the sec-

ond section—specialized in at least this one character—occurring west of the Bering Strait.

Of the relatively large number of species present in eastern Asia, by far the greatest number is restricted to the temperate regions north of the 40th parallel (latitude of Korea, of northern Japan, and Philadelphia). A partial break in the number of species occurs between there and the mountains adjoining the Tibetan Plateau (Yunnan, Szechwan, etc.), where again several kinds of *Sorex* dwell.

Apparently the largest known species, *Sorex mirabilis*, and the smallest, *S. ussuriensis*, are found in the same province of Siberia, Ussuri. The first of these has the length of the head and body $3\frac{1}{2}$ inches, the tail $2\frac{3}{5}$ inches, hind foot $\frac{3}{5}$ inch; the same three measurements in the Least Shrew, *S. ussuriensis*, are but $1\frac{2}{5}$ inches, 1 inch, and about $\frac{1}{4}$ inch. *S. ussuriensis* and its relatives *S. tsherskii* of Siberia and *hawkeri* of Japan are all considerably smaller than the smallest American species, *Microsorex hoyi*. They are among the smallest mammals in the world.

The very large number of varieties of *Sorex* makes their intelligible presentation a difficult matter. Certain major divisions of Shrews living in northeastern Asia may be indicated first:

1. Representative races of the Common Shrew of Europe, *Sorex araneus*, with head and body from 2 to $2\frac{3}{4}$ inches, tail $1\frac{1}{2}$ to 2 inches.
2. Least Shrews, *Sorex ussuriensis* and allies: head and body $1\frac{1}{2}$ to 2 inches, tail $\frac{7}{8}$ to $1\frac{1}{4}$ inches.
3. Pygmy Shrews, *Sorex minutus* and relatives: head and body $1\frac{3}{5}$ to 2 inches, tail 1 to $1\frac{2}{3}$ inches.
4. Greater Pygmy Shrews, *Sorex macropygmæus*: head and body $1\frac{3}{4}$ to $2\frac{1}{2}$ inches, tail $1\frac{1}{4}$ to $1\frac{3}{4}$ inches.
5. Japanese Shrew, *Sorex daphænodon* and related forms: head and body 2 to $2\frac{3}{4}$ inches, tail 1 to $1\frac{1}{2}$ inches.

6. Virile Shrew, *Sorex vir*, an ally of *S. araneus*: head and body $2\frac{2}{5}$ to $2\frac{4}{5}$ inches, tail $1\frac{1}{3}$ to $1\frac{1}{2}$ inches.
7. Long-clawed Shrew, *Sorex unguiculatus*—size as *S. vir*.
8. Miracle Shrew, *S. mirabilis*: head and body $3\frac{1}{2}$ inches, tail $2\frac{3}{4}$ inches.

All of the foregoing occur north or east of China. South of Mongolia, in the Chinese provinces of Shensi and Kansu, there exists the rather large species *Sorex sinalis*. Southwest of the range of *sinalis*, the highlands species *cylindricauda*, *excelsus*, *buxtoni*, and a Tibetan race of the Pygmy Shrew (see above) occur. *S. sinalis* is much the same size as *S. araneus*; *S. cylindricauda*, *excelsus*, and *buxtoni* are a little smaller. Most of these last-mentioned Shrews are found in areas adjoining the Tibetan tableland.

With the exception of the typical species, *Sorex araneus*, the several kinds of Shrews listed above from the northern part of eastern Asia have been arranged in order of size. This arrangement probably does not indicate their actual relationships, which are often obscure; but it may aid identification. It should be kept in mind that still other species, separated from the examples given by characters that cannot so easily be defined, exist in Siberia, Korea, and Japan.

Long-tailed Shrews are usually colored some tone of gray—yellowish gray, reddish gray, dark gray, rarely dull brown. The underparts may be either white or pale or dark brownish, depending upon species. The color differences occasioned by changing to winter fur can further complicate things in the case of northern species. In certain Shrews a tricolored pattern appears—a dark dorsal color, somewhat paler sides, and whitish underparts.

The Big-clawed Shrew, *S. unguiculatus*, of Sakhalin and Amur, which is a relative of *S. araneus*, has the dorsal color

dark gray-brown with a slight wash of straw color on the sides and underside grayish buff. Another ally of *S. araneus*, the Flat-headed Shrew, *S. platycranius* from Ussuri, has the winter pelage colored dorsally chestnut-brown, the sides ochraceous, and the underparts white. A third member of the same group, the Virile Shrew, *S. vir*, is much like *S. platycranius*—the back reddish brown, the upper part of the sides straw-brown, the undersurface buffy.

The Least Shrew, *S. tsherskii*, of southern Ussuri, in summer has the dorsal fur light gray-brown with a wash of straw color, the underparts grayish silvery. A relative, *S. ussuriensis* from the same general region, is dark gray, slightly paler beneath. Its feet and hands are blackish. Yet another ally, *S. hawkeri* of Japan, is darker still than *ussuriensis*.

The Pygmy Shrew, represented on Sakhalin by *S. minutus gracillimus*, is dark olive-brown above, grayish white beneath. The sides of the tail in that race are clad with thick erect hair, forming a tassel at the tip. The color of the tail is brownish gray above, whitish gray beneath. This race is found in marshy plains. Pygmy Shrews occur from Europe to Siberia, either in open marshy places or in low, larch-covered hill country near water. Wasmuth indicates that from 4 to 14 (?) young are born in July; or there may be two litters each year. The nest, made of twined grasses, may be found in calamus swamps. The food includes snails and earthworms.

The Greater Pygmy Shrew, *S. macropygmæus*, native of Kamchatka, is reported to occur in two color phases: (1) light reddish gray with underparts gray-white, washed with cinnamon; (2) dark brownish gray with underparts silver-white, with a wash of straw. Its representative along the coasts west of the Sea of Okhotsk, *S. m. koreni*, is found in three color phases: (1) above light straw with a reddish wash, underside silvery white; (2) reddish above; (3) dark brown, with the sides reddish buff and the underparts yellowish white. The tail is red-

brown above, yellowish white beneath. These reports are based upon work by the Russian mammalogist Ognev.

The Miracle Shrew, *Sorex mirabilis*, a comparatively new discovery in Ussuri, known by a single specimen, is colored brown above, paler brown beneath, and has the tail uniformly dull grayish brown.

The Chinese Shrew, *S. sinalis*, the largest of the several Shrews of China belonging to the genus *Sorex*, is uniformly grayish brown above, drab brown underneath, and has brownish white hands and feet. It is barely possible that *sinalis* and *mirabilis* may be close relatives.

The Striped-back Shrews, *S. cylindricauda* (meaning round-tailed), have a tricolored pattern; the upper side cinnamon-brown, with a darker stripe along the middle of the back; the underparts dark gray, washed with cinnamon. The members of the race *S. c. gomphus* in northeastern Burma (7000 feet) have the dorsal striping less obvious. In them the length of the tail is about 2 inches.

Allen's Shrew, *S. excelsus*, a medium-sized species from western Yunnan, is grayish brown above, below buffy gray with silvery lights in the fur. The hands and feet are silvery gray.

The Southern Long-tailed Shrews, genus *Soriculus*, are best distinguished from *Sorex* by the number of their teeth, which is 30 instead of 32. This reduction in the tooth count is carried farther in the next genus, *Chodsigoa*, which has but 28 teeth. In certain of the species only the tail is longer than the head and body. The distribution of *Soriculus* is mainly among the mountains of southern Asia, whereas that of *Sorex* is chiefly northern.

The typical species, *Soriculus nigrescens*, has the tail only about one-half of the length of the head and body. It is colored sooty brown both above and beneath and occurs in the neighborhood of Darjiling at moderate altitudes, between 3500 and 7400 feet. Three other races of it are known: *S. n. centralis* from

Nepal, *S. n. caurinus* from Cumaon, 7600 feet, and *S. n. pahari* from Sikkim, between 8000 and 12,300 feet. The three races have the tail proportionately a little longer than in typical *nigrescens*. The dimensions of *S. n. nigrescens* are: head and body $3\frac{1}{2}$ inches, length of tail $1\frac{1}{3}$ inches, hind foot $\frac{3}{5}$ inch.

A smaller series of *Soriculus* in which the tail is a very little shorter than the head and body is typified by *S. sacratus* of Szechwan, 6000 feet. In this species the head and body measure $2\frac{2}{5}$ inches, the tail $2\frac{1}{5}$ inches, the hind foot $\frac{1}{2}$ to $\frac{3}{5}$ inch. Two more Shrews, closely related to *sacratus*, are *S. s. umbrinus* of Yunnan, 7000 feet, and *S. gracilicauda* of Sikkim. Their dimensions are substantially the same as those of *S. sacratus*. In *S. s. umbrinus* the tail is dark beneath as well as above. Probably *S. minor* from Manipur is related to the above Shrews.

In northeastern Burma, *S. s. umbrinus* is found in damp situations near streams between 4000 and 6000 feet. It has been taken in second growths of brambles and bracken. In Tonkin it came from 10,000 feet.

The only species of *Soriculus* known from Formosa, 8000 feet, *S. fumidus*, is probably an offshoot of the *nigrescens* group. The dimensions are: head and body $2\frac{2}{5}$ inches, tail 2 inches, hind foot $\frac{3}{5}$ inch.

Soriculus caudatus is a species in which the length of head and body and the length of the tail are equal—approximately $2\frac{1}{2}$ inches. Like most other species it is brownish black. It comes originally from Sikkim and Darjiling and has been reported from Assam and Burma.

The Southern Large-clawed Shrew, *Soriculus radulus*, from Mishmi Hills, 5000 feet, and northern Burma, is chiefly distinguished by the relatively large size of the claws of the forefeet. It seems to bear the same relation to *Soriculus* that the northern *Sorex unguiculatus* of Siberia bears to the other species of *Sorex*. The color is brownish black above, smoky brown beneath, with tail black, scarcely lighter beneath, and

the hands and feet gray. The length of head and body is $2\frac{4}{5}$ inches, tail 2 inches, hind foot $\frac{3}{5}$ inch.

Finally there is a long-tailed group of forms exemplified by *Soriculus leucops*. In this species the length of the head and body, 3 inches, is exceeded by the length of the tail, $3\frac{1}{2}$ inches. The hind foot measures $\frac{3}{5}$ inch. The color is uniform blackish brown, with the tip of the tail white. Other related (or perhaps identical) long-tailed forms are *macrurus* from Darjiling and *irene* from Szechwan, 5200 feet. These have the head and body from 2 to $2\frac{1}{2}$ inches in length, the tail $3\frac{1}{2}$ to $3\frac{3}{4}$ inches. *S. baileyi*, a related form from the Mishmi Hills, 7500 feet, also reported from Tonkin, has the length of head and body $2\frac{3}{5}$ inches, of the tail 3 inches. This type of Shrew occurs also in Burma and Yunnan.

Kastschenko's Long-tailed Shrews, genus *Chodsigoa*, have only 28 teeth, two less than *Soriculus* and four less than *Sorex*. It is scarcely to be doubted that these denizens of the mountains of southern and central Asia are derived from *Soriculus*-like ancestors and that those in their turn were descended from pre-historic forms of *Sorex*. *Chodsigoa* includes several rather distinct species and a number of other races that are not always well defined. Four chief types are recognizable. These are *C. hypsibia* = *berezowski*, a moderately large species in which the tail is distinctly shorter than the combined head and body, and measurements, which vary considerably, are length of head and body $3\frac{1}{6}$ to $3\frac{2}{5}$ inches, tail $1\frac{4}{5}$ to 2 inches, hind foot $\frac{2}{5}$ to $\frac{3}{5}$ inch; *C. smithii*, with head and body from $2\frac{4}{5}$ to $3\frac{2}{5}$ inches, but the tail a little less than or slightly longer than head and body, $2\frac{3}{5}$ to $3\frac{3}{5}$ inches, hind foot about $\frac{3}{4}$ inch; *C. salenskii*, with the tail much longer than the combined head and body: head and body, $3\frac{1}{4}$ inches, tail $4\frac{2}{3}$ inches, hind foot, $\frac{4}{5}$ inch; and a fourth group, *C. sodalis*, occupied by "the smallest of the species," from Formosa at 8000 feet. The measurements of this last are unknown because it was described from a

skull without a skin; the skull was said to be less flattened than is usual.

The first species, *C. hypsibia*, comes from northern Szechwan. It and *C. h. lowei* of western Tonkin, 10,000 feet, are the largest of the races. All races of this group have smaller feet than *smithii* or *salenskii*. Two further races, *C. h. lamula* from Kansu, 9500 feet, and *C. h. larvarum* from the lowlands of the Province of Chihli, 1000 feet, have substantially the same dimensions, the length of head and body in each about $2\frac{1}{2}$ inches. The smallest race, *C. h. parva*, from Yunnan, has the length of the head and body only a little more than 2 inches.

The species *C. smithii* consists of three races of substantially equal size, *C. smithii* from Szechwan at 9000 feet, *C. s. parca* from western Yunnan, 8000 feet (in northern Siam at 8000 feet, in Burma from 4000 to 6000 feet), and *C. s. furva* from northeastern Burma. The last is even darker than the usually dark-colored forms of this genus. The first two races are distinguished by their mouse-gray dorsal coloring and brown tails, true *smithii* having the tail equal to the length of head and body, *parca* having it longer in proportion.

Chodsigoa salenskii from northern Szechwan, with its extreme length of tail, appears to be unique. The body is sharply bicolored, dark brown above, brownish white below. The length of head and body is $3\frac{1}{4}$ inches, tail $4\frac{1}{2}$ inches, hind foot $\frac{4}{5}$ inch. Most other forms of *Chodsigoa* are colored as in *Soriculus*, dark grayish brown above, paler beneath. The ears appear prominent and nearly naked.

Chodsigoa hypsibia is normally sooty brown except around the mouth and tip of tail and extremities which are whitish. *C. h. lowei* is very similar, with higher, fuller braincase. *C. h. parva* is "deep mouse gray," scarcely paler beneath; the tail beneath whitish. *C. h. lamula* is colored very like the type form. *C. h. larvarum*, though of the same size as *lamula*, is a lowlands

race with thinner but not shorter hair, the color "mouse gray" above, "smoky gray" below.

Chodsigoa smithii parca in Burma is said not to inhabit very dense forest but to live in the foothills in more open country. *C. s. furva*, on the contrary, has been taken in forest at a "damp, oozy spot" under logs and rocks near a small mountain stream. The feet are brownish instead of whitish as in true *smithii*. *C. h. lowei*, with rounded, unflattened braincase (like *C. sodalis*) is wholly dark gray with the final $\frac{1}{8}$ inch of the tail white.

The Oriental Short-tailed Shrews, *Blarinella*, are known only from the region about the eastern end of the Himalayas—Tibet, upper Burma, Szechwan, Kansu, and western Tonkin. Three forms, *quadraticauda*, *wardi*, and *griselda*, have been recognized. Their likeness to the American Short-tailed Shrews, *Blarina*, is more apparent than real, *Blarinella* being anatomically much more closely related to *Sorex*. The body is rather stout, the tail slender and about half as long as head and body. The external ears are very short. The color is brownish gray with silver reflections; in the race *wardi*, first recorded from Sikkin, dark smoky gray. The length of head and body varies from $2\frac{1}{2}$ to 3 inches, tail $1\frac{1}{4}$ to $1\frac{1}{2}$ inches, hind foot less than $\frac{1}{2}$ inch.

Blarinella quadraticauda was discovered first in northern Szechwan. The type specimen was one of those anomalous creatures with one more tooth in one side of the head than in the other. In the normal condition these Shrews have 5 unicuspid teeth in each side of the upper jaw. Ward's Short-tailed Shrew, *B. q. wardi*, occurs also between 5000 and 10,000 feet in north-eastern Burma and Yunnan. *B. q. griselda* is still known only from a single individual from Kansu, 10,000 feet.

The Old World Water Shrews, *Neomys fodiens*, are found principally in Europe and western Asia. But *N. argenteus* occurs at Lake Baikal in Siberia, and *N. f. brachyotis* near Kopal. The measurements of *N. argenteus* are: head and body $2\frac{3}{4}$ inches,

tail $2\frac{1}{4}$ inches, hind foot $\frac{3}{4}$ inch; of *brachyotis*, head and body $2\frac{3}{4}$ to $2\frac{5}{7}$ inches, tail $2\frac{1}{2}$ to $2\frac{3}{4}$ inches, hind foot $\frac{3}{4}$ inch. It is possible to distinguish between these two Siberian forms of Water Shrews by the fact that *brachyotis* is blackish with whitish underparts, and *argenteus* brown with underparts dull white.

The Old World Water Shrews are good swimmers. They feed upon a variety of insects and upon shrimp-like animals that live in the water. They have been known to take very small fish and to cause damage in fish hatcheries. In captivity they will kill and eat frogs. From 4 to 8 naked young are born. The nest cavity is proportionately larger than that of *Sorex araneus*.

THE WHITE-TOOTHED SHREWS (SUBFAMILY CROCIDURINÆ)

The White-toothed Shrews are confined to the Old World. They are found chiefly in the warmer parts but may also ascend mountains in the tropical zones to high altitudes. Like the Soricinæ, they have given rise to water-dwelling genera such as *Chimarrogale* and *Nectogale*, which have adaptations for swimming. The terrestrial Crocidurinæ are distinguished from the True Shrews not only by their unpigmented teeth but by the sprinkling of long hairs on the tails in some genera and the presence of four instead of five cusps on the last lower molar.

The non-burrowing terrestrial White-toothed Shrews include two genera, *Suncus* and *Crocidura*, both of which groups have the tail thinly clad with scattered long hairs. For convenience they will be treated as full genera; but they can be regarded as subgenera, since they differ only by the presence or absence of the front one of the two upper premolars (the last unicuspid). This tooth is never very large and in some species is exceedingly tiny. To make an important distinction between its absence or presence seems arbitrary, if one considers that occasional ani-

mals are found with the tooth present in one side of the head and absent from the other. Should the two groups be in reality merely subgenera, *Crocidura* would take precedence as the name for all; it was established in March, 1832, and *Suncus* in September of the same year. *Suncus* contains relatively few species, *Crocidura* many. In eastern Asia five genera are found which belong to the subfamily Crocidurinae: *Suncus*, *Crocidura*, *Anourosorex*, *Chimarrogale*, and *Nectogale*.

The House Shrews, Musk Shrews, or "Musk Rats," genus *Suncus*, formerly known as *Pachyura*, which have a total number of 30 teeth, include species as large as small rats. They also include a group of "pigmy Shrews" in which the length of head and body is less than 2 inches, and some smoky gray forms in the Philippines that externally resemble some *Crocidura*, for example, *S. luzoniensis*.

One of the best known of the large Shrews is *S. coeruleus* of the Indian Peninsula and Ceylon, an unusually colored species—pale gray with a slightly bluish cast in certain lights. The length of the head and body in this species varies from 5 to 6 inches, of the tail from 3 to 4 inches, of the hind foot from $\frac{3}{4}$ to 1 inch. A race, *S. c. fulvocinereus*, occurs in Assam. Osgood reports *coeruleus* from Annam.

Representatives of the same group, colored instead dark brownish gray and a little smaller in size, are spread through southern China to Japan and into most of the islands of the Indo-Australian Archipelago. The general name for this darker form is *S. murinus*. Strictly speaking, this name refers to the specimens that come from Java, but it has been widely used for animals from Burma and China as well. In certain regions local names appear, such as *S. m. temminckii* for the race present in Japan, *S. m. swinhoei* of Fukien, *S. m. griffithii* of Assam, and *S. m. saturator* of Sikkim.

House Shrews of this type are now almost as closely associated with man as are house rats and house mice, though with

the important difference that they eat roaches and other vermin instead of stored foods. They give off a musky odor, which is highly obnoxious. They were once believed to spoil bottled wine by merely running over the bottles. Such bottles of wine were rejected as "musk-ratty." Trying to refute this fable, the naturalist Sterndale states that after he had driven one of these Shrews back and forth a number of times across a clean handkerchief he could detect no smell of musk on the cloth. He taught one of the Shrews to come when he whistled and take grasshoppers from his fingers—"it seemed very short sighted, and did not notice the insect till quite close to my hand, when, with a short swift spring, it would pounce upon its prey."

This kind of Shrew is reputed to be no other than Chuchundra, "who never comes out in the middle of the floor . . . but always creeps around by the wall," in Kipling's famous tale *Rikki-tikki-tavi*, in which story the mongoose and the cobra fight it out.

The Pygmy House Shrews, *Suncus perrottetii* and relatives, are the smallest crocidurine Shrews in Asia. They agree with the large type of *Suncus* in possession of the extra unicuspid tooth. Their English name may be a misfit, since we do not know certainly that they enter houses like their larger allies. They are mouse-colored above and below, with the feet and hands grayish white. The tail is whitish basally, darker towards the tip, its underside whitish. The length of head and body varies from $1\frac{1}{2}$ to $1\frac{9}{10}$ inches, of the tail from 1 to $1\frac{2}{5}$ inches, of the hind foot from $\frac{1}{3}$ to $\frac{2}{5}$ inch. This type of Shrew seems restricted to India and the area which includes Burma and Indo-China. The form found in Tenasserim at the base of the Malay Peninsula is named *nudipes*, and *malayanus* from peninsular Siam may be identical. A mountain-dwelling species, specimens of which have been found in numbers dead on the snow of the eastern Himalayas, is variously called *micronyx* (from Landour) and *pygmæoides* (from "Himalayas"). Although its size

is about the same as the lowlands Pygmy House Shrews, it may not be very closely related.

A third group currently placed in *Suncus*, although externally like the *Crocidura dracula* group, is reputed to exist in the mountainous parts of eastern India and Burma. Its named members are *S. soccatus* and *S. nemorivagus* from Nepal, and *S. heterodon* from the Khasia Hills. It is barely possible that when the type specimens of these Shrews are critically re-examined they may be found to lack the small unicuspid tooth which if present would keep them in *Suncus*, and if absent would place them in *Crocidura*, or they may be continental relatives of *Suncus* of the Philippines. The color, dimensions, and geographical ranges of these forms agree well with the above-mentioned group of *Crocidura*. *S. soccatus* is said to have strongly tumid upper lips, a character given by Taylor for the insular *palawanensis*, large ears, and depressed head.

The True White-toothed Shrews, genus *Crocidura*, though represented in eastern Asia by many more forms than *Suncus*, include neither such extremely large nor such extremely small species. Only two of them—*C. aoris* of the east coast of the Malay Peninsula and *C. yamashinai* of north Korea—have the length of the head and body as much as 4 inches. The smallest Asiatic members of the genus are *C. umbrina* of Japan and *C. longicauda* of Korea, with length of head and body respectively 2 and 2½ inches. The majority of the species and races have the tail but slightly shorter than the head and body. Exceptions are the above-mentioned *C. yamashinai* and *C. pullata* from Kashmir, in both of which the tail measures less than half the head and body length.

In the northern group containing *C. dzi-nezumi* and *umbrina* of Japan, *lasiura* of Ussuri, *lar* from Mongolia, *sibirica*, *coreæ*, *longicauda*, *thomasi*, and *sodyi*, the last four from Korea, the tail length is equal to or slightly more than half of the length of head and body. *C. lar* is reputed to be a northern offshoot of

the *C. ilensis* group (see below). This distinctly northern group of forms includes all of the members of *Crocidura* from north and east of China except the large, isolated Yamashina's Shrew and the Korean *thomasi*, which by reason of its larger size falls into the southern group, *dracula* (see below). The assembly represents a northeastern outpost of an otherwise tropical genus, adjusted to northern climatic conditions. The colors vary from very dark brown to slate, the undersides little if any paler. The dimensions of the north Asiatic group vary from: length of head and body $2\frac{1}{3}$ to $2\frac{3}{4}$ inches, tail $1\frac{1}{5}$ to 2 inches, hind foot approximately $\frac{1}{2}$ inch.

The remaining species of *Crocidura* with which this book deals are found mainly in southern Asia. For practical purposes they can be distributed among four groups, representing size and proportions. The first contains only the short-tailed *C. pullata* of Kashmir. The second, which includes a number of forms from a wide range of territories, has the length of head and body between 3 and $3\frac{1}{2}$ inches and only a little in excess of the length of the tail, while the length of the hind foot varies from $\frac{3}{5}$ to $\frac{3}{4}$ inch. This group is well typified by *C. dracula* of Yunnan.

The third group comprises slightly smaller Shrews exemplified by *C. rubricosa* of Assam, in which the length of the head and body is less than 3 inches and more than $2\frac{1}{2}$ inches; the length of the tail varies from 2 to $2\frac{1}{4}$ inches, and of the hind foot is about $\frac{1}{2}$ inch. This group also has a wide geographical representation.

The fourth group consists of *C. ilensis* and its subspecies. It is characterized by its short tail, $1\frac{1}{4}$ to $1\frac{1}{2}$ inches, and small foot, $\frac{2}{5}$ to $\frac{1}{2}$ inch. Typically (in central Asia) this is a very small species; but the race *C. i. shantungensis* includes larger individuals in which the length of head and body may reach $3\frac{3}{4}$ inches. The *ilensis* Shrews are colored dark brown above, without as much gray as in other groups; their underparts are

ashy with dark hair bases; the tail is brown above, ashy beneath. This Shrew alone in the genus takes up an intermediate geographical position between the northeastern and southern centers of *Crocidura*; its eastern race, *shantungensis*, extends over an enormous territory from south of the Yangtse (lat. N. 30°) north to southern Jehol (about lat. N. 42°), and from the Yellow Sea west into Shensi and Shansi. The little species *myoides* from Ladak may be related to *ilensis*. *C. lar* of Mongolia is perhaps related to *ilensis*.

The *Crocidura dracula* group comprises brownish gray Shrews with a generally smoky hue and slightly paler underparts. The size is as shown a page earlier. The forms tentatively placed here are *dracula* of Yunnan, *kingiana* of Sikkim, *attenuata* of Szechwan and eastward, *prædax* of the Likiang Range; also, doubtfully, *fuliginosa* of southern Burma, *negligens* of the northern Malay Peninsula, *aagardi* of Siam, *grisescens* of Fukien, and *thomasi* of Korea. *Crocidura attenuata*, the common Gray Shrew of China, ranges, according to Sowerby, over much of south China.

Crocidura dracula of northeastern Burma, sometimes called the White-tipped Shrew, is generally taken below 6000 feet. A dark race, *C. dracula mansumensis*, occurs at Mansum, Burma. The species is present also in western Tonkin.

It is to this group that reference has been made when discussing the dubiously classified third group of *Suncus*, the genus treated immediately prior to *Crocidura*. Possibly some of the forms there mentioned ought to be included here.

The *Crocidura rubricosa* group, containing the smaller species and separated here purely for convenience, comprises Shrews colored substantially like those of the *C. dracula* group, though *rubricosa* itself may be a little redder. These are *rubricosa* of Assam and in the Chindwin drainage, *vorax* of Yunnan and northern Siam, *rapax* of Yunnan, *indochinensis* of southern Annam, *grisea* of Fukien, and *tanakæ* of Formosa. Shrews

from Burma taken between 4000 and 7000 feet, 1200 miles away from the typical region of the Indo-Chinese *indochinensis*, have been identified as belonging to this species. It is also present in western Siam.

It must be understood that the foregoing arrangement of *Crocidura* is purely a classification of convenience. Many of the forms will eventually be proved either identical to each other or representative races. In addition, no account here has been taken of the many races and species reported from the islands of the East Indies. When final order is brought into this difficult genus all of those varied Shrews will need to be considered.

The Asiatic Short-tailed Shrews, *Anourosorex*, just fail to live up to their technical name, which means "tailless Shrew"; the tail is present, even though only one-tenth to one-eighth of the length of the head and body, and practically naked. There is virtually no external ear. The eyes are so greatly reduced as not to be evident in skins. The number of teeth is reduced to 28. The snout is short for a Shrew. The fur of the body, extremely glossy and mole-like, is colored light slate with silvery reflections. The hands and feet are white.

There are three varieties, all living in high country: *A. squamipes* occurs in Yunnan, Szechwan, and Shensi; a weak race, *A. s. assamensis*, inhabits Burma and Assam; the third form, *A. s. yamashinai*, is found on Formosa at 5500 feet above sea-level. The length of head and body in *A. s. assamensis* is just under 3 inches (in *squamipes*, 4 inches) of the tail $\frac{1}{2}$ inch, of the hind foot about $\frac{3}{5}$ inch. The tail is reported to be shorter in *A. squamipes*.

In Burma, *A. squamipes* is found from 4200 to 7700 feet above sea-level, in China up to 10,000 feet; in northern Siam it was not taken below 8000 feet, while in western Tonkin it was caught at about 10,000 feet.

These Shrews are distinguished by the presence on the rump

of markedly elongated paler hairs which are usually matted together by an oily liquid, perhaps of glandular origin.

The Himalayan Water Shrew, *Chimarrogale*, is one of the aquatic representatives of the White-toothed Shrews just as *Neomys* is of the "Red-toothed" or True Shrews. Like *Crocidura*, it has 28 teeth. The typical race, *C. himalaica*, of Nepal and Burma, is represented by a distinct race, *leander*, in northern Chekiang and Fukien. Three other forms are known, *C. styani* from 11,000 feet in Szechwan and Burma, *C. varennæ* from Annam, and *C. platycephala* from Japan. The ear, though very small, is present. The color of *C. himalaica* is slate-gray, with the tips of the hairs brown, the lower parts gray. The tail is gray-brown above, white beneath. In *C. styani* the line of demarcation between the upper- and underparts is more strongly emphasized than in *himalaica* and *leander*. The three are probably only subspecies of *himalaica*, though in *varennæ* the tail is wholly black. The length of head and body amounts to $4\frac{1}{3}$ inches, of the tail 3 inches, of the hind foot $\frac{3}{4}$ inch.

The Japanese Water Shrew, *C. platycephala* "of the size of *Sorex indicus*" appears to be slightly larger than any of the Himalayas and to have the skull flatter than *C. himalaica*.

Chimarrogale lives in the neighborhood of mountain streams, in which it swims freely. Its food is said to consist of small fish and crustaceans. It can be trapped at the sides of small waterfalls in mountain streams, where it is compelled to leave the water in order to go from the lower level to the higher.

This interesting genus is a very close relative of the Bornean Water Shrew, *Crossogale*. In fact, the latter is better considered as a subgenus of *Chimarrogale*. Together with the Japanese species, it represents an outstanding example of the discontinuous distribution of a specialized genus.

The Web-footed or Tibetan Water Shrew, *Nectogale*, which also has 28 teeth, contains a single species, *N. elegans* from Szechwan, Shensi, Yunnan, Sikkim, and northeastern

Burma at 6000 feet. This is a large Shrew of about the same size as the Musk Shrew, *Suncus murinus*. It has beautiful soft slaty dorsal fur interspersed with long white guard hairs, each separate one of which shows clearly against the dark basal fur. The fur of the underparts is silvery gray with gray bases, except about the mouth where it is cream-colored. In Sikkim, 10,000 feet, the fur may be washed with buffy color beneath. The ears

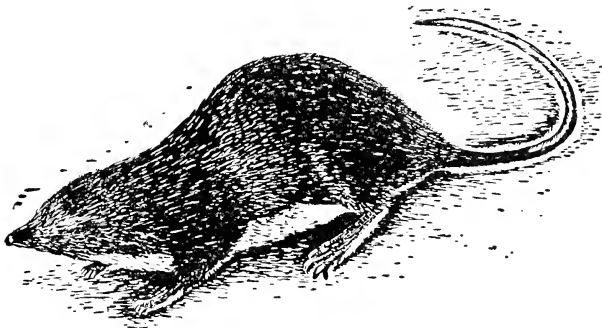


FIG. 8. Web-footed Water Shrew, *Nectogale elegans*.
Note the keel-like fringes on the tail (see text).

are so much reduced that the outer ear conch can scarcely be detected. The broad, webbed feet are provided with a fringe of stiff short white hairs that may help in swimming. The tail, a little shorter than the head and body, is rather thick. It is provided with fringes of short white hairs arranged in a peculiar manner: From the root of the tail two lateral fringes come together in a single fringe that extends along the undersurfaces of the tail to the tip. Two other lateral fringes, beginning at the first third of the tail length, die out in the terminal third. A dorsal fringe originates about the beginning of the terminal third and extends to the tip. Apparently the tail, equipped with these keel-like rows of hairs, is highly functional in swimming.

The head and body measure $4\frac{1}{2}$ inches, the tail 4 inches, and the hind foot about $1\frac{1}{8}$ inches.

Natives in northern Burma capture these animals by partially damming the brooks and setting wicker traps in the water-races formed in the beds of the lowered streams.

THE BATS (ORDER CHIROPTERA)

Bats are so commonly regarded with repugnance and loathing, and ladies are so persistently fearful that Bats may entangle themselves in their hair, that it is difficult to convince many folk that both the loathing and the fear, arising from the public's nearly total ignorance of Bats and their ways, are virtually groundless. Actually, the very numerous kinds of Bats of the world form one of the most interesting groups of mammals. Our slight acquaintance with them here in the United States is due at least partly to the comparatively few kinds found here, to their nocturnal habits, and the difficulty of catching them. Our almost ludicrous ignorance of the world of Bats was illustrated in a recent question-and-answer broadcast over the radio: The people quizzed had to decide which of the three following statements was wrong—A pelican is a bird; a bat is a bird; an ostrich is a bird. Only after prolonged cogitation did the questionees decide that a Bat was not a bird.

Other people vaguely regard a Bat as a mouse with wings. They scarcely question how a mouse could possibly have acquired wings and remained a mouse. Even after granting that Bats are neither birds nor winged mice, some folk find it hard to realize that they are as much mammals, though very distinct and special kinds of mammals, as we ourselves are, and that they are built on the basic mammalian plan and behave in true mammalian ways.

Bats alone among mammals have acquired the power of flight. Like birds they have become strongly modified in various ways that make flying and a whole array of attendant habits easier to perform. Certain parts of the body skeleton have ac-

quired unusual rigidity; others, like the finger joints, unusual elasticity. A Bat's wing has been produced by greatly lengthening the bones of the hand and fingers to act as a framework on which is stretched the elastic skin of the hand. The skin of this hand-wing is continued along the sides of the body to the hind limbs, and usually to the tail. In this amazing transformation the thumb is the only digit to remain relatively unaltered; it is provided with a hook-like claw which enables the animal to cling to supports or drag itself along flat surfaces.

Many changes in the body have accompanied this transformation of hands into wings. Among them are great development of the powerful chest muscles that provide the motive power for the wings, the alteration of the hind legs and feet into mechanisms to hang by, the evolution of an assortment of special organs related to the senses of hearing, smell, and touch.

The hind legs have rotated at the hips to such an extent that the knees bend backward. This helps to control the movement of those parts of the wing membranes which stretch from the "little fingers" to the ankles, and it also plays a part in the Bats' usual resting posture, hanging upside down by means of the five long hooked claws of the hind feet.

The ears of many sorts of Bats are greatly lengthened or broadened, or both. In some they are joined together by a fleshy band above the crown of the head. Those of some of the Big-eared Bats are strengthened by rib-like folds and cartilages and can be partly folded.

Bats have made all sorts of changes in their tails. Some have lost their tails; others have them still, though greatly shortened; one family has the tail long, thin, and mouse-like. In most kinds it is combined in various ways with the flying membranes.

The ability to fly carries with it certain penalties. The profound alteration of almost every part of the body needed to convert a running animal into a flying animal allows only awkward movements on the ground. The hind legs, as already stated, are

permanently rotated so that the knee points outward and backward. Since the foot, too, points backward, the long, hook-like claws must to some extent hinder attempts to crawl. However, Bats on the ground do scramble along with some degree of agility, although they lack the speed and assurance of movement of most ground-living mammals.

“Blind as a bat” is an expression representing yet another human misconception. Bats see well, some of them very well. The giant Fruit Bats of the tropics of the Old World have large eyes that glow at night in the beam of a flashlight like those of dogs and horses. In many of the little Bats found here in the north, the eyes are proportionately small and partly concealed by hair. Such Bats, hiding in a cave, may be dazzled when a light is thrown upon them, though scarcely more than we ourselves would be.

The senses of touch and hearing in the Bats have become extremely acute. In many kinds there are special leaf-like folds of skin about the muzzle, which are believed to play a part in helping their sense of touch. The inner parts of the ears, where the actual hearing takes place, are tuned up for the perception of the shrill chirps of other Bats, which are sometimes above the range of human hearing. In this connection it is now known that some Bats can hear “supersonic sounds”—vibrations far more rapid than anything we can appreciate, sounds which can be produced in our laboratories mechanically. The ability of some Bats to avoid obstacles in the dark may be connected with the detection of echoes from those obstacles.

The geological age of Bats, counted in years, is scarcely imaginable even by a public accustomed to modern financial statistics. When the little five-toed horse and the tapir-like elephant still roamed this earth, Bats were already Bats. One of the oldest American fossil Bats, from the rocks of the Middle Eocene, is much like a modern insect-eating Bat.

Even in the reproduction of their kind, Bats have done un-

usual things. The bony pelvis of some Fruit Bats is not closed in front but is elastic and bounded by ligaments. This permits large embryos to be developed and new-born baby Bats to be precociously large compared with those of most other sorts of animals. Furthermore, except in a very few, possibly primitive species, only one baby Bat is born and raised at a time. Such oversized single young, though almost constantly carried about by the mother, need her care for a comparatively short while. They soon learn to fly.

An astonishingly large number of different genera and species of Bats are known. Those of the Orient can be sorted into no less than six families, of very unequal size; some families contain but a handful of genera, others very many. The families are grouped into two suborders, the Megachiroptera or Fruit Bats and the Microchiroptera or Insect-eating Bats. These two divisions, in their turn, combine to form the Order Chiroptera, or merely "The Bats." The subordinal names are not very appropriate. The Fruit Bats, it is true, contain only species that eat vegetable matter but the Insect-eating Bats include both fruit- and insect-eating Bats and even those with carnivorous and sanguivorous predilections. If we think only of "Mega-" and "Micro-," big and little Bats, we also run into difficulties, for some of the "big" Bats are smaller than some of the "little" Bats. If you examine a Bat's grinding or cheek teeth, you can always tell to which group it belongs. The Order Chiroptera, which contains all Bats, is better named; the word means "hand-winged."

When studying Bats, some important things to note are the characters of the ears, the shapes of the nasal appendages if present, the shape of the wings and the proportions of the fingers to each other, the character of the tail and hind limbs, and whether the wing membranes extend to include the tail.

One of the most helpful pieces of information, when distinguishing very closely related species from each other, is the

length of the forearm. It will be seen that this measurement has been given very frequently in the pages that follow, when the different kinds of Bats are discussed.

THE FRUIT BATS AND FLYING FOXES
(SUBORDER MEGACHIROPTERA)

All of the really big Flying Foxes with wing-span of 3 feet or more belong here, and also quite a number of little Bats. With the exception of one genus found in Fiji and the New Hebrides, all these Bats have the tail either absent or shortened to a brief appendage shorter than the hind foot. Only a rudimentary flying membrane is developed between the hind limbs. An infallible test for the Asiatic Megachiroptera rests upon the character of the cheek teeth. If the cheek teeth are irregular rounded stumpy objects, they belong to a Fruit Bat; if they are complicated, provided with several pointed cusps and sharp ridges, which often have a W-shaped pattern, they are the teeth of an Insect-eating Bat. The Suborder Megachiroptera, unknown in the New World and confined to the tropics of the Old World, contains but one family, the Pteropodidæ.

FAMILY PTEROPODIDÆ

The Pteropodidæ of eastern Asia are separated into two sub-families, the Pteropodinæ or True Flying Foxes and Fruit Bats, and the Macroglossinæ or Long-tongued Fruit Bats.

SUBFAMILY PTEROPODINÆ

The Bats of eastern Asia that belong to this subfamily are the Rousettes, the True Flying Foxes, and the Short-faced Fruit Bats, *Cynopterus*, the last with several closely related monotypic genera—*Megarops*, *Chironax*, *Balionycteris*, *Sphærias*,

and *Penthetor*. The tail is either very short or absent in the Pteropodinæ; the claw on the index finger is never lost. In none of the genera is the tongue greatly extrusile or the front of the lower mandible specially modified. Besides the genera mentioned above, others are found in the islands of the Indo-Australian Archipelago and in Africa.

The Rousettes or Russet Flying Foxes, genus *Rousettus*, which include several species, are dull-colored Bats with quite short fur, rather long narrow ears, a short tail, and a distinct though blunt claw on the index finger. This claw distinguishes them from *Eonycteris*, one of the Long-tongued Fruit Bats, with which they may be confused. The wing-span varies from 12 to 18 inches, the forearm from $2\frac{3}{4}$ to 4 inches. Rousettes are found from Africa to eastern Asia and New Guinea. We are concerned with but two species.

Geoffroy's Rousette, *Rousettus amplexicaudatus*, one of the smaller species with forearm from 3 to $3\frac{1}{2}$ inches in length, is colored dark sooty brown on the back and the crown of the head. The area of the neck is pale gray. The underparts are gray-brown, with the throat and neck grayish white. The species occurs throughout the Malay Peninsula, Tenasserim, and Siam.

Leschenaults' Rousette, *Rousettus leschenaulti*, is a somewhat larger species, with the length of the forearm $3\frac{1}{4}$ to $3\frac{1}{2}$ inches. It is slightly paler in color than *R. amplexicaudatus*, though still dark brown, and has similarly a pale collar of very short hairs. The underparts are brown, less mixed with gray. This Bat occurs through India, Burma, Siam, and Tonkin to Fukien in south China. Although there is a related race in Java, it appears to be absent from the Malay Peninsula.

The True Flying Foxes, genus *Pteropus*, include the majority of the species contained in the family Pteropodinæ. When people speak of Flying Foxes of gigantic size, they invariably mean some member of this genus. These Fruit Bats can usually be recognized at once by the contrasted coloring of the mantle

(the area across the shoulders); the mantle is usually yellowish or tawny, the rest of the body dark gray-brown or black. These are large Bats, some of them very large. The wing-spread may reach nearly 5 feet; the length of the forearm of such a large species may be almost 9 inches. Some of the small ones, on the

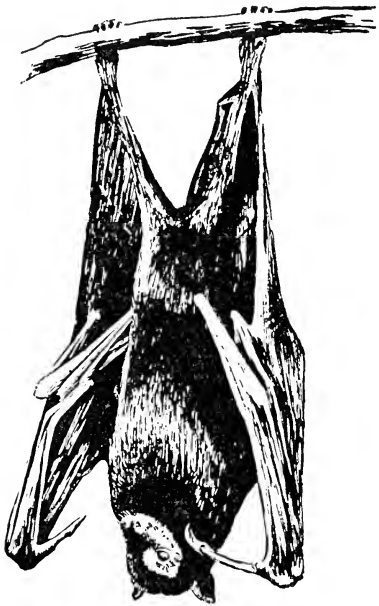


FIG. 9. Flying Fox,
Pteropus.

contrary, have forearms less than 4 inches in length and wing-spans of only about 2 feet. There is a well-developed, if blunt, claw on the index finger of the wing. The tail is absent.

The species of *Pteropus* lead a communal existence, spending the day hanging upside down from the upper branches of some great tree in the forest or near a river bank, and at dusk winging their way, in groups numbering scores, in search of the ripening fruit or the flowers upon which they feed. In the Orient and Australia they may do considerable damage to cultivated

fruit. The flesh of *Pteropus* is relished by many natives, at least in New Guinea.

Pteropus is a tropical genus found also in Madagascar, certain islands in the Indian Ocean, tropical Asia, the Indo-Australian Archipelago, New Guinea, and eastern Australia, and outwards among the islands of the Pacific Ocean as far as Fiji and Samoa. It is not found in Africa or China, nor has it reached the Hawaiian group in the Pacific. Relatively few

species live on the Asiatic mainland; the greatest number of species occur through the Indo-Australian region.

Lyle's Flying Fox, *Pteropus lylei*, and the forms following are members of a section of *Pteropus* called the *P. vampyrus* group. These are medium-sized to very large Flying Foxes, with the forearms measuring from 6 to nearly 9 inches. The general color of the back is very dark brown, the mantle (the area of the shoulders and base of the neck) buffy. The group includes five species.

Pteropus lylei of Siam and Cochin-China, one of the smaller species, has the forearm 6 inches in length. The back is colored seal-brown, the underparts blackish seal-brown, the mantle reddish buff, the top of the head nearly as the mantle.

The Intermediate Flying Fox, *Pteropus intermedius*, though closely related to Lyle's Flying Fox, is distinctly larger. The length of the forearm is a little more than 7 inches. The body color is seal-brown as in *P. lylei* but the mantle is yellowish buff and the crown russet. This Bat occurs in Tenasserim and peninsular Siam, generally southwest of the range of *P. lylei*.

The Assam Flying Fox, *Pteropus giganteus leucocephalus*, a race of the Indian Flying Fox, is found in Assam and among the foothills of the Himalayas. It is somewhat long-furred, and the forearm measures from 6½ to 7 inches. The color is blackish brown, scantily sprinkled with grayish white hairs, the underparts paler than the back, the mantle varying from golden buff to tawny.

The Sunda Islands Flying Fox, *Pteropus vampyrus*, divides into a number of geographical races, one of which, *P. v. malaccensis*, is found from the central and lower part of the Malay Peninsula to Cochin-China and Annam. This large-sized race, with forearm from 7½ to 8½ inches long, has the back grayish brown or russet-brown, with the rump sometimes touched with chestnut; the mantle varies from reddish orange to

orange-buff. The crown of the head is dark chestnut, darker than the mantle.

The Condoro Island Flying Fox, *Pteropus hypomelanus condorensis*, has much the same range as *P. lylei*—Siam and Cochin-China—but belongs to a distinct group. The length of the forearm is about $5\frac{1}{2}$ inches; the color of the back is gray-brown, the underparts hazel, darkening on the sides to seal-brown, the mantle and the crown of the head varied shades of chestnut. A near ally, *P. h. geminorum*, taken from islands west of Siam, differs chiefly by having the crown black-brown.

The Formosa Flying Fox, *Pteropus dasymallus formosus*, also a member of the *P. hypomelanus* group, is colored like others described above, dark brown; but the mantle is creamy white and the crown of the head grizzled dark brown. The forearm measures $5\frac{1}{4}$ to $5\frac{1}{2}$ inches. The Flying Foxes that occur on the Luchu Islands and the Philippines are near relatives of this species.

The Short-nosed or Dog-faced Fruit Bats, *Cynopterus*, have the nostrils prominent and almost tubular. The rather broad, short ears are generally edged with a fine white line. This white color is not produced by hairs; the skin at the edges of the ears is white. The wing membrane in immediate contact with the terminal and next to terminal joints of the third, fourth, and fifth fingers may be whitish. There is a sharp claw on the index finger. The fur is rather long and dense, and colored some shade of olive-brown. The wing-span varies from 12 to 16 inches. The Short-nosed Fruit Bats occur through India and Ceylon to Siam, Malaysia, and the Sunda Islands, also on the Island of Hainan in south China. Three species belong in our area: *C. sphinx*, *C. brachyotis*, and *C. horsfieldi*.

The typical species, *Cynopterus sphinx*, extends from India through Burma and Siam to Annam and Cochin-China. It appears to miss China and reappears on Hainan. This species is colored smoky brown, with the roots of the hairs greenish

gray, the underparts paler. The forearm measures $2\frac{2}{3}$ to nearly 3 inches. *C. brachyotis*, a short-eared relative, is smaller, the forearm 2 to $2\frac{3}{4}$ inches. It is found from Assam to Canton, China, and south to Java and Celebes. The dorsal color is paler than that of *sphinx*, being light dull brown above, slightly darker on the head; the underside of the neck and the sides are yellowish brown. *Cynopterus horsfieldi* is much like *C. brachyotis* externally. The forearm varies from $2\frac{1}{2}$ to $2\frac{3}{4}$ inches. This last is typically found in Java but a race, *C. h. lyoni*, occurs in the southern part of the Malay Peninsula.

The Tailless Short-nosed Fruit Bat, *Megærops ecaudatus*, is a purely tropical Fruit Bat still so rare that its habits are unknown. It resembles *Cynopterus* so closely that it was at first believed to be a member of that genus. The distinctions, other than absence of the tail, have to do with the teeth. The animal is recorded from Tonkin, Annam, and Cochin-China to the Malay Peninsula. Another Fruit Bat, *wetmorei* from the Philippines, in which a short external tail is present, has been placed in *Megærops*.

The Spotted-winged Fruit Bat, *Balionycteris maculatus seimundi* of the Malay States, is a race of the species found in Borneo. The dorsal color is sooty brown, the head blackish, the underparts drab. The dark brown wings are marked with small yellowish spots. The length of the forearm is about $1\frac{3}{5}$ inches.

The Black-capped Fruit Bat, *Chironax melanocephalus*, is another monotypic genus related to *Cynopterus*. The colors are gray-brown above, dirty white beneath. The length of the forearm is only $1\frac{2}{3}$ inches. Found originally in western Java, this Bat has been reported from Sumatra and the Malay States (Selangor).

Blanford's Fruit Bat, *Sphærias blanfordi* from the Karin Hills, Burma and Mt. Angka, northern Siam, is still another of the specialized Short-nosed Bats. The color of the rather long fur is dull grayish brown above, beneath duller than the back.

The ears are edged with white in front. The length of the forearm is 2 inches.

Lucas's Short-nosed Fruit Bat, *Penthetor lucasi*, is another offshoot of the *Cynopterus* group. The tail is slender and only $\frac{1}{4}$ inch long. The color is smoky brown, the areas about the neck and rump being almost bald. The forearm measures from $2\frac{1}{3}$ to $2\frac{2}{3}$ inches in length. This Bat is found in the Malay Peninsula and Borneo.

THE LONG-TONGUED FRUIT BATS (SUBFAMILY MACROGLOSSINÆ)

This is a special subdivision of the Fruit Bat family, the members of which have tongues of a peculiar type. They are long, slender, and very extensile, for the purpose, it is thought, of reaching the nectar deep in flowers. To accommodate the movement of the tongue, the front of the lower jaw is somewhat spoon-shaped and the lower front teeth lie forward and flat. The claw on the index finger of the wing, present in most True Fruit Bats, is absent in the genus *Eonycteris* of this subfamily. Of the half-dozen genera belonging here, most occur in the eastern part of Indonesia.

The Dawn Bats, *Eonycteris*, are singularly like *Rousettus* in outward appearance and size. They can be distinguished at once by the absence of the claw of the index finger. The snout is long and slender.

Eonycteris spelæa occurs in caves from southern Burma, the Malay Peninsula, and the Greater Sunda Islands to Laos, Tonkin, and Cochin-China. The color of this Bat is dark dusty brown, the head darker, the almost bare neck gray-white, the underparts scarcely paler than the upper. The hair everywhere is very short. Behind the shoulders, bare areas on the sides narrow the haired portion of the back to little more than $\frac{1}{2}$ inch. The tail is scarcely more than $\frac{1}{2}$ inch long; the forearm varies

from 3 to nearly $3\frac{1}{2}$ inches. The ears are narrow and round-pointed.

The True Long-tongued Fruit Bats, genus *Macroglossus*, are scarcely larger than our Red Bat of the United States. The tail is reduced to about $\frac{1}{8}$ inch; sometimes it is difficult to find in dried skins. The ears are rather broad and rounded, and the pelage is ample. Unlike *Eonycteris*, *Macroglossus* retains the claw on the index finger of the wing. Two species occur in southeastern Asia, *M. minimus* and *M. lagochilus*, the latter distinguished by the presence of a deep vertical median groove on the upper lip and by its slightly smaller size. Both species are colored dull light brown.

Macroglossus minimus occurs from Darjiling, Burma, and Siam to the Malay Peninsula and the Sunda Islands; *M. lagochilus*, found principally in Celebes and New Guinea, has been recorded from the Malay Peninsula. In both species the forearm measures about $1\frac{2}{3}$ inches.

“INSECT-EATING” BATS (SUBORDER MICROCHIROPTERA)

Most of the Microchiroptera are small Bats with wing-spans from 8 to 12 inches. The largest found in the Orient are the False Vampires, *Lyroderma*, which span about 20 inches. The presence of fleshy processes around the nostrils or of structures on the top of the muzzle of a Bat invariably indicate a member of this suborder; their absence does not necessarily indicate a Fruit Bat. In the same way, extreme complexity or bizarre shape of the ears points to the insectivorous division, although simplicity does not. But if in a Bat a simple type of ear is seen in conjunction with a long tail, connected throughout its length to the legs and feet by an extensive membrane, that Bat is sure to be a member of the Microchiroptera. With the exception of certain South American Bats, the molar teeth of the Microchiroptera bear on their crown surfaces sharp cusps joined together

by ridges that tend to form a pattern like the letter W. Some of the South American Glossophaginæ have the molars reduced to compressed, nearly patternless structures somewhat like those seen in most Megachiroptera.

Many members of the Microchiroptera are found in the temperate climates of the globe as well as in the tropics, while the Megachiroptera must be regarded as nearly confined to the tropics and subtropics. Some Microchiroptera hibernate in caverns during the northern winters; others migrate. The number of young produced is usually one, sometimes two; but the North American Red Bats, in which there are two pairs of nipples instead of the usual one pair, may have four young.

It has been indicated that among Bats the "Micros" include a large number of families, while the "Megs," the Fruit Bats, comprise but one. Such being the case, a correspondingly wider range of form and behavior is naturally to be encountered in

Families	Subfamilies	Number of Genera	Number of Species	Distribution
Vespertilionidæ	Vespertilioninæ*	Many	Very many	World-wide tropics to temperate
	Kerivoulinæ	3	Few	Old World tropics
	Murininae	3	Few	Oriental tropics and subtropics
	Miniopterinae	1	Few	Old World tropics
Molossidæ		Several	Numerous	World-wide tropics and subtropics
Rhinopomidæ		1	Few	Sumatra and Africa only
Emballonuridæ		2	Numerous	Indo-Australia and Africa
Megadermidæ		2	Few	Indo-Australia and Africa
Rhinolophidæ	Rhinolophinae*	1	Many	Old World tropics and subtropics
	Hipposiderinae*	Several	Many	Old World tropics
	Coelopsinae	1	Few	Oriental tropics

* Contain most of the species of Asiatic Bats.

the Microchiroptera. At the same time, the small size and seeming uniformity among a large number of the species tend to obscure their very great diversity. It has been thought worth while to outline the families and subfamilies, with the number of genera in each, which will be treated in the present work. There exist also a number of other families, notably in the New World tropics. The reader can see at a glance from the preceding table that a very large proportion of the Insect-eating Bats belong to the two large families Rhinolophidæ and Vespertilionidæ, and to three only of the seven subfamilies composing them.

THE TRUE INSECT-EATING BATS
(FAMILY VESPERTILIONIDÆ)

When we see a Bat flit past in the dusk in the northern United States, the chances are overwhelmingly great that it is a member of this family. The word *Vespertilio* comes from the Latin word meaning "a bat." By a quirk of circumstances this generic name has become associated with a genus of the Old World temperate zone whose members are by no means the most abundant. The Bats more commonly seen in the north are the Brown Bats of the genera *Myotis* and *Eptesicus*.

In all members of the family the tail is long—considerably longer than the hind legs—and the membrane connecting it with the legs is more or less diamond-shaped. In all five subfamilies but one (found only in Australia and western America), there is total absence of noseleaves. The ears are usually small and separate, but in the Long-eared Bat, *Plecotus* and its American relatives, they are very large. A number of other adaptations found in the Vespertilionidæ will be discussed in their places.

No very large Bats occur in this family; the forearm measures less than 3 inches in the largest species, and quite small species having the length of the forearm only about 1½ inches are numerous. Although a limited number of genera are found

well within the temperate zone, this family is best represented in the tropics. It occurs in both hemispheres.

Of the five distinct subfamilies of Vespertilionidæ known, four occur in southern Asia. They are: Vespertilioninæ, containing the majority of the genera; the Miniopterinæ, or Bent-winged Bats, with one genus, *Miniopterus*, having the fur velvety dark brown; the Murininæ, or Murine Bats, with three genera, the upper surface of the tail membrane being densely hairy and the nostrils extended sideways as tubes; and the Kerivoulinæ, or Funnel-eared Bats, with three genera (two outside our area), all tiny Bats with the ears somewhat funnel-shaped.

The last three subfamilies, containing few genera, are specialized sharply in a number of respects. The larger subfamily, the Vespertilioninæ, also contains special types but their affinities to the parent group are well ascertained. All Vespertilionid Bats of Eastern Asia that do not belong to one of the three specialized small subfamilies just mentioned must belong to the Vespertilioninæ.

SUBFAMILY VESPERTILIONINÆ

A substantial number of the genera belonging to this group of Bats can be distinguished only by minute characters needing a magnifying glass for their satisfactory study, including the number and shape of their teeth. Since it will be impractical in this book to go into such details, those Bats are lumped together and their names are merely listed, or in special cases outstanding characters are mentioned. They comprise the following large list of generic groups: the group Myotini, with *Myotis*, the Mouse-eared Bats, one of the least specialized species; the group Plecotini, with *Plecotus*, the Long-eared Bats; the group Pipistrellini, containing many genera of both large and small Bats, such as *Pipistrellus*, the Pipistrelles; *Scotozus*; *Nyctalus*, the Noctules;

Ia; *Hesperoptenus*, Tickell's Bats; *Tylonycteris*, the Flat-headed Bats; *Barbastella*, the Barbastelles; the group Vespertilionini, containing *Vespertilio*, the Frosted or Linnæus's Bats; *Eptesicus*, the Big Brown Bats and Serotine Bats; and the group Nycticeini, including *Scotophilus*, the Yellow Bats, and *Scotomanes*, the Harlequin Bats.

The majority of these Bats are colored some shade of brown: light ashy brown, as in many Mouse-ears, Pipistrelles, and Serotines; red-brown, as in other Mouse-ears, Noctules, and Scotophiles; or blackish brown, as in still other Mouse-ears, Pipistrelles, *Ia*, and the Barbastelle. In *Vespertilio* and *Pipistrellus affinis* the tips of the brown hairs are frosted; and in *P. circumdatus* the dark brown hairs are tipped with bronze.

Outstandingly conspicuous on account of their color patterns are those Bats of the genus *Myotis* that are distinguished as the subgenus *Chrysopteron* (meaning "copper-winged"), and *Scotomanes ornatus*. In *Chrysopteron* the wings are patterned in two colors, red and dark gray. In *Scotomanes ornatus* the color is composed of richly varying shades of brown, but the outstanding features are a pure white patch on the forehead, a narrow stripe of white on the middle of the back, and on either side a white mark just where the wings join the body.

The Mouse-eared Bats, genus *Myotis*, according to the authority of Miller, include some eighty species. The genus is distributed almost throughout the continents of the world, and is absent only from the polar regions, from very high mountains, and from the southern parts of Australia.

The best way to distinguish *Myotis* from other genera, when in captivity, is to examine and count the teeth. If 3 upper and 3 lower premolars (the middle one of each lower set of three extremely small) are present, you have *Myotis*. No other living Vespertilionine genus except *Plecotus* has as many premolars. With the exception of the subgenus *Chrysopteron* (see above), *Myotis* are colored grayish, brownish, reddish, or nearly black.

The hind foot in two of the subgenera, *leuconöe* and *Rickettia*, is proportionately much enlarged, its length 60 to 65 per cent or more of the length of the shin bone, while in the remaining subgenera it measures only about 50 per cent of that length.

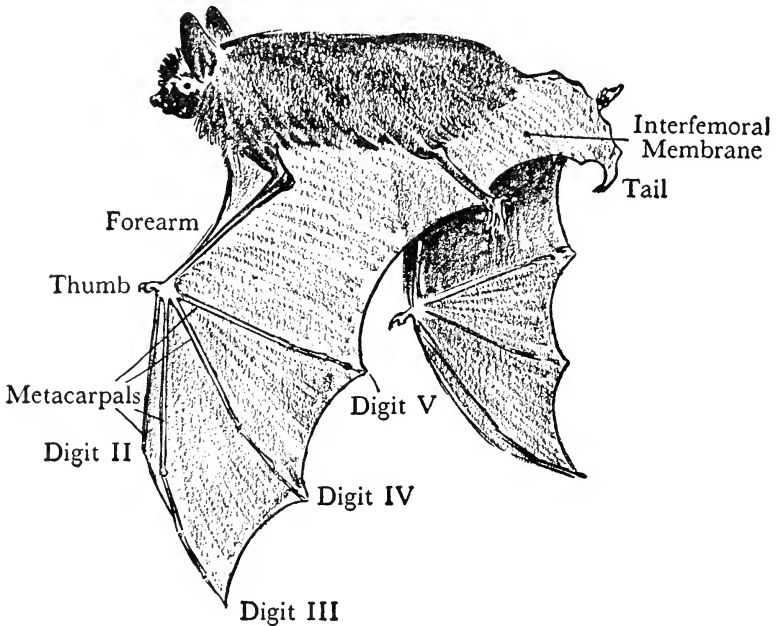


FIG. 10. Mouse-eared Bat, *Myotis*, illustrating the parts of the wing and tail in most kinds of Bats.

The snout is long, in order to accommodate the larger number of teeth. The various species spend the day in caves, hollow trees, or empty dwellings.

Seven subgenera have recently been recognized, six of which occur in our area. As is the case with many other large genera, a few of the groups contain most of the species. The subgenera with their more important species are shown next:

The **Whiskered Bats**, subgenus *Selysius*, contain many species and races, including the European Whiskered Bat,

Myotis mystacinus, with forearm $1\frac{1}{2}$ inches. A large number of closely related forms are known, among them the species *M. siligorensis*, with greatly domed braincase, from the Himalayas, Siam, Tonkin, Fukien. Other continental species of Bats of this subgenus are *sibiricus* from northern Mongolia, *gracilis* from Vladivostok, *muricola* from Nepal and Laos, *lobipes* from Akyab, western Burma, *altarium* from Szechwan, *frater* from Fukien, *latirostris* and *orii* (if distinct from one another) from Formosa, *deignani* from Siam, *federatus* from Selangor, *oreias* from Singapore. All are small brownish Bats, distinguished from each other by minute characters which cannot be elaborated here. They are often gregarious, hiding in thatches, caves, or hollow trees by day and coming forth to hawk insects by night.

The Natterer's Bats, subgenus *Isotus*, are a small group of the temperate zone, in which the length of the forearm is about $1\frac{1}{2}$ inches. The ear typically is longer and narrower than in the Whiskered Bats. In eastern Asia the species is represented by *M. nattereri amurensis* of eastern Siberia and by *M. n. bombinus* of Japan.

The Copper-winged Bats, subgenus *Chrysopteron*, with conspicuously bicolored red and slate wings, occur in southeastern Asia, the Indo-Australian Archipelago, and Africa. The only forms in the eastern Asiatic mainland areas are *formosus* from Nepal (which may well equal *auratus* from Darjiling and Assam), *flavus* from Formosa, *rufoniger* from Shanghai, and *chofukusei* from Korea. The geographical pattern suggested by these localities suggests for *Chrysopteron* a coastal type of distribution.

These are by far the most interestingly colored species of the genus, the pattern of the wings being somewhat similar to that of the Painted Trumpet-eared Bat, *Kerivoula picta*.

The True Mouse-ear Bats, subgenus *Myotis*, are the largest of the Mouse-ears and inhabit the mild temperate zone of the Old World. The length of the forearm varies from $2\frac{2}{5}$ to $2\frac{3}{4}$ inches. The color is rather dark brownish gray, slightly

paler beneath. The braincases are rather high and longitudinally crested like some *Eptesicus*. All may be races of the typical species *M. myotis*. In eastern Asia the Bats are represented by several races: *dobsoni* from the Himalayas, *sicarius* from Sikkim, *luctuosus* from Szechwan, *ancilla* from Shensi, *chinensis* from "China."

The Large-footed Mouse-ear Bats, subgenus *Leuconöe*, which include Daubenton's and Cappaccini's Bats of Europe and the North American *Myotis grisescens*, form a large, well-developed, chiefly south Asiatic group, more closely confined to the tropics than are the Whiskered and Natterer's Bats. They are distinguished by the greater size of the hind foot, which is two-thirds the length of the shank instead of one-half or less. It is larger only in *Rickettia*. Some species have the interfemoral membrane furry as in *Murina*, a member of a different Vespertilionid subfamily. *Leuconöe* comprises about five species groups, the most northern of which is the *daubentonii* group, represented in eastern Siberia and Korea (Kuroda) by *ussuriensis* and in Fukien by *laniger* and *fimbriatus*. The forearm is from $1\frac{2}{5}$ to $1\frac{3}{5}$ inches, the color dusty gray-brown. In the neighborhood of Peking there is a slightly smaller species, *M. davidii*, and a larger one, *M. pequinus*, with the length of the forearm 2 inches. The central group of *Leuconöe*, tropical and subtropical in range, with its typical species *M. adversus* of Java, is represented in the foothills of the Himalayas and Tonkin by *longipes*, in Siam by *continentis*, in Japan by *macro-dactylus*, and in Formosa by *taiwanensis*. The forearm in the *adversus* group is about $1\frac{1}{2}$ inches in length.

In Europe, Daubenton's Bats are called Water Bats, from their habit of dipping to the surfaces of pools and tanks to drink.

Rickett's Mouse-ear Bat, subgenus *Rickettia*, is unique; the single specimen, *Myotis ricketti*, is of uncertain though probably Chinese origin. It is extremely large-footed; the length of the foot is approximately equal to the length of the tibia. In this

respect it somewhat resembles the Fish-eating Bat, *Pizonyx*, of Lower California, Mexico.

The Long-eared Bats, genus *Plecotus*, are outstandingly different from all other Old World Vespertilionine Bats because of the relatively enormous size of the ears, which are about as long as the forearm ($1\frac{3}{5}$ inches). The typical species, *P. auritus*, extends from Europe to Japan, where the local race has



FIG. 11. Head of Long-eared Bat, *Plecotus auritus*.



FIG. 12. Head of Barbastelle, *Barbastella barbastellus*.

been named *P. a. sacrimontis*. A slightly larger form, *P. ariel*, is known from Szechwan, Kansu, and the Himalayas. In Siberia a species of *Plecotus*, probably referable to *sacrimontis*, has been taken in the Yablonoï Mountains as well as in trans-Baikal, northwest Mongolia, and Sakhalin.

The length of the ear in these extraordinary Bats may reach $1\frac{1}{2}$ inches. The ears are said to be kept in constant motion while the animal is resting, or again they may be cleaned and folded back motionless against the head and neck. The color is light gray or drab, somewhat tinged with buffy on the underside. Like many other Bats, these eat prodigious quantities of insects. Ognev mentions a peculiar case of *Plecotus* becoming entangled

with the hooked burs of burdock plants and dying there. One or two young are produced. The Bats hide by day in small colonies in hollow trees and attics. They begin hibernation in Russia about the middle of September.

The Pipistrelles, genus *Pipistrellus*, like the Mouse-ear Bats, *Myotis*, comprise a vast array of species and races, of which no more than a rapid survey can be given here. Pipistrelles look much like *Myotis* but have shorter muzzles in company with their smaller number of teeth. They may be colored blackish, brown, red, or, in desert regions, gray-brown. They have produced no such contrastingly colored forms as the subgenus *Chrysopteron* in *Myotis*.

Pipistrellus abramus group is a medium-sized (forearm $1\frac{1}{3}$ to $1\frac{1}{2}$ inches), gray-brown Oriental group found from Japan and Formosa through China and Burma to the Sunda Islands.

Pipistrellus coromandrus group, smaller than the foregoing (forearm $1\frac{1}{6}$ to $1\frac{1}{4}$ inches) are tiny dark brown Bats found from India, Burma, and the Malay Peninsula to south China (Hainan). One race even occurs on the Bonin (Volcano) Islands. They inhabit fairly warm, low regions.

Pipistrellus tenuis group, the smallest of all, with forearms only $1\frac{1}{12}$ to $1\frac{1}{5}$ inches in length, occurs only in the extreme south of our area, from India to Assam, Annam, and probably in the Malay Peninsula. These are also dark brown (grayish brown in the dry parts of western India).

Pipistrellus affinis group includes *affinis* from Burma, *pulveratus* from Fukien, and *lophurus* from Tenasserim. *Pipistrellus affinis* is dark, with the lower ventral area (where the hind legs join the body) white; the length of forearm is $1\frac{1}{2}$ inches. *Pipistrellus pulveratus* of Fukien and Yunnan is dusty brown; its forearm measures $1\frac{1}{3}$ inches. *Pipistrellus lophurus*, very imperfectly known, is described as "warm bister . . ."

Pipistrellus ceylonicus group, though characteristically from southern India, has relatives in Burma: *P. shanorum* from the

Shan States and *P. raptor* from Tonkin. Both are dark brown, with the forearms about $1\frac{1}{2}$ inches.

Pipistrellus savii group, in the Orient, comprises several species not strictly typical, including *P. cadornæ* and *austenianus*, both from Assam, with the lengths of the forearms $1\frac{1}{3}$ inches. These two may be identical to one another.

Pipistrellus circumdatus group, containing only the species *P. circumdatus*, is unusually large for a Pipistrelle; the forearm is about $1\frac{1}{2}$ inches long. The color is very dark slaty brown with the tip of each hair of the back bronze. The animal was discovered in Java. Either a close relative or the identical species has been found recently in upper Burma.

Pipistrellus annectens of Assam, a unique Bat, forms a group by itself. The length of the forearm is $1\frac{2}{3}$ inches. The distinguishing characters consist, however, in minute anatomical features of the teeth and skull.

Pipistrellus joffrei group, the largest *Pipistrellus*, and the most like *Nyctalus* (the Noctule Bats), comprise *joffrei* from Kachin Hills, *anthonyi* from Northern Burma, and two forms respectively from Sumatra and Borneo. Both of the former have very wide muzzles and the forearms about $1\frac{3}{4}$ inches long. Incidentally, the largest known Pipistrelle, found in Australia and Tasmania, has the forearm a shade less than 2 inches long.

Like *Myotis*, many of the kinds of Pipistrelles live in colonies, concealed in the roofs of houses or in hollow trees. In the Old World form, *P. pipistrellus pipistrellus*, but one young one is born at a birth; in *P. p. bactrianus* twins are commonly produced. The food consists of tiny flying insects. The genus is poorly represented in America.

The Noctules, genus *Nyctalus*, of our area are all rather large reddish brown Bats, much resembling large red Pipistrelles. The length of the forearm in the species of the Orient varies from 2 to $2\frac{3}{4}$ inches. The best-known Noctule is the

European Noctule, *N. noctula*, but those of the East are very similar. They comprise two groups: the first group, *N. lasiopterus aviator*, from off the mouth of Yangtse River and from Japan; the second group, *N. noctula motoyoshii* also from Japan, *N. plancei* (-*sinensis*) from Hopei, Hunan, and Szechwan, and *N. velutinus* from Fukien, Chekiang, Hupeh, and Kiangsu. The first is a large species with the forearm $2\frac{2}{5}$ inches long; the others are smaller, with forearms only about 2 inches long. *N. labiatus* from Nepal, northern India, though nearest in size to *N. noctula*, appears to be aberrant. The distribution of the Noctules is chiefly subtropical. They are unknown in the New World.

Nyctalus velutinus is reported to hide by day in the hollow joints of bamboo that birds may have drilled. *Nyctalus noctula* lives in forests, hiding during the day in groups in old hollow trees. Although it flies high at night, it has been observed by day flying low over water. It is reported by Ognev to eat numbers of cockchafer beetles, diving upon them while they are on the wing. Either 1 or 2 young are born. There is evidence to show that in Russia these bats assemble in flocks and migrate as some birds do.

The **Ia Bat**, *Ia io*, is a blackish brown Bat with the outward appearance of a *Nyctalus*. The pair of two-letter words which form its name were bestowed by a scientist momentarily exasperated at long technical words. *Io* was a Goddess of Greek mythology. Because she and Zeus became too friendly, Hera, Zeus's wife, changed her into a heifer. As for *Ia*, we suspect it was just invented.

Aside from its name, *Ia io* is a fine large Bat with the forearm a shade less than 3 inches long. It is found in Hupeh and Szechwan, and has been recorded from a cave at Chiengo Dao, on the Mekong River, northern Siam.

The **Barbastelle Bats**, genus *Barbastella* (Fig. 12), are small, blackish brown Bats with pale underparts and short, thick,

truncate ears joined by a low band across the forehead. They are found from Europe, southern Russia, and Arabia to the Himalayas and China. One species, *B. darjelingensis*, that represents them in the East, has the forearm about $1\frac{4}{5}$ inches long. It occurs from Assam and the Himalayas to Yunnan and Szechwan.

The Flat-headed Bats, genus *Tylonycteris*, are very tiny species with a number of peculiarities. Besides the extraordinarily flattened skull, they possess adhesive fleshy disks at the bases of the thumbs and on the soles of the feet. The number of teeth is 32. There are two chief types: *T. pachypus* (meaning "thick-footed") and *T. robustula*. The former occur in the Malay Peninsula, India, Burma, and Yunnan; the latter in the Malay Peninsula and Siam. The *pachypus* group are usually reddish brown and have the length of the forearm scarcely more than 1 inch. The *robustula* group are darker brown and have the forearm about $1\frac{1}{8}$ inches long.

The Disk-footed Bat, *Discopus denticulus* from Laos, resembles the Flat-headed Bats in having a flattened skull and in its even more completely developed disk-like pads. It differs by having a greater number of teeth. The color is cinnamon-brown, the underparts near amber-brown. The forearm measures $1\frac{2}{5}$ inches.

Tickell's Bats, genus *Hesperoptenus*, are represented by *tickelli*, a good-sized light reddish brown Bat, with forearm $2\frac{3}{8}$ inches. It is characterized by the fact that the outer upper incisor tooth stands directly behind the inner one, somewhat as in rabbits and hares. The Bat occurs in India and Burma. A related species, Blanford's Bat, *H. blanfordi*, found in Tenasserim, is only half the size, the forearm $1\frac{1}{10}$ inches. It also is dull reddish brown. The thumb in *H. blanfordi* has an adhesive pad as in *Tylonycteris*. It is by no means certain that these two Bats should be kept in the same genus. Because the second is so rare, this point remains to be settled.

The Frosted or Linnæan Bats, *Vespertilio murinus*, are a tiny group of rather large Bats, deep brown in color, with the tips of the hairs frosted with white. In eastern Asia two forms are known, *V. m. superans* from Vladivostok, Amur, the Yangtse Valley, Szechwan, Hupeh, Shansi, Hopei; and *V. nameyei* from Japan. Both have the length of the forearm 2 inches or slightly less. *Vespertilio murinus*, rapid high fliers, live in hollow trees and under roofs in colonies. One group of twenty specimens taken in Russia included eighteen males and two females. The two young are apparently born at the beginning of June, and begin to fly by the end of that month. The Bats hibernate in large groups.

The Serotine or "Big Brown Bats," genus *Eptesicus*, are near relatives of *Vespertilio* but have not the frosting on the fur. The genus is a large one with world-wide range; it has been separated into a number of groups, five of which are found in eastern Asia.

Eptesicus nilssonii group is represented in the East by *E. n. velox* from Vladivostok and Korea and by *E. n. gobiensis* from Mongolia. Forearm about $1\frac{5}{8}$ to $1\frac{3}{4}$ inches. The entire group is subtropical to northern. The original *nilssonii* comes from Sweden. Two young are born. This group is sometimes separated under the generic name *Amblyotus*.

Eptesicus fuscus group includes the "Big Brown Bats" of the United States. The forearm varies from $1\frac{3}{4}$ to $2\frac{1}{8}$ inches. A number of Oriental races occur: *andersoni* in Yunnan, Fukien, and Chekiang, *sinensis* in Peking, *pallens* in Kansu, and *brachydigitus* in Korea. The European race, *E. f. serotinus*, is recorded also from Siberia (Dauria and Lakes Argun and Tari-Nor). Bats of the *fuscus* group live in hollow trees, barns, and attics, occasionally gregariously; they hibernate sometimes alone in similar localities. The course of flight is less erratic than that of *Pipistrellus*. Only one baby Bat is born at a time.

Eptesicus demissus, a unique chestnut-brown species, comes

from the Malay Peninsula. The length of forearm is $1\frac{7}{12}$ inches.

Eptesicus pachyotis ("thick-eared") is a special type, with the basal part of the ear thickened. The color is dark brown, the length of the forearm $1\frac{3}{5}$ inches. This bat is known from Assam, the northern part of the Malay Peninsula, and Siam.

Eptesicus verecundus is apparently rather similar to *E. pachyotis* but a trifle smaller. Forearm $1\frac{2}{5}$ inches. It is found in Perak, Malay Peninsula.

Several species of *Eptesicus* have been proposed by Japanese authors. We have no specimens and know little about them. They include *E. horikawai* from Formosa, *E. kobayashi* from Korea, *E. pravus* from northern Korea.

The Yellow Bats, *Scotophilus* (= *Pachyotus*), the first from the Greek words meaning "loving darkness," includes only two species groups, a larger kind, *S. heathii*, with forearm $2\frac{1}{6}$ to $2\frac{4}{5}$ inches, and a smaller, *S. temminckii*, with forearm measuring from just short of 2 inches to $2\frac{1}{5}$ inches. The Bats of this genus are heavy-bodied, strongly built animals with powerful jaws and teeth. They are usually colored yellowish brown, with the underparts buffy. A reddish phase that occurs in the Malay Peninsula has been named *castaneus* (chestnut-colored).

The *S. heathii* group has its headquarters in peninsular India but a representative, *insularis*, olive-brown in color, occurs in Siam, Annam, Tonkin, Yunnan, and the Island of Hainan in southern China. A large *Scotophilus* "*kuhlii insularis*" is recorded by Kuroda from Formosa. The *S. temminckii* group is also widely distributed. It is represented by *gairdneri* in Siam, *castaneus* in the Malay Peninsula and Annam, and *consobrinus* in Hainan.

The Harlequin Bats, *Scotomanes ornatus*, have been mentioned earlier as one of the few Bat genera tricked out with striking colors. They are brown above, tipped with a slight frosting of russet. They have pure white marks on the forehead, the

middle of back, and on the sides of the back where wings and body join. Their size is about equal to that of *Scotophilus heathii*, the length of the forearm $2\frac{1}{4}$ inches. The typical Harlequin Bats are from Burma, but a slightly darker variety, *S. o. imbreensis* from Assam, has been distinguished, as well as a third race, *S. o. sinensis* from Fukien and Szechwan, slightly smaller, with the forearm 2 to $2\frac{1}{4}$ inches. The "prettiest" Bats in the Orient, with their long soft hair and ornate color scheme, they are found in caverns in wooded hilly regions between 2000 and 3000 feet above sea-level.

THE BENT-WINGED BATS (SUBFAMILY MINIOPTERINÆ)

These Bats constitute one of the quite small subfamilies of the Vespertilionidæ; they comprise but a single genus with a handful of species and are restricted to the warmer parts of the Old World.

The Bent-winged Bats, genus *Miniopterus* in the Orient, are recognizable by their short, velvety dark brown fur, their low rounded ears, and the very long second joint of the third finger of the wing, which is nearly three times as long as the first joint. Only two species dwell in our area, a medium-sized species, *M. schreibersii*, with forearm between $1\frac{7}{8}$ and 2 inches, and *M. pusillus* in which the forearm measures only about $1\frac{3}{5}$ inches. The larger species includes several named races, *fuliginosus* from Nepal and Burma, *parvipes* from Fukien, Hainan, and Tonkin, *chinensis* from Hopei and Chekiang, *japoniæ* from Formosa and Japan. Probably the form found in the Malay Peninsula is the same as the Javanese race *blepotis*. All are so much alike that they cannot always be distinguished by experts. The range of the *M. schreibersii* group extends to Europe and Africa.

Miniopterus pusillus, the much smaller species, is a member of the *australis* group, found throughout the Indo-Australian

Archipelago, though only in southern continental Asia. *M. pusillus* has been found in India, Siam, and the Island of Hainan.

Because of the length of the wings the flight is rapid, sustained, and swallow-like. The Bats are cave-dwellers. They ap-

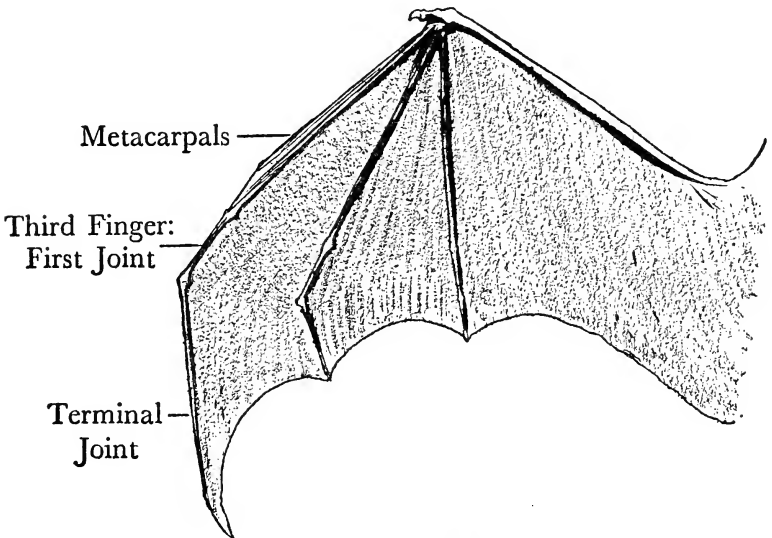


FIG. 13. Wing of Bent-winged Bat, *Miniopterus*, to show the unusually long second joint of the third finger.

pear soon after sundown and fly very high. In the case of *M. schreibersii*, one young is born at a birth.

THE MURINE OR TUBE-NOSED INSECTIVOROUS BATS
(SUBFAMILY MURININÆ)

Although their name implies “mouse-like,” these little Bats are no more mouse-like than any others of the small Bats. Names were often bestowed upon animals by authors at their wits’ end

to imagine reasonably suitable names that had never been used before. Many, in consequence, were often distinctly unsuitable. *Murina*, as a name, is in no way distinctive.

The Bats of this subfamily are all Old World forms and all have the upper surface of the membrane uniting the tail and hind legs quite densely hairy. In addition, the nostrils are drawn out into distinct tubes, much as in certain of the Flying Foxes (*Nyctimene*) of New Guinea and Australia.

Only three genera belong in the subfamily: *Murina*, *Harpiocephalus*, and *Harpiola*. (The harpies were mythological birds of ill omen. Again, the word has little or no significance in the present case.) The principal genus is *Murina*. *Harpiola* occurs in the western Himalayas only.

The Tube-nosed Insectivorous Bats, genus *Murina*, include a number of species from India, Burma, China, eastern Asiatic Russia, and Japan. They comprise several main groups, arranged here according to size:

Forearm length, $1\frac{3}{5}$ to $1\frac{4}{5}$ inches: *leucogaster* (Szechwan and Fukien), *hilgendorfi* (Japan), *intermedia* (Korea), *ognevi* (Siberia), *rubex* (Assam). All of the foregoing except *rubex*, it will be noted, are northern, from China, Japan, or Siberia.



FIG. 14. Head of Tube-nosed Insectivorous Bat, *Murina*.



FIG. 15. Ear of Trum-pet-eared Bat, *Kerivoula*. The outer ear is funnel-shaped. The tragus, pale in the drawing, is extremely long and pointed.



FIG. 16. Head of Naked Bulldog Bat, *Cheiro-meles torquatus*.

Forearm length, $1\frac{1}{3}$ to $1\frac{2}{5}$ inches: *huttoni* (Himalayas, Laos, and Tonkin), *rubella* (Fukien).

Forearm length, $1\frac{1}{8}$ to $1\frac{1}{3}$ inches: *cyclotis* (Himalayas, Burma, Tonkin, Laos, and Indo-China), *aurata* (Szechwan and Yunnan), *feæ* (Burma), *suilla* (Malay Peninsula), *ussuriensis* (Siberia).

The majority of the forms have brownish gray fur, but in *rubex*, *rubella*, and *feæ* the pelage is distinctly rufescent, and in *aurata* it is golden yellow.

The Harpy-headed Bats, genus *Harpiocephalus*, are colored either orange-red or gray, and have the length of the forearm about $1\frac{3}{4}$ inches, or as large as the largest species of *Murina*. They are distinguished by their extraordinarily massive, crushing-type teeth. The following forms are known: *lasiurus* from Assam, *harpia* from Java, *mordax* from Burma.

THE TRUMPET-EARED BATS (SUBFAMILY KERIVOULINÆ)

These tiny, butterfly-like Bats are distributed in southern Asia very much as are the Murine or Tube-nosed Bats, but do not extend nearly so far to the northeast. They are unknown in Japan and northern China. One of them, *Kerivoula picta*, has the wings strikingly patterned with orange and gray, the body fur orange-brown. All are small. The external ear is short (Fig. 15), rounded, and almost tubular, the snout long and slender, the braincase of the skull full and rounded.

Trumpet-eared Bats of eastern Asia are: *depressa* from Burma and Tonkin, *minuta* from Siam, *bellissima* from Hainan Island off southern China, *bicolor* and *malayana* both from the Malay Peninsula. They fall into three groups, based upon size:

Forearm length, $1\frac{3}{5}$ inches: *malayana*

Forearm length, $1\frac{1}{3}$ inches: *picta* and *bellissima*

Forearm length, $1\frac{1}{6}$ to $1\frac{1}{4}$ inches: *depressa*, *minuta*, *bicolor*.

Most of the foregoing Bats are colored gray-brown or ashy brown. The large *malayana* is the peninsular representative of *K. papillosa* of Java. It has been recorded from Tonkin and probably occurs in the intervening territories. The bright orange-brown body fur, and wings variegated with gray and orange, makes *picta*, found from Moluccas to Malaya and Siam, and its close relative *bellissima* of Hainan the most conspicuous Bat of the genus.

The great student of Bats, Mr. G. E. Dobson, believed that the peculiar color patterns of the wings of *K. picta* and of the myotine subgenus *Chrysopteron* were explained by "protective mimicry," their resemblance to brightly colored decaying leaves affording them concealment.

THE MASTIFF OR BULLDOG BATS (FAMILY MOLOSSIDÆ)

In many ways this is one of the most peculiar of the families of Bats. The common name implies a fancied resemblance to bulldogs. The head is broad, short, and rounded; and in some genera the ears are large, thick, ribbed or folded, and lie almost in a plane with the animal's direction of flight. In all but one genus the ears are united by a fleshy band across the forehead, but in *Chæromeles* they are small, thickish, simple, and widely separated. The tails of the Molossid Bats are unique in that the terminal half extends free beyond the interfemoral membrane and this latter can be slid by muscles freely along the length of the tail to increase or decrease its area. The feet also are exceptional, being provided with thick, fleshy toes and stiff, fringing, spoon-shaped hairs. The wings are narrow, the wing-beat rapid. The species are apparently all insectivorous. The family inhabits the tropical parts of both hemispheres.

The few eastern Asiatic members of the Molossidæ include the large, extraordinarily ugly, almost naked *Chæromeles* in which the ears are widely separate, and two or three weakly

separable genera with united ears, namely *Chærephon* and *Nyctinomus*, and possibly *Mops*, the last known in India and Celebes.

Chærephon and *Nyctinomus* are distinguished from one another mainly by characters of the palate—not very helpful to those who are not Bat specialists!

The Naked Bulldog Bat, *Chæromeles torquatus* (Fig. 16), is found in the Malay Peninsula and Indo-China; it has been taken at Singapore, Pahang, Selangor, and in Siam. The lips, unlike those of most of the other genera in the family, are smooth. There is a peculiar fleshy fold of skin around the neck and a median gland beneath it, and the hind part of the wing adjoining the body has a loose pocket or membrane, by some thought to shelter the nursing young one, even though it is present in both sexes. The color is dark gray, the forearm length $3\frac{1}{4}$ inches. This genus of Bats was first made known from Java. It occurs also on Sumatra and Borneo.

The Malay Wrinkled-lipped Bat, *Chærophon johorensis*, from Johore in the Malay Peninsula, is the original and typical *Chærophon*. The band of skin uniting the ears is so deep that it forms a distinct pocket with the head and ears. The forearm is $1\frac{9}{10}$ inches in length, the color very dark brown. *C. plicatus*

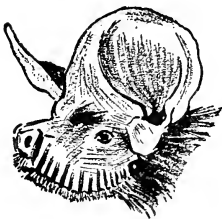


FIG. 17. Head of Wrinkled-lipped Bat, *Chærophon*.

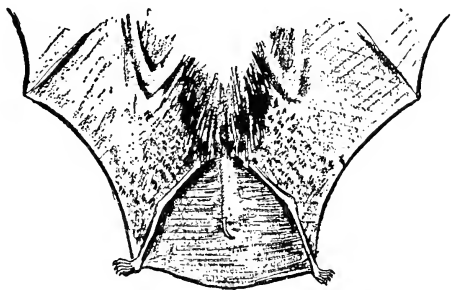


FIG. 18. Tail of Sheath-tailed Bat, *Emballonura*, emerging onto the upper surface of the interfemoral membrane.

(meaning "folded," in allusion to the ears) is an allied, perhaps not very different species. Its forearm measures 2 inches. The color is also dark brown. This latter Bat, which hides in caves and deserted buildings, was described first from Java. It has been reported since from Bengal and Hainan.

The Egyptian Wrinkled-lipped Bat, *Nyctinomus tæniotis* ("banded-ear," relating to the stiffening bands of cartilage in the conch of the ear), is a species of wide range in the Old World tropics. The length of the forearm is $2\frac{1}{5}$ to $2\frac{3}{5}$ inches. Originally collected in Egypt, it is represented in Fukien and Yunnan by the form *insignis*. Satunin indicates that another race, *latouchei*, reaches Korea and Vladivostok.

MOUSE-TAILED BATS (FAMILY RHINOPOMIDÆ)

This is another very small family containing the single genus *Rhinopoma*. Its mixture of specialized and residual characters proves that it has developed, separated from the remaining Microchiroptera, for an extremely long period of time.

It differs from all other living insectivorous Bats by retaining two joints of the index finger in the wing, though unlike the majority of the Fruit Bats, it has lost the claw and terminal joint. It also differs by possessing a mouse-like tail almost as long as the head and body while the interfemoral membrane is so short that it extends down the tail little more than $\frac{1}{8}$ inch. *Rhinopoma* has gone much farther in dental reduction and specialization than have some of the primitive Vespertilionid Bats such as *Myotis*. The free tail and the shortness of the interfemoral membrane may actually be a secondary condition. A similar type of tail occurs in the Fruit Bat *Notopteris*.

There is a small, low, rounded noseleaf, and the ears are ample, short, round-pointed, and joined together by a deep band of skin across the forehead. The nostrils appear as forwardly opening slits. The broadening of the rostrum of the skull is

somewhat like that of *Emballonura*. The family is found from northeast Africa to Siam and Sumatra.

The Malay Mouse-tailed Bat, *Rhinopoma hardwickii*, is dark brown above, rather paler beneath. The forearm measures $2\frac{3}{5}$ inches, the head and body 3 inches, the tail $2\frac{1}{3}$ inches. *Rhinopoma* is found in ruins, caves, and rock crevices and appears to be rare. The Sumatran form is reported to be slightly larger, the length given for the forearm being about $2\frac{4}{5}$ inches.

THE SHEATH-TAILED AND TOMB BATS
(FAMILY EMBALLONURIDÆ)

The Bats belonging to this family can be distinguished from all others by the fact that although the basal part of the tail is enclosed in the flying membrane stretching between the two hind legs (interfemoral membrane), the terminal part of the tail emerges and lies free upon the upper surface of the membrane. This arrangement is easy to see when the Bats are held in the hand. There is never any noseleaf, and the ears are comparatively simple. The family presents certain other special characters in combination with a number of primitive ones. It is represented in the tropical belts throughout both Old and New Worlds. In our area only two genera are found, the small Sheath-tailed Bats, *Emballonura*, and the considerably larger, heavy-bodied, sometimes spotted Tomb Bats, *Taphozous*.

The Sheath-tailed Bats, genus *Emballonura* (Fig. 18) are plentiful through the Indo-Australian Archipelago; the genus appears also in Madagascar. One of the species, *E. monticola*, described originally from Java, extends on the mainland through the lower Malay Peninsula to Trang in peninsular Siam. The color is dark brown, slightly paler beneath. The length of the forearm is $1\frac{1}{2}$ inches. Some species, though they fly around the tops of high trees in the forest at dusk, roost habitually by day in low-growing palms in small groups.

The Tomb Bats, genus *Taphozous*, are rather large blackish or brownish Bats, some with yellowish white spots on the body, others with pure white underparts. They live in hollow trees, caverns, deserted temples. In Egypt a species is found hiding by day in tombs, whence the common name. This tropical genus extends from Africa to Australia. *Taphozous* can be treated as a subfamily, distinct from *Emballonura* and its relatives.

The Black-bearded Tomb Bat, *T. melanopogon*, is one of the smaller brown species. The males especially are recognized by the jet-black patch of hairs on the throat and chin. The species is found from Java and Bali to Laos, and southern Yunnan, China. The length of head and body is from 4 to 4½ inches, of the tail 1 inch, of the forearm about 2½ inches.

Flower found these Bats common in his kitchen at Bangkok. They used to hunt through the rooms of the house in research of insects in the evening. They crawled actively on the walls of the houses and eaves, often traveling backward up a wall. They rested with the head turned slightly upward and the ears pressed flat against the neck.

Two related Tomb Bats, the Spotted Tomb Bat, *T. saccolaimus* (Penang and Singapore), and the White-winged Tomb Bat, *T. affinis* (Singapore), are recorded in the Malay fauna.

THE FALSE VAMPIRES (FAMILY MEGADERMIDÆ)

These are big Bats with large, rounded ears that are united across the crown of the head. The tragus, a peculiar structure of the ear common in Bats, located in front of the ear opening, is forked in the Megadermidæ, having a short anterior branch and a long posterior one. There is a distinct, large noseleaf above the nostrils. The wings are ample; the tail absent externally; the interfemoral membrane extends nearly an inch beyond the body.

The family is found from tropical Africa to Asia, the East

Indian islands, and Australia. Though mainly insect-eaters, some of the species will kill and eat other kinds of Bats, small birds, mice, frogs, and even fish. They are called False Vampires because, though strongly carnivorous, their teeth and gullets are not specialized for feeding on blood as are the much smaller True Vampires of the New World tropics.

The two genera, *Megaderma* and *Lyroderma*, which are perhaps only subgenera, differ from each other by relatively insignificant characters. *Lyroderma* is larger and has the noseleaf flat at the top; *Megaderma* is smaller and has the noseleaf pointed at the top.

The Malay False Vampire, genus *Megaderma*, occurs from Ceylon and India through Burma to Indo-China and the Malay Peninsula and is present also on a number of the islands south of eastern Asia. It is represented in our region by the races: *M. spasma majus* of Chindwin Valley, Burma, *M. s. minus* of Cambodia, and *M. s. medius* of the Malay Peninsula.

The single species, *Megaderma spasma*, is colored smoky bluish gray on the back, brownish gray on the underparts. The membranes and ears are blackish gray except the extreme tip of each wing along the third finger, which is white. The length of the head and body is about 3 inches, of the forearm 2 to 2¼ inches.

The Lyrate False Vampire, *Lyroderma lyra*, was first discovered in the Province of Fukien, China, by the British naturalist Swinhoe. It also occurs through most of India. The color is gray-brown above, whitish gray below. The length of the head and body amounts to 3½ inches, of the forearm 2⅔ to 2¾ inches.



FIG. 19. Head of False Vampire, *Megaderma spasma*.

THE HOLLOW-FACED BATS (FAMILY NYCTERIDÆ)

This small family, containing the single genus *Nycteris*, is perhaps descended from the same ancestry as the False Vampires, Megadermidæ. The ears are rather large, with somewhat rounded outline. There is a distinct noseleaf; the six-jointed tail is long, terminating at the edge of the interfemoral membrane



FIG. 20. Head of Hollow-faced or Slit-faced Bat, *Nycteris javanica*.



FIG. 21. Head of Horseshoe Bat, *Rhinolophus*.

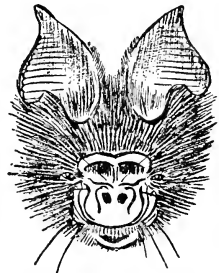


FIG. 22. Head of Round-leaf Horseshoe Bat, *Hipposideros armiger*.

in a wide cartilaginous fork. The skull is noteworthy for the very large broad depression between and behind the positions of the eyes. The limb bones are exceedingly slender. Most of the species are African; one lives in the Malay area.

The Malayan Hollow-faced Bat, *Nycteris javanica tragata*, is colored pale buffy brown, the membranes and ears light slate, the underparts yellowish brown. The length of the forearm is 2 inches, somewhat longer than the true Javan race. This Bat occurs in caves in the Malay Peninsula, Sumatra, and Borneo.

THE HORSESHOE BATS (FAMILY RHINOLOPHIDÆ)

A large number of small to moderate-sized species go to make up this Old World family. About half of the species belong to

the subfamily Rhinolophinæ, containing only the genus *Rhinolophus*. The other half are members of the subfamily Hipposiderinæ, which comprises the large genus *Hipposideros* and several smaller genera. The genus *Coelops* may be treated as a third subfamily, the Coelopsinæ.

All species have, at the front of the muzzle, an expanded, foliaceous, horseshoe-shaped structure, the "horseshoe," in the center of which are the nostrils. Above and behind the horseshoe stand supplementary structures, the shape of which differs in the first two subfamilies. In the Rhinolophinæ we see a forward-facing tombstone-shaped (with rounded top) membranous structure, the "sella" or "saddle," which is joined by a thin membrane running lengthwise, the "connecting process," to a high wedge-shaped eminence, the "posterior noseleaf." On the cheeks, either side of these complex organs, there may be other much smaller "lateral noseleaves."

In the second subfamily, the Hipposiderinæ, there is neither sella nor connecting process, and the posterior noseleaf, instead of being wedge-shaped and pointed above, has a broadly rounded, almost fan-shaped outline. The posterior noseleaf may be smoothly continuous across its upper margin as in *Hipposideros* or it may be toothed or even more complex as in certain of the allied genera.

In *Coelops* the noseleaves are not only specially formed but they are concealed in a dense coat of long, rather bristly hairs.

The tails of the Horseshoe Bats, of only moderate length, extend to the hind edge of the interfemoral membrane (the web which unites the hind legs), or a joint or two of the tail may protrude beyond it. In *Coelops* the tail is rudimentary.

The ears are moderately large, in some forms very large. The front edge of the ear is strongly curved, the lateral edge sometimes slightly hollowed out. The whole of the external ear is commonly stiffened by rib-like thickenings and folds.

It is quite common to find the individual species of the Bats

of this family occurring in two color phases, red or gray, and living in the same cave or hollow tree, so that color is not always a safe criterion for differentiating species.

THE TYPICAL HORSESHOE BATS
(SUBFAMILY RHINOLOPHINÆ)

The genus *Rhinolophus* (Fig. 21), the only one in its subfamily and confined to the Old World tropics and subtropics, contains a great many different forms distributed among some eight superspecific groups. Three of those groups are represented in continental southeastern Asia. All possess the horseshoe, sella, connecting process, and posterior noseleaf described earlier. The differences between species are in many cases based upon differences in these nasal structures, combined with differences of size (length of forearm, hind foot, tail) and of the structure of the skull. The following are the three species groups found in southern and eastern Asia:

- R. lepidus* group. The smallest Rhinolophus. Forearm about $1\frac{1}{4}$ inches long. Connecting process triangular; pointed on top.
- R. ferrum-equinum* group. Small to medium in size. Outline of sella lyre-shaped. The connecting process rounded above. Forearm $1\frac{3}{4}$ to $2\frac{2}{5}$ inches.
- R. philippinensis* group. Ears much to enormously enlarged; noseleaves variously specialized; forearm $1\frac{3}{4}$ to nearly 3 inches long.

The Least Horseshoe Bats, the *R. lepidus* group, comprise three subdivisions, *lepidus*, *minor*, and *subbadius*. All three are represented in eastern Asia. They are best distinguished by characters of the connecting process. In *lepidus* the central process above, seen from the side, is broadly triangular; in

minor it is narrow and acutely pointed; in *subbadius* it is narrow, pointed, and curved forward.

The *R. lepidus* subdivision is represented geographically by true *lepidus* in the Ganges Valley, *shortridgei* in the Irrawaddy Valley, *refulgens* in the Malay Peninsula (Perak), *famulus* in the Karin Hills, Burma. The group is represented in Yunnan and Szechwan.

The *R. minor* subdivision extends farther north and east. Many of its members are mountain dwellers. They include *gracilis* on the Malacca coast, Malay Peninsula, *blythi* in the Kumaon Hills, Assam, *szechwanus* in Szechwan, *parcus* in Hainan, *calidus* in Fukien, and *cornutus* in Japan. Members of this group are recorded also from Tonkin and Cochinchina.

The *R. subbadius* subdivision is poorly known. In our area there are only true *subbadius* in Nepal, northern Burma, and Tonkin, and *monoceros* in Formosa.

All these little bats look singularly alike. Normally the color is brownish gray, with underparts ash-brown, but in some at least a red phase exists alongside the gray one. The forearm varies from $1\frac{1}{5}$ to $1\frac{2}{5}$ inches.

The Greater Horseshoe Bat, the *R. ferrum-equinum* (Latin, "horseshoe") group, is of special importance because it includes the first Horseshoe Bat ever to be recognized and named, the cave-dwelling Greater Horseshoe Bat of Europe. All members of the group have the dorsal outline of the connecting process rounded instead of pointed. *Rhinolophus ferrum-equinum* is a moderately large, grayish-brown species, the forearm measuring about $2\frac{1}{4}$ to $2\frac{1}{2}$ inches. Neither the ears nor the noseleaves are enlarged. Several representatives of the species occur in the East, including *R. ferrum-equinum tragatus* in Yunnan and Nepal, *R. f. nippon* in Szechwan, Shantung, Fukien, Japan, Korea, Shanghai, and possibly Ussuri, and *R. f. mikadoi* in Yokohama, Japan.

The Intermediate Horseshoe Bats, *Rhinolophus affinis*, slightly smaller than *R. ferrum-equinum*, with the length of the forearm about $2\frac{1}{10}$ inches, are also widely distributed in eastern Asia. The red phases appear to be nearly as common as the gray in many localities. The races of this group include *himalayanus* in the foothills of the Himalaya Mountains, and Szechwan, *macrurus* in the Karin Hills, Burma, Tonkin, Fukien, Chekiang, *tener* at the mouth of the Irrawaddy River, *robinsoni* in lower Siam, and *hainanus* on the Island of Hainan, southern China.

Roux's Horseshoe Bats, *Rhinolophus rouxi*, are yet smaller than *affinis*, the forearm about $1\frac{3}{4}$ inches. In these, too, the red phase is often developed. The representatives in the area dealt with in this book are true *rouxi* from the district of Darjiling, Sikkim, *thomasi* from the Karin Hills, Burma, and *sinicus* from the Valley of the Yangtse; also Hupeh, Szechwan, and Fukien.

The Big-eared Horseshoe Bats, the *R. philippinensis* group, comprise six rather markedly divergent kinds of *Rhinolophus*. In all of them the ears are considerably enlarged, though the maximum enlargement occurs in true *R. philippinensis*, a Bat not found on continental Asia. The group contains the following additional very distinct types:

The Narrow-cupped Bats, *R. macrotis*, are moderate to small in size, with a cup-shaped structure scarcely wider than the sella at its base. The posterior noseleaf is tall, its tip rounded. Their geographical representatives include *R. macrotis*, the typical form from Himalayan foothills, *siamensis* from Siam and Tonkin, a small race, with forearm $1\frac{2}{5}$ inches, *episcopus* from Szechwan, China, and *caldwelli* from Fukien, China, to Tonkin.

The Short-leafed Bats, *R. coelophyllus*, are moderate-sized bats with "cup" and sella as above, but the posterior noseleaf short and fringed with hairs. *R. coelophyllus*, typically from the Salween Valley, Burma, occurs also in Siam and Shan States. A smaller form, *R. c. shameli*, is known from peninsular Siam.

The Royal Horseshoe Bat, *R. rex*, somewhat larger than *R. coelophyllus*, has the "cup" very large, twice as wide as the greatly broadened sella. The posterior noseleaf is very low. *R. rex* is a highly peculiar species with very large ears and noseleaf. It is known only from Szechwan. The length of the forearm is $2\frac{1}{3}$ inches.

The Trefoil Horseshoe Bats, *R. trifoliatu*s, are moderate-sized Bats with a very high, narrow posterior noseleaf and with a pair of small lappets, often in-folded, on either side of the base of the sella. The noseleaves and other parts of the body are weakly pigmented. The upper incisors are minute. The Trefoil Bat, so named from the trefoil shape of the sella with its pair of lappets, is chiefly a species of the Sunda Islands. It occurs also in the Malay Peninsula and Siam.

The Woolly Horseshoe Bats, *R. luctu*s, are generally even larger Bats than *R. trifoliatu*s, but have similar structure of the posterior noseleaf and lateral lappets on the sella. They are strongly pigmented with blackish or very dark brown and the hairs of the body are somewhat frizzy. The upper incisors are large and in contact with each other. The Woolly Horseshoe Bats have received a number of regional names: *morio* from Singapore to Siam, *perniger* from Nepal, northwestern India, *spurcus* from the Island of Hainan, and *lanosus* from Fukien, China, and others. Which of them are valid has not been fully determined. The forearm is about $2\frac{3}{4}$ inches long.

THE ROUND-LEAF HORSESHOE BATS (SUBFAMILY HIPPOSIDERINÆ)

All the genera belonging to this assemblage are distinguishable from the typical rhinolophs by the absence of the high, wedge-shaped posterior noseleaf and the development instead of a posterior noseleaf broadly rounded or fan-shaped, which may carry on its upper edge various small processes. There may be

a large gland on the forehead behind the noseleaves. Another distinguishing character, easily seen in captive living specimens held in the hand, is the reduction of the number of joints in the toes of the hind feet from three to two. Furthermore, one of the small premolar teeth of the lower jaw present in *Rhinolophus*, is absent in *Hipposideros*. The general appearance of many of the Bats of the Hipposiderinæ is very much like that of the Rhinolophinæ, and Bats of both sorts may sometimes be found in the same cave.

Besides the large central genus *Hipposideros* (Greek: "horse," "iron"; and hence "horseshoe"), members of a second related small genus, *Aselliscus*, are found in southeastern Asia. *Hipposideros* breaks up into a number of main divisions, some showing greater or less specialization than others. *Aselliscus* can be thought of as one of those divisions which have become sufficiently specialized to warrant receiving a distinguishing name.

The Round-leaf Horseshoe Bats, genus *Hipposideros* (Fig. 22), vary in size from little species with the forearm only $1\frac{1}{4}$ inches long to rather large Bats having the length of the forearm almost $3\frac{1}{2}$ inches. Most are colored some shade of brown, but some (*H. diadema* of the East Indies) are gray, marked along the sides of the back and on the face with white. Distinctive characters are seen, as in *Rhinolophus*, in the form of the nasal appendages. In one group (*H. pratti*) the size of the posterior noseleaf is dependent upon the sex of the animal. The geographical distribution of *Hipposideros* is substantially the same as that of *Rhinolophus*, chiefly the warmer parts of Asia and Africa.

Of the eleven major subdivisions of *Hipposideros*, six are represented in southeastern Asia. They are: *H. bicolor* group, comprising very small (forearm $1\frac{1}{3}$ to $1\frac{2}{3}$ inches) gray or red Bats with ears scarcely pointed; *H. galeritus* group, composed of small (forearm $1\frac{4}{5}$ to $1\frac{9}{10}$ inches) gray, rarely red Bats with ears strongly hook-pointed; *H. pratti* group, containing

very large (forearm $3\frac{1}{4}$ to $3\frac{1}{2}$ inches) red-brown Bats; *H. armiger* group, with very large (forearm 3 to $3\frac{1}{3}$ inches) red-brown or gray Bats; *H. diadema* group, including very large (forearm about $3\frac{1}{2}$ inches) gray Bats, marked with white; and *H. speoris* group, consisting of medium-sized (forearm $2\frac{1}{10}$ to $2\frac{1}{3}$ inches) gray or brown species. The length of forearms of these groups is given for continental specimens only.

In most instances only a single species represents any one group. In the *H. bicolor* and *H. galeritus* groups many names have been proposed for weakly distinguishable forms. As in *Rhinolophus*, both red and gray phases appear in certain groups.

The Least Round-leaf Horseshoe Bats, the *H. bicolor* group, are represented by at least four forms: *H. b. gentilis* from the Valley of the Irrawaddy, *H. b. sinensis* from Fukien, *H. b. atrox* from Malay Peninsula, and *H. b. ridleyi* from Singapore. In addition, a less closely related species, *H. nequam*, is found at Penang, Malay Peninsula. All of these are little Bats, with the forearm less than $1\frac{3}{4}$ inches. The ears are broad and leafy, with the outer margin not cut out (as in most species). No gland occurs on the forehead. The color is usually light grayish brown, buffy white beneath. But there also occurs a pretty coppery red color phase in at least some of the races. The group is present in Tonkin and Annam. Osgood also records the tiny Punjabi form *cineraceus* from Tonkin.

The Lesser Sac-bearing Horseshoe Bats, *Hipposideros galeritus* and relatives, a large group, are found chiefly in the islands of the Indo-Australian Archipelago. Only one species, *galeritus* proper, occurs in southern Asia. It appears to be restricted to Assam, Burma, and the Malay Peninsula. Only slightly larger in size than *H. bicolor* (forearm $1\frac{3}{4}$ inches), *galeritus* can be distinguished by the excised outer margins of the ears and by the glandular sac on the forehead. The nasal appendages are more or less flesh-colored, and at either side of the horseshoe there are two lateral leaflets (none in *bicolor*).

The Common Sac-bearing Horseshoe Bats, the *H. speoris* group, typically South Asiatic and African, have a representative species, *H. larvatus*, in southeastern Asia, which is widely distributed. One of the easiest characters by which *larvatus* (and its geographical races) can be distinguished from other species is by the pronounced cleft at the middle of the front edge of the horseshoe, just above the upper lip. This Bat is larger than either *bicolor* or *galeritus*, its forearm measuring from $2\frac{1}{3}$ to $2\frac{5}{8}$ inches, but is smaller than any of the Bats of the genus yet to be mentioned. The color is usually dark brown, though a red phase occurs. It is represented geographically as follows: *H. larvatus leptophylla* (= ?*grandis*) from the Irrawaddy Valley, *H. larvatus larvatus* from the Malay Peninsula to Tonkin, and *H. larvatus poutensis* from Hainan Island.

The *speoris* group is rarely found above 1000 feet. Both *Hipposideros speoris* of India and *H. larvatus* live in caves, as the name of the first indicates.

Pratt's Round-leaf Horseshoe Bat, *H. pratti*, is perhaps the most peculiar of all the species of *Hipposideros*. It is unusual because it shows extreme sexual dimorphism in relation to the form and size of the posterior noseleaf. It is a large, reddish brown Bat with dark membranes, having the forearm measurement $3\frac{1}{2}$ to $3\frac{3}{4}$ inches. Typical *pratti* is found in caves in Chekiang, Fukien, Tonkin, Szechwan, and Hunan. A geographical race, *H. p. lylei*, is known from northern Siam and from the mountainous parts of the lower Malay Peninsula.

The Armor-bearer Horseshoe Bat, *H. armiger*, is a species almost as large as *H. pratti*. Its English name has no particular significance. The color, dark brown (there is also a red phase), is not dissimilar to that of Pratt's Horseshoe Bat. But the noseleaf is proportionately small and there is no great difference in the size of the sexes. A frontal gland is present. *Hipposideros armiger* and *H. pratti* may often be found in the same cave.

The species is represented regionally as follows: *H. armiger armiger* in Nepal and Tonkin, *H. a. pendleburyi* in peninsular Siam, *H. a. delibis* in the Malay Peninsula, *H. a. swinhoei* in Fukien, *H. a. terasensis* in Formosa, and *H. a. turpis* in the Luchu Islands (a small-sized race).

The Diadem-bearing Bat, *H. diadema*, is so named from a fancied resemblance of the posterior noseleaf to a crown. These Bats, which, with the length of the forearm about 31½ inches, are about as large as *pratti* and *armiger*, reach only the southern portions of tropical Asia. There are three or four lateral leaflets on the face on either side of the horseshoe. No frontal gland is present on the forehead, although this structure is present in the *galeritus*, *pratti*, *armiger*, and *speoris* groups. The red color phase is apparently never developed in *H. diadema*, although the closely related *H. lankadiva* of India and Ceylon is reddish. The color instead is gray or brownish gray with white marks on the face and the sides of the back. The headquarters of *diadema*, like the much smaller *calcaratus* and *bicolor*, is the Indo-Australian Archipelago. Only two races enter our territory: *H. d. nobilis* in the lower Malay Peninsula and *H. d. masoni* from southern Burma east through Siam to Annam.

The Trident Horseshoe Bats, genus *Aselliscus*, are very tiny species, differing from all of the foregoing groups of *Hipposideros* by having the upper edge of the posterior noseleaf divided into three distinct points. There is no frontal sac on the forehead. The rather long tail extends a short way beyond the membrane.

The typical species, *A. tricuspидatus*, is an island form not known in our area. Three others, *stoliczkanus* from Penang Island, *trifida* from Burma, and *wheeleri* from northern Burma, which possess very similar characteristics of the noseleaf, are here referred to *Aselliscus*. Formerly they were placed either in *Hipposideros*, *Triænops*, or *Asellia*. The last two genera, African and Arabian, are markedly unlike these little Malayan Bats.

The specific names of the continental Bats mentioned above may in reality relate to but a single insufficiently studied species. "*Triænops wheeleri*" is recorded from Burma, Tonkin, and Kweichow, China. The forearm measures about 2 inches.

THE HAIRY-FACED HORSESHOE BATS
(SUBFAMILY COELOPSINÆ)

Coelops, the single genus of this subfamily, is very different from all previously described Rhinolophidæ. The horseshoe, if it may still be so called, has in front a deep notch reaching back to the septum between the nostrils, and each half of the horseshoe is parted into two greatly overlapping lobes, the outer one over the inner. The whole area of the nasal appendages is partly hidden by a dense development of minute though stiff bristles. The ears are funnel-like, the tail rudimentary—less than $\frac{1}{8}$ inch in length. The forearm measures $1\frac{2}{5}$ to $1\frac{3}{5}$ inches.

This peculiar genus is found from Bengal through Burma and Szechwan, to Fukien and Formosa. It is recorded in Annam and Tonkin, and occurs also on Java and the Philippines. Local continental names are: *C. frithii* in Bengal, *C. robinsoni* in the Malay Peninsula and Siam, *C. sinicus* in Szechwan, *C. inflata* in Fukien, and *C. formosanus* in Formosa.

THE PANGOLINS OR SCALY ANTEATERS
(ORDER NOMARTHRA)
(FAMILY MANIDÆ)

The scaly covering of their bodies and tails, their elongate forms and awkward gait make the living members of this order, all of which are contained in the single family Manidæ, appear almost reptile-like. If alarmed they can roll the body in a ball, wrapping their tail about it. When in that position they look a little like very large pine-cones. The scales are broad, horny

plates, regularly arranged to overlap one another like the shingles on a roof; they are modified from hairs.

Pangolins (a corruption of the Malay word "Tanjiling") are believed to be exceedingly remote relatives of the South American sloths, anteaters, and armadillos, from which, however, they differ in important ways. They have no collar bones; the joints of the hinder part of the spine have special types of articulation; the single pair of nipples lies behind the armpits; the sexual organs also are very different. The resemblances to anteaters and armadillos seen in the large digging claws, the lack of teeth, and the long, sticky, extensible tongue, possibly indicate not so much real relationship as similarity of adaptations to diets of termites (white ants) and other insects.

Three subfamilies of the recent Manidæ are currently recognized, of which two, the Smutsiinæ and the Uromaninæ, are African, and the third, the Maninæ, containing the most typical of the Pangolins, is Asiatic. The three subfamilies, taken together, contain but a half dozen genera. The Asiatic Pangolins are distinguished by having a single median row of scales from the nape to the end of the tail, in contrast to the sudden change to a double row in the tail in the case of the African Pangolins; and further, by the hinder part of the "breastbone" forking into two delicate branches that connect with the hindmost ribs. The Pangolins of Asia include three fairly well-marked genera, the True or Chinese Pangolin, *Manis*, the Malay Pangolin, *Paramanis*, and the Indian Pangolin, *Phatages*. The first has a small but distinct flap-like outer ear; the other two have only a thickened ridge to represent the outer ear. On the other hand, the Chinese and Malay Pangolins have each a distinct, non-scaly pad of skin beneath the tip of the tail, while the Indian Pangolin bears scales there.

Pangolins walk on the knuckles of their fore feet, with the sharp, powerful claws bent upward against the palms and wrists; their hind feet are set down flat. They have been known to bur-

row their way to the very center of the hardest termite nests, entering through one side and hollowing out the interior. Though so fond of termites for food, they are reported also to consume quantities of true stinging ants. Besides insects, they are supposed to swallow tiny pebbles. A Pangolin (*Phatages*) kept in captivity in Ceylon soon learned to take milk and even became reluctant to accept termites.

The sense of smell seems strongly developed. That of sight, on the contrary, is poor. The reduction of the external ear by no means implies poor hearing but may be correlated instead with the animal's burrowing habits.

A large fossil species of Pangolin discovered in Java was estimated to have reached a length of about 8 feet.

The Common or Chinese Pangolin, *Manis pentadactyla*, originally found in Formosa, occurs all across southern China to Hainan, Indo-China, Siam, Burma, and Assam.

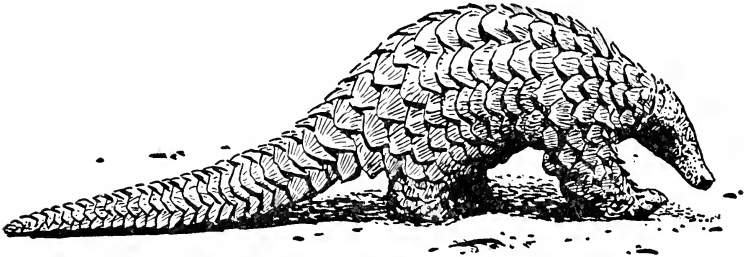


FIG. 23. Common Pangolin, *Manis pentadactyla*.

The color of the scales may be dark or light gray-brown, or somewhat the color of horn; the underparts of the body, not of the tail, clad with coarse thin hair instead of scales, are grayish white or brownish white. Typically there is a membranous pad beneath the very tip of the tail. The length of the head and body in Chinese specimens is usually from 18 to 20 inches, of the tail 10 to 13 inches, the hind foot $2\frac{3}{4}$ inches. A male specimen from the Chin Hills, Burma, had the corresponding dimensions 30

and 16 inches respectively, and weighed 17 pounds. The Pangolin of the mainland, *M. p. dalmanni*, is slightly smaller than either the Hainan Island race *pusilla* or the Formosan Pangolin.

One or sometimes two young ones are produced in the spring in a brood chamber at the bottom of a burrow from 8 to 12 feet in depth. The young ride on the back of the mother. Pangolins are good climbers as well as expert diggers, and ascend high trees in order to tear open the nests of arboreal termites. The only offensive action possible is rapid switching with the tail so that the sharp edges of the scales may wound an aggressor.

In Burma the natives believe it unlucky to meet a Pangolin; in China the scales of these mammals are valued for medicine.

The Malay Pangolin, *Paramanis javanica*, is distinguished from the Chinese Pangolin by development of a fairly prominent ridge representing the external ear, instead of the very slight ridge seen in *M. pentadactyla*. It resembles the Chinese species and differs from *Phatages* of the Indian peninsula and Ceylon, by having a non-scaly pad beneath the tip of the tail. The length of the head and body is 20 inches, tail 15½ inches, hind foot without the claws 3 inches.

The range extends through the Malay Peninsula to Sumatra, Java, Borneo, and Philippines; to the northeast it reaches northern Siam, Laos, Annam, and Cochin-China.

In the Malay Peninsula the Malay Pangolin is often found in open sandy country making large burrows (Ridley). Flower tells a Malay story to the effect that it lies on the ground and raises its scales. Ants, believing it dead, swarm over it, whereupon it snaps down its scales, runs to a pond and drowns the ants, afterward making a meal of them.

THE FLYING LEMURS (ORDER DERMOPTERA) (FAMILY CYNOCEPHALIDÆ)

This extraordinary type of gliding mammal is an example of a "living fossil." The Order Dermoptera contains but two



FIG. 24. Malay Flying Lemur, *Cynocephalus variegatus*.

species, *Cynocephalus variegatus* and the Philippine form, *philippinensis*, which belong to the single family, the Cynocephalidæ. Their relationship to other kinds of mammals undoubtedly harks back to the remote geological past.

The shapes of the skull and teeth are somewhat like those of certain lemurs, whence the expression "Flying Lemur." But by developing the parachutes connecting together its neck, sides, and tail, and even the tips of its fingers, this creature has departed far from the Order Primates, to which the lemurs belong. Probably the broad comb-like form of the lower front teeth (in the upper jaw there is only one tiny front tooth each side) also suggested a superficial likeness to real lemurs. The resemblance, however, is superficial, for the "comb" of the Flying Lemurs is really quite different, resulting from the subdivision of each single true tooth into as many as 12 comb-teeth. In a true lemur each comb-tooth is an actual tooth—a very different arrangement. Flying Lemurs are believed by some to be co-ancestral with the bats.

The Malay Flying Lemur, *Cynocephalus variegatus peninsulae*, is the mainland representative of this unique but variable species, which has received about a dozen subspecific names on the many East Indian islands upon which it occurs. The mainland form is found through the Malay Peninsula into lower Burma and east to Cochin-China.

The adult is variably mottled with shades of brown in males; females are gray, sometimes very pale gray. Widely spaced, small white spots are scattered over all the upper surface of the body except the shoulders and the membranes. The underside, colored a paler tone than the upper side, is unspotted.

In juveniles from Burma there is a distinct pattern of soft grays, browns, and blacks, which results in a close resemblance to the bark of certain trees. Pale areas, edged with black, extend from the cheeks onto the neck; a second pale area occupies approximately the position of each shoulder blade; a third runs from the thigh to the knee. The top of the head, the back, and

the rump are conspicuously tinted with soft pale gray. The fore-arms and the general area of each shoulder are dark gray mottled with brown and black. The lateral membranes are gray-brown and the tail membrane is light buffy gray lightly dotted with black. All in all, this animal, provided it keeps still, can be distinguished on the bark of a tree only with great difficulty. In nursing young the underparts are clothed with short thin soft fur, pale buff in color except under the chin, where the longer gray dorsal pelage encroaches from either side.

The ears of Flying Lemurs are short, rounded, and almost naked. In life they appear pinkish. The claws of the hands and feet are short, strongly curved, and very sharp. The eyes are large, hazel-colored, and rather prominent, as befits an almost wholly nocturnal animal. The anus lies at the inner end of a deep, pouch-like depression that can be almost closed if the tail is curved downward. There is a single pair of mammæ, one just behind each arm. One young one is born.

The Flying Lemur is unable to stand erect and so slow-moving as to be nearly helpless on the ground. It seeks to climb any object encountered. A captive specimen ate fruit and drank milk in preference to meat and insects. It made a soft rattling sound like a pencil point drawn sharply across the teeth of a comb, and when frightened, a hissing sound.

When in a resting position Flying Lemurs cling with their claws, head up, to vertical limbs or tree trunks, but quite as often they hang in a sloth-like attitude, with their hands and feet placed close together and wrapped around a branch. In that upside-down pose the head is tilted upward and forward to rest on the chest and the tail is curled inward over the abdomen.

THE LEMURS, MONKEYS AND APES (ORDER PRIMATES)

In the older natural histories it was usual to place the Primates first among the orders of mammals, partly in conformity

with the name, meaning "first," and partly to provide a satisfactory sense of eminence to Man, a member of the order. As research into comparative anatomy and comparative psychology uncovers more and more facts about them, the preeminence once given the Primates becomes more doubtful. In only one particular, admittedly a very important one, have the Primates surpassed the other progressive mammalian orders. That particular is the special development of parts of the brain and the ability (in man) to reason from cause to effect. In virtually all other ways, in acuteness of the senses, in physical endurance, in functional effectiveness, some of the Primates are easily surpassed by many other kinds of animals. Bearing this in mind, it is well for Man, The Primate, to conduct himself with reasonable humility toward other organisms.

The Primates include four primary groups of animals of very different levels of development and of very different numerical importance. The lowest in the scale of evolution, the Lemurs, are believed most nearly related to the Insectivora and to the Menotyphla, that branch of the Insectivora to which the tree-shrews and hedgehogs belong. That relationship, though exceedingly remote, appears to be fairly well established. The separation took place many millions of years ago, in the Mesozoic period, before the total extinction of the dinosaurs. Successive division of those dawn Primates gave rise to the chief groups of the order still living in the world today—to the Lemurs, the Marmosets, the Prehensile-tailed Monkeys of tropical America, the Old World Monkeys, and the Gibbons and Anthropoid Apes. The degree of evolutionary development of each is expressed by the succession above. Man is one of the Apes.

Broadly speaking, the Primates are animals of the tropics. A few enter the subtropics, chiefly by living at considerable heights up mountains within the tropical zones. The Macaque of Japan and the Snub-nosed Monkeys of China are at home in relatively cold climates. All three of the large anthropoids,

the Gorillas, Chimpanzees, and Orang-utans, prefer the warm tropics (the Mountain Gorilla lives fairly high on the mountains of central Africa). Man himself seems to have originated in the tropics and perhaps only entered the colder regions after learning to wear skins.

THE LEMURS (SUBORDER LEMUROIDEA)

This large group of primitive Primates, though found chiefly today in Africa and Madagascar, is represented in the Indo-Malay region by three genera, the Slender Lorises, the Slow Lorises, and the Tarsiers. The Lorises and the Tarsiers belong to distinct families. The Tarsiers, placed by some authorities with the monkey-like Primates instead of as usual with the Lemurs, are known nowhere on the continental mainland but are represented on the Sunda Islands and the Philippines by several forms.

THE LORISES (FAMILY LORISIDÆ)

This family includes the short-tailed Slow Lorises of Ceylon and India, the Slender Lorises of southeastern Asia, and the Pottos of Africa, members of the subfamily Lorisinæ; it also includes the long-tailed Bush-babies or Galagos, all African, of the subfamily Galaginæ. The Slender Lorises, genus *Loris*, are confined to Ceylon and India. Only the Slow Lorises are found in eastern Asia.

The Slow Lorises, *Nycticebus coucang*, are round-headed, virtually tailless Lemurs with the eyes large and placed close together, the ears so small as to be buried in the fur, the limbs short and the hands and feet adapted for grasping. Their movements are extremely slow and deliberate. The color, though variable, is generally silvery gray with a buffy wash. Dark

brown marks encircle the eyes and appear on the top of the head. The fur is very dense and soft. The length of the head and body varies from 12 to 15 inches.

Slow Lorises are nocturnal and arboreal, rarely descending to the ground. They feed on insects, fruit, and small birds

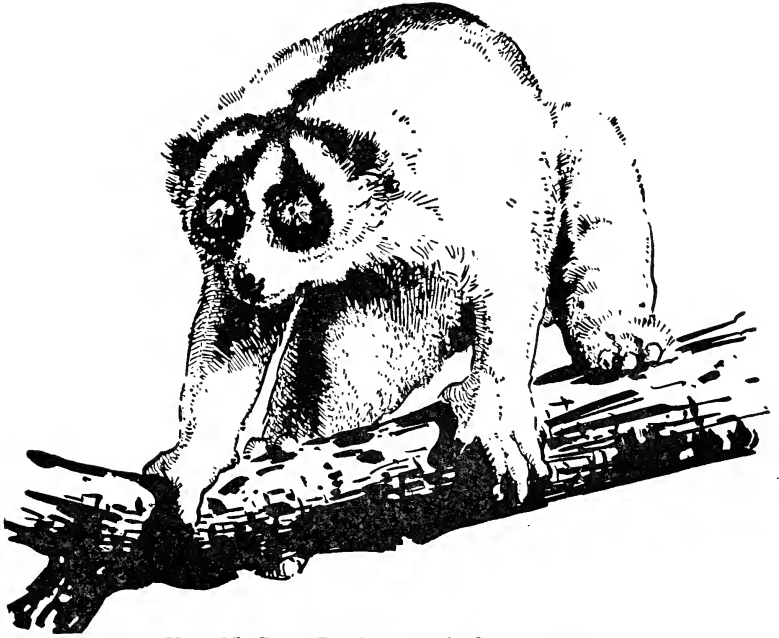


FIG. 25. Slow Loris, *Nycticebus coucang*.

(Flower). The young are carried under the mother's body, where they hold her fur by all four hands, until they almost equal her in size.

The homeland of the Slow Loris is the Malay Peninsula, whence it extends northward to Bengal, Burma, extreme southwest Yunnan, Siam, and Cochin-China. The form found in Bengal is distinguished as *N. c. bengalensis*, that in upper Burma, Laos, Annam, and Yunnan as *N. c. cinereus*.

The Pigmy Slow Loris, *Nycticebus c. pygmæus*, occurring in southern Annam, Laos, and Cochin-China (Saigon), is called by Osgood a "very distinct species. It is small, and rather uniformly colored."

THE OLD WORLD MONKEYS
(SUBORDER CERCOPITHECOIDEA)

Excluding the Lemurs, Gibbons, and Apes, the Primates of the Old World are all referable to one or the other of two families, the Leaf Monkeys and Langurs, Family Colobidæ, and the Macaques, Guenons, and Baboons, Family Cercopithecidæ. Both these families have wide geographical distribution; both are present in Asia and in Africa. Their distinction is not always easy. The colobids are, in general, neatly patterned and brightly-colored, long-tailed, short-faced, tree-living Monkeys, while the cercopithecids tend to have dull-hued pelage with areas of skin blue or red, shortened tails, and longish snouts, and some kinds at least affect rocky places either in the open or in forest. In addition, there are definite anatomical distinctions relating to dentition, limb proportions, the opposability of the great toe, and other structures.

THE LEAF MONKEYS, LANGURS, PIG-TAILED LANGURS
(FAMILY COLOBIDÆ)

The Monkeys of this family typically have long, straight tails (there are exceptions), the hind legs longer than the fore-legs, the face and nose short (except *Nasalis*), and no cheek pouches (in Langurs). The large stomachs, divided into compartments, are adapted to the digestion of their usual diet of leaves, young growing shoots, and fruits. The family is typified by the African genus *Colobus*, some species of which are resplendently patterned in black and white. Four of the eight

Asiatic genera are rather unspecialized, having long tails and unmodified noses; the other four have one or other of those organs modified.

The long-tailed unspecialized Langurs and Leaf Monkeys were once known under the collective name *Pithecus*, which although no longer permitted¹ still appears sometimes in print. It is customary to use the four names, *Semnopithecus*, the Indian Holy Monkeys and Purple-faced Langurs; *Trachypithecus*, the Capped Leaf Monkeys or Langurs; *Presbytis*, the Mitred Leaf Monkeys; and *Pygathrix*, the Doucs. These four names in the opinions of some authorities are of only subgeneric importance. But they serve to emphasize the fact that the unspecialized Asiatic Colobid Monkeys form four distinct groups, each having a characteristic type of juvenile coloration. The young of certain *Semnopithecus* of India, not treated now, are dark brown or blackish brown. Those of the other genera will be dealt with successively.

Most species of Langurs inhabit the tropical lowlands but a species has been observed among snow-blanketed fir trees of the Himalayas at 11,000 feet (Forbes). The Snub-nosed Monkeys, *Rhinopithecus*, also withstand extremely cold climates.

The Capped Leaf Monkeys, genus *Trachypithecus*, typified by the Negro Monkey of Java, *T. pyrrhus*, though they are distinguished from *Presbytis*, the Sureli Leaf Monkeys, only by average differences in the skulls, agree with one another in the color of the young, which is uniformly light brown or "golden red," with the tail dusky, in contrast to the black and white young of *Presbytis*.

This group, widely distributed in the Sunda Islands, is represented on the continent by *T. obscurus*, found in the Malay Peninsula, peninsular Siam, Tenasserim, and Cochin-China. Another species, *T. phayrei* of Arakan, reaches upper Burma, Yunnan, north Tenasserim, Siam, and Indo-China from Laos

¹ Opinion 114, The International Rules of Zoological Nomenclature.

to Annam. *Trachypithecus francoisi* occurs in Tonkin and Kwangsi; *T. laotum* in Laos; *T. poliocephalus* in northeast Tonkin; and *T. delacouri* in Annam. In the west of our area there is still another species, *Trachypithecus pileatus* with several races, found in Assam, the Chindwin area, and north and south of the Brahmaputra River.

The Bonneted Leaf Monkeys, *Trachypithecus pileatus*, are colored gray above, contrasting whitish or buffy below, with a dark dense matted cap of hairs on the head. The face is black, the whiskers whitish. A race with reddish underparts, *T. p. durga*, is found in Chittagong, northern Assam, and the Naga Hills. In the Chindwin basin the form *T. p. shorridgei* lacks the sharp contrast between dorsal and ventral color. Its whiskers do not contrast with the crown. The tail is much longer than in other species of *Trachypithecus*.

The length of head and body in *T. pileatus* is from 23 to 28 inches, of the tail from 35 to 41 inches, of the foot about $7\frac{1}{2}$ inches. In *T. p. shorridgei* the corresponding dimensions are 26 to $28\frac{1}{8}$ inches, 38 to 41 inches, $7\frac{1}{2}$ to 8 inches.

Phayre's Leaf Monkeys, *Trachypithecus phayrei*, found typically in Arakan, south of upper Burma, are blackish brown above, yellowish white below; these colors meet in sharp contrast along the flanks. The hands, forearms, and feet are dark brown. The areas around the eyelids and mouth are not dark-pigmented. The form found in Siam, *T. p. wroughtoni*, has the underparts pale gray instead of white. From the Shan States comes *T. p. shanicus*, which has a frontal hair whorl but no crest, and from northern Burma and southwest Yunnan Barbe's Langur, *T. p. barbei*, gray above, silvery beneath, with a buffy wash on the back and a fringe of long black hairs on the forehead.

The length of head and body in *T. p. argenteus* is from $19\frac{1}{2}$ to 23 inches, of the tail from 30 to 32 inches.



FIG. 26. Dusky Langur, *Trachypithecus obscurus*.

The Dusky or Spectacled Leaf Monkeys, *Trachypithecus obscurus* of the Malay Peninsula (up to 5000 feet), resemble *T. phayrei* by having circles of unpigmented skin around the eyelids and mouth. The color is dark gray. One race, *T. o. flavicauda*, found in peninsular Siam, has the tail washed with yellow. Other scarcely distinguishable races have been named. A race, *T. o. germani* of Siam, Annam, Cambodia, and Cochin-China, sometimes treated as a race of the Javan *T. pyrrhus*, has yellowish or silvery hairs on the temples, cheeks, and ears. The tail and forearms are dark. A still paler race is *argenteus*, the Silvery Langur of Laos, Annam, and Cochin-China. *Trachypithecus o. cristatus* from the Malay Peninsula likewise has been treated as a race of *T. pyrrhus*. It is dark gray, with the tips of the hairs touched with silvery gray. The limbs, back, and tail are darker. There is a crest.

The length of head and body in *T. o. germani* varies from 19½ to 23½ inches; in *T. o. cristatus* (Selangor) it is about 22 inches; in *T. o. obscurus*, from 18 to 27 inches; the length of the tail, respectively, is from 28½ to 33 inches, about 27 inches, and from 28 to 32 inches.

The Tonkin Langur or Leaf Monkey, *Trachypithecus francoisi*, is a blackish form with a white stripe running from the corner of the mouth to the ear. The hairs of the crest rise from two whorls. In *T. laotum* of Laos the white area includes the forehead, cheeks, and sides of the neck. In *T. poliocephalus* from northeast Tonkin the head and neck are buffy white. In *T. delacouri* of Annam the outer sides of the thighs are pure white.

The forms *francoisi* and *delacouri* have the length of head and body respectively about 25 and 23 inches, and the length of the tail 33 to 34 inches. The dimensions recorded for *laotum* and *poliocephalus* may be erroneous and are not here repeated. *Trachypithecus f. delacouri* is a strikingly colored Langur with a broad white area across the lower back and rump, a white

patch behind each ear, but the rest of the body and the limbs black.

The Mitred or Sureli Leaf Monkeys, genus *Presbytis*, with type species *P. aygula* of Java, are morphologically separable from the Monkeys of the genus *Trachypithecus* only by average characters of the skull. They agree with one another in the color pattern of the young—white, with a blackish cross-shaped pattern running from the back of the head to the end of the tail and to the elbows or beyond; or rarely the young are entirely white. The young are never orange-brown like the young of *Trachypithecus*.

The genus comprises mostly island species, including the Gray Leaf Monkey, *P. aygula*. But one species, *P. femoralis*, the Banded Leaf Monkey of Singapore, is present on the Malay Peninsula and extends north as *P. f. australis* and *P. f. siamensis* to Tenasserim. There are a number of races of *P. femoralis* in the Sunda Islands.

The Banded Leaf Monkey, *Presbytis femoralis*, is colored dark brown above, grayish white beneath. There is a well-marked stripe on the thigh. The hairs of the brows are pointed forward. A crest on the top of the head stands between a pair of hair whorls, and there is a thick posterior tuft. The ears and face are black, the chin and throat white. The typical form is from Singapore. The form *P. f. siamensis* of Selangor, Malay Peninsula, has the underparts white and a fleshy white area around the eyes and mouth; *P. f. keatii* of peninsular Siam has the underparts dark brown and a thigh stripe reaching the ankle. Occasionally whitish forms are found.

The length of head and body in adults of *P. f. keatii* is from 18 to 23 inches, of the tail from 29 to 33 inches.

The Doucs, genus *Pygathrix*, typified by *P. nemæa* of Cochin-China, are confined to the French Indo-Chinese side of the Burma-Indo-Chinese peninsula, to Laos, and the Island of Hainan. They are distinguished by the unusually great pro-

portional width of the posterior part of the palate. The young have a coat pattern of white and red with some gray. There are two races, the type and the Black-footed Douc, *P. nigripes*.

The Douc Langur, *Pygathrix nemæa*, can be recognized by the flesh-colored face, white forearms and black hands. The chin, throat, and cheeks are white. Across the hind throat is a broad band of reddish, adjoining a black collar that reaches the front of the shoulders. The body color is gray; the tail and inguinal regions are white, set off by black on the thighs and hind abdomen; the legs between knee and ankle are reddish. The length of the head and body is from 23 to 25 inches, of the tail from 20 to 22 inches.

This Monkey occurs in northern Cochin-China, central Annam, central Laos, and in the Island of Hainan.

The Black-footed Douc, *Pygathrix nemæa nigripes*, is darker than the last. The face and feet are blackish and the forearms gray. The leg between knee and ankle is black. The length of head and body is from 22 to 28 inches, of the tail from 28 to 30 inches.

The range includes southern Cochin-China, the delta areas of the Mekong River, and the extreme south of Annam.

The specialized Colobid Monkeys that have either shortened their tails or altered the shapes of their noses, or both, include the Pig-tailed Langur of Sumatra, *Simias*, the Snub-nosed Monkeys, including the Golden Monkey of China, *Rhinopithecus*, the Tonkin Snub-nosed Monkey, *Presbytiscus*, and the Proboscis Monkey, *Nasalis*, of Borneo. Of these only the continental *Presbytiscus* and *Rhinopithecus* need be considered.

The Snub-nosed Monkeys, genus *Rhinopithecus*, with type *R. roxellana*, contain three widely separated species in China. Though related to the Langurs by the lack of cheek pouches and large sacculated stomach, these Monkeys are distinguished by the peculiarly up-turned and prominent nose and the proportions of the thickish limbs: the upper arm is longer than the forearm.

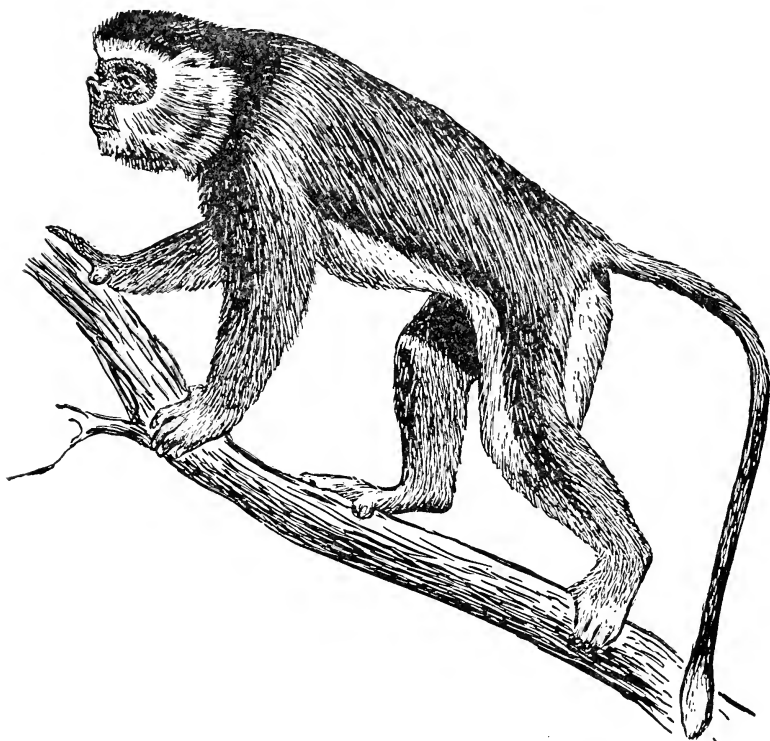


FIG. 27. Snub-nosed Langur, *Rhinopithecus roxellanae*, female.

The body is thick-set and the tail may be either rather short (*R. roxellanae* and *R. bieti*) or very long (*R. brelichi*).

The Orange Snub-nosed Monkey, *Rhinopithecus roxellanae*, has strikingly colored males. In life the face and nose are blue, the eyes brown. The neck and back, the top of the head, and the tail are grayish black, overlaid with long silvery hairs. The underparts, the forehead, ears, sides of head and neck, limbs, hand, and feet are reddish golden. In females the outer sides of the limbs are brownish black and the thighs and anal region are whitish. The newly born young are light buff in color.

The length of head and body in a male is 2 feet 5 inches, of

the tail 2 feet. This Monkey lives in cold parts of Szechwan and Kansu in pine woods between 7000 and 10,000 feet above sea-level.

The Golden Monkey or Yunnan Snub-nosed Monkey, *R. bieti*, differs from *R. roxellanae* by having the back light brown instead of blackish and the rear of the haunches white (as in females of *roxellanae*). The head is crested, with blackish hairs projecting over the brows. The upper surface, limbs, hands, feet, and tail are black. Very young animals are white, with black on the head, back, and outer sides of limbs. This pattern is reminiscent of the juvenile pattern of *Presbytis*. The length of the head and body in males is 33 inches, of the tail 27 to 29 inches. Females are a few inches smaller.

The Golden Monkey is found in the region where Burma, Yunnan, and Hsi-Kiang meet.

Brelich's Snub-nosed Monkey, *R. brelichi*, the largest of the Snub-nosed Monkeys, is slate-gray on the back, with a patch of white at the midline between the shoulders. The crown of the head and the cheeks are washed with yellowish and black. The ears are white. The underparts are gray. The limbs are gray, becoming blackish in front, yellowish behind. The hands and feet (missing in the type skin) are probably black. The tail, very long, is black with the tip white. A yellow patch is seen on each side of the base of the tail. The length of the head and body is about 29 inches, of the tail 39 inches.

This Monkey is found south of the Yangtse River in the high country marking the boundary between Szechwan and Kweichow.

The Tonkin Snub-nosed Monkey, *Presbytiscus avunculus*, is distinguished perhaps only subgenerically from other Snub-nosed Monkeys by the proportions of the hands and feet; the fingers and toes are unusually long, the palms and soles exceptionally short. The back and limbs are black, the underside yellowish buff. The forehead and cheeks are creamy, sides of the

neck orange-buff, and the ears creamy white. A buffy white patch shows on the rump on either side of the tail; light-colored marks appear on the backs of the thighs. The hands and feet are black, the inner sides of the limbs buffy to the wrists and ankles, and the long tail is mixed black and buff with the tip white or buffy white.

The length of the head and body is 21 inches, of the tail 25 inches, the hind foot $6\frac{1}{2}$ inches.

Found in rocky forest near the Song-Koi River, Tonkin.

THE MACAQUES (FAMILY CERCOPITHECIDÆ)

This family of Monkeys goes in extensively for taillessness. In addition, large cheek pouches used for food storage are often developed, and the snout tends to become elongated. The Guenons and Baboons of Africa are members of the family. In *Macaca*, depending upon the species, the tail may be slightly or much abbreviated. The Stump-tailed Macaques, *Lyssodes*, and the Celebes "Ape," *Cynopithecus*, are members of the same family.

There are four principal types of Macaques: the Long-tailed Macaque, the Rhesus Macaque, the Pig-tailed and Stump-tailed Macaques. The first three are commonly treated as subdivisions of the genus *Macaca*; the last, partly because of the extreme degree of atrophy of the tail and partly because of special characters of the male sexual organs, is segregated as a distinct genus, *Lyssodes*.

The Asiatic Macaques, genus *Macaca*, have heavier, more compactly formed bodies than the slender-bodied Langurs. Males are much larger than females. Large horny pads are developed where the animals sit down. The muzzle is protruding and dog-like, but the nose does not extend as far forward as the protrusible lips. The nostrils open obliquely outward and downward. The eyes, placed close together, look out from be-

neath heavy brow ridges. There are large canine teeth, and capacious cheek pouches accommodate excess food. The period of gestation is about 7 months. Usually only 1 young is born. The type species of *Macaca* is the Gibraltar Monkey or Barbary Ape, *Macaca inuus*, a species with rudimentary tail.

The Long-tailed or Crab-eating Macaques, comprising *Macaca irus* and its related races, most of which are island forms, may be considered comparatively unspecialized. The color of the upper parts is greenish olive, varying to reddish brown, sometimes brownish on the head and dorsal line; the underparts are grayish white. The arms and legs become olive-gray and terminate in brownish black hands and feet. The tail at the base is like the body, toward the end smoky gray, beneath whitish. The face is brown; white skin shows around the eyes, the lids are bluish white, and the ears black. The bare posterior callosities are flesh-colored. The length of the head and body is 18 to 22 inches, of the tail 26 inches, of the foot $5\frac{1}{4}$ inches.

These Monkeys are found from Burma and Assam through Tenasserim to the Malay Peninsula. A related Macaque, *M. capitalis* of lower Siam, has gray hands and feet, the top of the head yellowish brown. Osgood records *M. irus* from Saigon.

Like most Macaques, this species is gregarious, occurring in troupes of fifteen or twenty individuals of both sexes and all ages. It prefers mangrove swamps and forests near the mouths of rivers and will wade about in the mud picking up crabs and shrimps. It swims well.

The Rhesus Macaques, *Macaca mulata* of Burma and Assam, have the tail shorter than the Long-tailed Macaques but longer than the Pig-tailed Macaques. The length of the tail is about half of the length of the head and body.

Macaca mulata has the head and anterior part of the back grayish buff, turning to reddish gray on the rump, thighs, and the tail brown. The limbs are gray with a buff wash, the under-



FIG. 28. Rhesus Macaque, *Macaca mulata*.

parts whitish. The face and ears are flesh-colored, and the callosities red. The length of the head and body is about 2 feet, of the tail 13 inches, of the foot $5\frac{3}{4}$ inches.

The type region of the Rhesus Monkey was fixed by Pocock in 1932 as the Nepal Terai, northern India. The Rhesus, reaching an altitude of 10,000 feet in Kashmir, extends eastward through Assam, Burma, Siam, Laos, Annam, Tonkin, China, to Fukien and Formosa. The form found in Szechwan at 13,000 feet is named *lasiotis* (hairy-eared). Other forms, *M. m. siamica* of Siam, and the larger *M. assamensis* of Assam and Yunnan, with the fur nearly uniform brown, have been recognized, as well as the shorter-tailed (9 inches) *coolidgei* from northern Annam. Both of the latter occur between 3000 and 6000 feet above sea-level.

The doubtfully valid form on Hainan Island, *M. brevicaudatus*, has the tail somewhat shorter than the Rhesus and is more reddish. The Formosan Rhesus, *M. cyclopsis*, which lives in rocky places, is colored olive-brown, the feet and hands grayish, the top of the tail nearly black above. Its head and body measure from 15 to 16 inches, its tail 13 to 18 inches, its foot 5 to 6 inches. Macaques occur in the mountains of Tchili and in Hopei.

Rhesus Monkeys in the wild live in large groups. They are good swimmers, noisy, and pugnacious. Near Simla, India, they do considerable damage to gardens.

The Pig-tailed Macaques, *Macaca nemestrina*, have the tail slender, about one-third the length of the body, and carried erect. The face, ears, and callosities are bare. The pelage is brownish black all along the back and to the tip of the tail. The neck and the back of the head are mixed red and black; the crown of the head is black but its sides are reddish buff. The underparts are yellowish or grayish white. The arms and legs, hands and feet, and the underside of the tail are reddish yellow. The young are more brightly colored than the adults.

The Pig-tailed Macaque, native of Sumatra and ranging into India and China, is represented on the Malay Peninsula as far north as Tenasserim by the form *M. adusta*, which has the back and shoulders blackish red, the tail dark, the limbs drabby gray.

The length of the head and body in the mainland race, *adusta*, is from 20 to 21 inches, of the tail from 7 to 9 inches, of the foot from 6 to 7 inches.

These animals live gregariously in dense lowland forests. They feed on fruits, seeds, and insects.

The Stump-tailed Macaques, genus *Lyssodes* which includes the Japanese Macaque, are set off from the Long-tailed and Short-tailed Macaques of Asia by having virtually no external tail. The type species is *L. speciosa*.

The Brown Stump-tailed Macaque, *Lyssodes speciosa*, is dark brown, the back blackish brown, the limbs, hands, and feet reddish brown, and the underparts yellowish white. The skin of the face is red. The length of the head and body is about 30 inches; the tail is virtually obsolete. *Lyssodes speciosa* occurs in northern Assam, northern Burma, Yunnan, Tonkin, Annam, Cochin-China (Elliot), and Borneo.

From time to time stories emerge from Burma of large "apes" being seen in the forest. True Apes are not known from nearer than Sumatra, and the long-armed Gibbons would be recognized as such. It seems likely that the "apes" seen were merely large specimens of Stump-tailed Macaques.

In Cambodia and Siam the representative of this group, *Lyssodes harmandi*, has the back, shoulders, arms to the elbows, and sides black. The head, rump, limbs, hands, and feet are "reddish chocolate," the underparts "reddish brown." In Tenasserim a strongly rufescent form, *L. rufescens*, measures about 18 inches. The tail is 1 inch long. In Tibet and Szechwan the local form is *Lyssodes s. thibetanus*, and in Kwangtung and Fukien *L. s. melli*.

The Japanese Stump-tailed Macaque, *Lyssodes fuscata*, has long, dense fur, as befits a Macaque dwelling in fairly temperate latitudes. The color is blackish brown with a trace of yellowish due to banding of the individual hairs with buff. There is a blackish area across the forehead. The bare face is red, whitish in the young. There are long whiskers and a beard. The hands and feet are blackish, the limbs gray. The very short tail is gray-black with a tinge of reddish. The females are generally

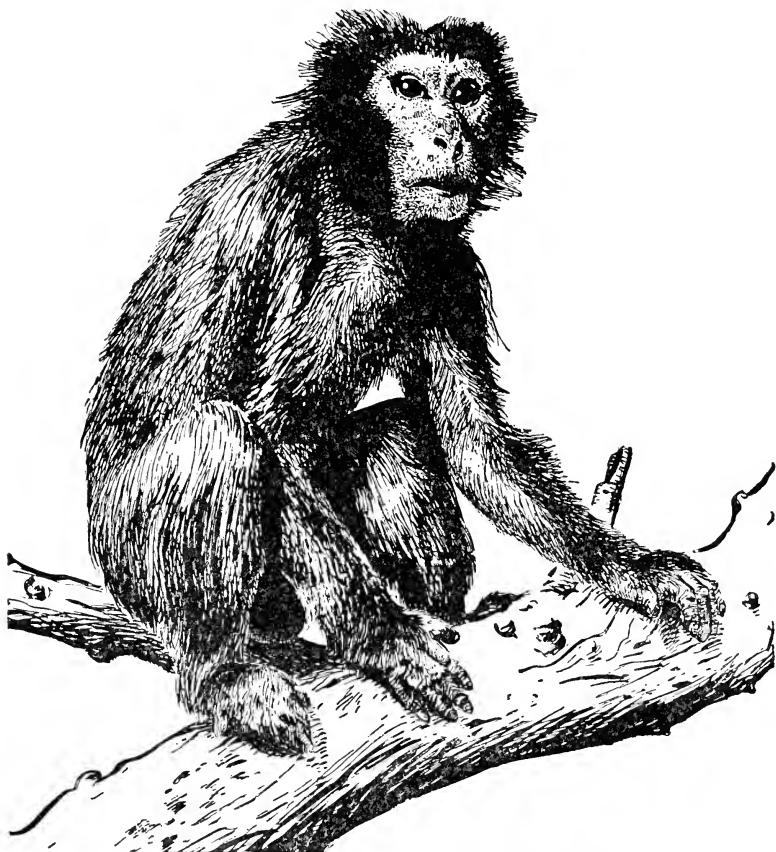


FIG. 29. Japanese Macaque, *Lyssodes fuscata*.

paler. The length of the head and body is 28 inches (less in females), foot about $5\frac{1}{2}$ inches. This Macaque is found in Yakushima, Japan, north to lat. N. 41° .

THE MAN-LIKE APES (SUBORDER ANTHROPOIDEA)

The man-like Primates comprise the Gorillas, Chimpanzees, and Orang-outans or "Great Apes," and the peculiarly long-armed Gibbons.

All are tailless, long-armed brachiating (able to swing by their arms) animals. They have no cheek pouches. The stomach is simple, not complicated as in the Langurs. Some anthropoids at least have the ability to construct sleeping platforms and exhibit a relatively high degree of intelligence.

None of the Great Apes lives today on the mainland of Asia, although in Pleistocene time large Apes existed in northern India, and the Orang-outan is still found in Sumatra and Borneo. On the other hand, southeastern Asia is the headquarters of the Gibbon family.

THE GIBBONS (FAMILY HYLOBATIDÆ)

Here is contained the single genus *Hylobates* (meaning "tree-walker"), in which the arms are proportionately greatly lengthened. The hands are longer than the feet; the forearm is longer than the upper arm; the body is relatively light and the hind limbs are short. Swinging by the arms is brought to a high degree of perfection, for the animals swing themselves across wide gaps among the branches of trees and seldom descend to the ground. On the occasions when Gibbons do descend, they are able to run quite swiftly on their hind legs, with the arms held up out of the way. They possess small hard pads of naked skin to sit upon, like the Monkeys and Baboons, but lack cheek pouches. Their voices are extraordinarily powerful.

The type species of the genus is the White-handed Gibbon, *Hylobates lar*.

At least four species of Gibbons exist on the continental mainland of Asia, and the Sunda Islands Gibbon, *H. moloch*, on Java and Borneo. The mainland species are the Siamang, *H. syndactylus*, the White-handed Gibbon, *H. lar*, the Hoolock Gibbon, *H. hoolock*, and the Black or Crested Gibbon, *H. concolor*. In addition, *H. agilis* may be separated from *H. lar* as a full species.

The Siamang, *Hylobates syndactylus*, is distinguished from all other Gibbons by the fact that the second and third toes are contained in a common web of skin. There is an inflatable sac in the throat. The head is uncrested. The color of this Gibbon is black, unrelieved by any white on the brows. The length of the head and body is about 3 feet; the span across the arms about 5 feet.

The Siamang occurs in Tenasserim and the Malay Peninsula between 2000 and 6000 feet, and on Sumatra. The form in Sumatra is typical, the peninsular race being distinguished as *H. s. continentis*.

The Black, Crested, or Indo-Chinese Gibbons, *Hylobates concolor*, are sharply set apart from all other Gibbons by possession of an erect mat of hairs or crest on the head and by the extremely long clitoris of the female sexual organs, a condition analogous to that in the Spider Monkeys of tropical America.

As in *H. syndactylus*, there is no white band of hairs across the brows. The female has a patch of dusky on the crown of the head. Baby Crested Gibbons of both sexes are pale yellowish gray. Males become and remain black; females turn very dark and then lighten to buff or grayish buff. In the typical race found on Hainan Island and the hilly parts of Tonkin and northern Annam, the males are wholly black, the females pale gray. Related races are found in Indo-China, and the Crested

Gibbon may eventually be discovered near the south coast of China. The length of the head and body is about 20 inches, of the foot 6 inches (Osgood).

The White-cheeked Crested Gibbon, *H. c. leucogenys* of Laos and Siam, considered by Pocock equal to the Hainan form, has the cheeks and throat buffy white instead of black. Females are golden buff.

Gabriella's Crested Gibbon, *H. c. gabriellæ* of southern Annam and southern Laos, also has the cheeks and throat contrastingly colored, but reddish buff in place of the buffy white in *leucogenys*.

In the remaining species of Gibbons a white line on the brows is present and the body and limbs are only occasionally black in males of the form *H. lar pileatus*.

The White-handed Gibbon, *Hylobates lar*, is usually brown, sometimes blackish brown, rarely buffy brown. The hands and feet are whitish buff to above the wrists and ankles. A whitish ring surrounding the reddish brown face may be expanded onto the cheeks and throat. The females are often pale buffy. This is a small Gibbon, the length of the head and body varying from 20 to 22½ inches, the foot from 5¼ to 6 inches. The typical White-handed Gibbon is found up to 3500 feet in the lower part of the Malay Peninsula, lower Burma, and Arakan, but the total range of *H. lar*, including its other subspecies, extends to Siam and Cochin-China.

Several geographical races of the White-handed Gibbon are recognized: *H. l. entelloides* from Tenasserim has the white of the brow, face, and hands reduced in extent. *H. l. pileatus* of Siam, Cambodia, and Cochin-China has a distinct blackish cap on the head surrounded by a grayish band. Much of the coat in males may be quite black, and the pale areas of the face and extremities may be shaded. A race, *H. l. albimanus*, occurs on Sumatra.

In continental Malaysia there are two more types of Gibbons,

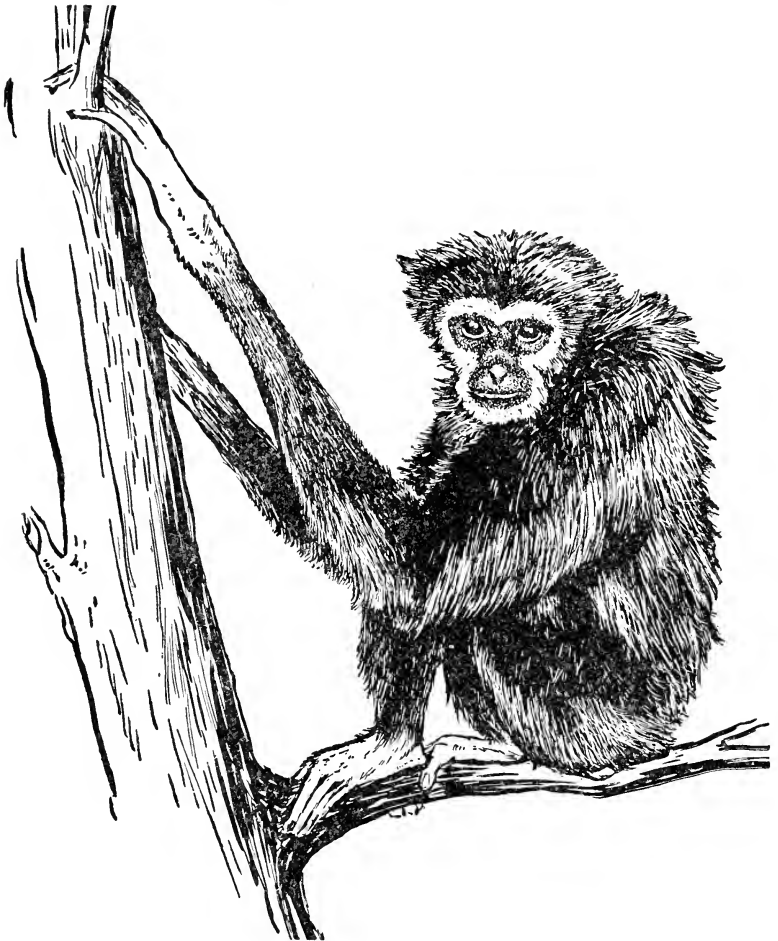


FIG. 30. White-handed Gibbon, *Hylobates lar*.

neither of which has differentially colored hands and feet. These are the Agile and Hoolock Gibbons. The former is a smallish Gibbon believed by Pocock to be closely related to *H. lar*, the White-handed Gibbon; the latter is a large species standing apart by itself.

The Agile Gibbons, *Hylobates agilis*, which appear in two sometimes intergrading color phases—blackish brown and buffy brown—are the only members of the genus in which the set of the hair of the forearm lies from the elbow toward the wrist. In the dark-colored phase the rump area is conspicuously paler; in the pale phase the underparts may be darker brown than the back. In both phases the white brow band is well defined, the whiskers white, and the throat buffy. The face is black. There is no dark cap as in *H. lar entelloides*. The Agile Gibbons are rather smaller than the White-handed; the length of head and body $18\frac{1}{2}$ to $19\frac{1}{2}$ inches, of the foot 5 to $5\frac{1}{2}$ inches. The range includes the lower Malay Peninsula and Sumatra.

The Hoolock Gibbon, *Hylobates hoolock*, like the Agile Gibbon, displays two color phases, which, however, seem not to intergrade. In the dark phase the color varies from brownish black to black and the underparts are very dark brown. In the pale phase the upper parts vary from yellowish to reddish buff, clouded with brown on the flanks and limbs. The tips of the fingers are usually blackish. The brown undersurface is always darker than the upper surface. In the dark phase the whitish brow band, sometimes interrupted at the center, is present. The cheeks, chin, or even the whole face may be whitish. The pale phase has the brow area and a ring around the eye pale, but the cheeks often very dark. In females the color is whitish, tinged with brown; the chin, chest, hands, and feet are white. The length of the head and body varies from 23 to 25 inches, that of the hind foot is about 6 inches. The species, originally from the Garo Hills, is found up to 4000 feet through Assam, the northern part of Burma, the Shan States, and southern Yunnan.

The Hoolocks are great vocalizers. In the Burmese jungles in the early morning they can be heard calling and answering with their intensely resonant and penetrating "Whoko! Whoko!" They are likely to be found on steep, heavily forested hillsides, where difficulty of approach combined with the keenness of

sight and hearing possessed by these Gibbons keep them relatively safe. The food consists of leaves, insects, eggs, birds, and especially spiders.

THE FLESH-EATERS (ORDER CARNIVORA)

Most of the members of this order have keen senses of sight, smell, and hearing. They show adaptations for the two inter-related functions, catching and killing living prey, and eating meat. To accomplish the first, the carnivores have usually strong claws and heavy canine teeth, combined with great agility, strength, and endurance. To carve up the bodies of their victims they are equipped with powerful jaws and a combination of shearing and crushing teeth that can slice through tendons and break bones.

This basic equipment of the carnivores, though widely prevalent, is not always retained. In a few instances secondary changes suited to a mixed or even vegetarian or insect diet are seen. The Bears, which live largely upon fish, grubs, and berries, are no longer very agile; their claws though enormous are not sharp; their cheek teeth have been converted almost wholly to crushing organs. To some extent the Badgers have pursued a similar course. The Hyænas have given up the aggressive pursuit of live prey and have become carrion-eaters. In conformity with this way of life, their molar teeth and jaws and even their heads have been enlarged, enabling them to crush the big bones of dead animals much larger than themselves. The Aard-wolf of South Africa, a relative of the Hyænas, has taken a different course and become addicted to digging out and eating termites or white ants, with an occasional supplement of other insects, lizards, or carrion. The teeth of these animals have become the merest travesties of the characteristic carnivore teeth.

Another curious fact about the teeth of the carnivores is the identity of the two great shearing cheek teeth used to cut

through gristle and tendons. The lower one of these teeth is the first lower molar, a permanent tooth; its functional upper counterpart is not the first upper molar as one might expect, but the fourth premolar, a tooth that at the end of puppyhood, kittenhood, or cubhood replaces the temporary or "milk" fourth premolar. These two "sectorial" teeth at their fullest development each bear a large, blade-like cusp. The edges of these cusps work together like the blades of scissors.

Among the more highly predaceous members of the order, such as the Cats and Dogs, the whiskers on either side of the muzzle are strongly developed. Predaciousness manifests itself in the Cats by the stealthy approach and the sudden spring, in the Dogs by ability to run down the victim. The feet of the Cats are soft, cushioned, and armed with sharp retractable claws, while those of Dogs are hard and tough, with a tendency toward reduction of the outer and inner toes; the first (innermost) toe may be absent. In both of these types of carnivores the hind part of the foot is furry and kept well above the ground in walking. In the slower-moving Bears all five toes are retained and in walking the entire foot to the heel is often placed on the ground.

The Carnivora are divided into two primary divisions, the recognition of which, though not at all obvious, is based upon fundamental differences of anatomy, particularly the conditions of the ethmoturbinal bones of the inside of the nose and the structure of the resonating chamber of the ear. The first group, the Arctoidea, from the Greek word meaning "bear," contains the Dog family, Canidæ, the Bear family, Ursidæ, the Greater and Lesser Pandas, placed in separate families by themselves, and the Weasels, Badgers, and Otters, Mustelidæ. The American Raccoons, Procyonidæ, belong also in this latter division.

The second group, the Aeluroidea, from the Greek word meaning "cat," includes the Cat family, Felidæ, the Hyænas, Hyænidæ, the Civets, Viverridæ, and the Mongooses, Herpestidæ.

SUBORDER ARCTOIDEA (CANOIDEA SIMPSON)
THE WEASELS, WOLVERINES, BADGERS, OTTERS
(FAMILY MUSTELIDÆ)

This is a widely diversified family of small to moderate-sized carnivores, for which inclusive characteristics are hard to find. The legs are often very short; the feet have five toes, all reaching the ground. The face is generally quite short, while the braincase is proportionately long. There is only one upper molar on each side. The mustelids are neither cat-like, dog-like, bear-like, nor civet-like.

This family, which is represented in every large land mass in the world except Australia and New Guinea, in the Orient comprises three major divisions: running and climbing types, Weasels, Martens, Wolverines; digging types with large claws, Badgers, Honey Badgers, and Ferret Badgers; and partly web-footed swimming types, Otters. The Skunks of America are also members of the family. In practice the Weasels, Martens, and Wolverines are each put in a separate subfamily, as are the Badgers, Honey Badgers, and Sun Badgers. But the distinctions in some instances are not very clear.

THE WOLVERINES (SUBFAMILY GULONINÆ)

Here belongs only the genus *Gulo*, a large, long-legged member of the Weasel family which bears a very dense pelage and lives in the north temperate and subpolar regions of Eurasia and America. The typical species is *Gulo gulo*. Genera also belonging to the Guloninæ are found in South America.

The Wolverines are stout, almost bear-like animals with bushy tails, hairy soles, short ears, and four premolars each side, above and below. The color of *G. gulo* is dark brown, paler and grayer on the crown and cheeks. A band of buffy brown in the Siberian form begins on each shoulder, passes backward

along the sides and across the rump to meet the one of the opposite side in front of the base of the tail. There are whitish marks on the throat and chest. The species is circumpolar. In eastern Asia it occurs from near the Arctic Ocean (e.g., the Kolyma River), south to Lake Baikal, northern Manchuria, and almost to Vladivostok. It is found in the northern half of Sakhalin Island and the eastern side of Kamchatka, but is said not quite to reach the east cape of Siberia. The average length of head and body in males is about 3 feet 5 inches (in females 3 feet 1 inch), of the tail from 7 to 8 inches, hind foot 7 to 8 inches. The height at the shoulder is 1 foot.

MARTENS AND SABLE (SUBFAMILY MARTINÆ)

From the Weasel subfamily, which they resemble very closely, the Martens are distinguished by having 4 premolars instead of 3, and, in general, by their somewhat larger size and less shortened legs. The feet are furred beneath. Only the genera *Martes* and *Charronia* are contained here.

The True Martens, genus *Martes*, of eastern Asia have well-developed ears and are about the size of a small Cat. The color is rather uniformly brownish with the underhair paler. There is a distinct vertical groove dividing the center of the upper lip. The typical species is the Pine Marten of Europe, *Martes martes*. In America this genus is represented by the Fisher and the American Marten.

The Beech or Stone Marten, *Martes foina*, of central and southern Europe, is distinguished from *M. martes* by its coarser slaty fur, longer tail, and whitish; instead of yellow, throat patch, as well as certain characters of the teeth. Its eastward range is much greater; it occurs in the evergreen forests of Mongolia, and in Chihli and Shansi, China. The length of the head and body is about 18 inches, of the tail 10½ inches, hind foot 3½ inches.

The Sables, *Martes zibellina*, are brown, with the foreneck and throat colored like the body; the throat patch varies from dusky to salmon; the underfur is pale brown. The tail is proportionately shorter than that of *M. foina*. The Sable ranges across northern Asia from the Ural Mountains to Ussuri and the shore of the Okhotsk Sea. Its southern limit is marked at lat. N. 45°, about opposite Yezo Island in Japan. It occurs on Sakhalin. It is also found in the Kamchatka Peninsula and the adjoining parts of the continent north of it.

The typical Sable is from European Russia. Several eastern races have been distinguished: *M. z. sajanensis* from the Sajansk Mountains area, *M. z. yeniseensis* from the basin of the Yenisei River, *M. z. princeps* from around Bargusin, east of Lake Baikal, *M. z. kamtschadalis* from Kamchatka, and *M. z. sahalinensis* from Sakhalin.

The length of the head and body in the Siberian Sable is 14 to 16 inches, of the tail 5 to 5½ inches; of the hind foot, without the claws, 3 to 3½ inches. In the Kamchatka Sable, the equivalent measurements are rather more, 19 to 20 inches, 5 to 7 inches, 3 to 4 inches (Ognev).

The Yellow-throated Martens, genus *Charronia* (= *Lamprogale*) are larger than *Martes* and strikingly colored with yellow and black. The upper lip lacks the vertical groove at the middle, seen in *Martes*. The body is long and heavy, the tail cylindrical, the legs rather short. There is virtually only one species, *C. flavigula*, although the representative of the genus in southern India, *gwatkinsii*, is sometimes treated as a second species. *Charronia flavigula* becomes fully as large as a Cat. The color, though variable, is normally brown, darkening to blackish brown of the lower back and tail. The throat is orange. The length of the head and body is from 1 foot 10 inches to 2 feet, of the tail from 15 to 17 inches, hind foot 3½ to 4½ inches. Females are smaller.

The typical race of the Yellow-throated Marten occurs from

Kashmir to Assam, upper Burma and into China, where it extends through Szechwan and Yunnan into Fukien and Formosa. In specimens from Indo-China and the Malay Peninsula the hind foot is naked above the plantar pad. Specimens from Indo-China, Annam, and Siam, with the head black, the shoul-

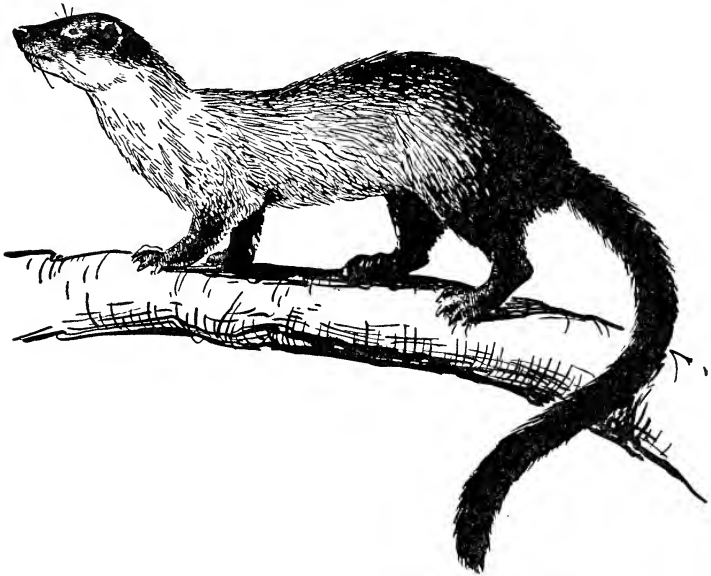


FIG. 31. Yellow-throated Marten, *Charronia flavigula*.

ders yellowish, and the abdomen pale, are *C. f. indochinensis*. Those with the head brown and the nape, back, and abdomen brown, coming from Tenasserim and the Malay Peninsula, are named *C. f. peninsularis*. The form found on Formosa, named *C. f. chrysospila*, was said to have the head blackish brown. It may be identical to the Fukien animal. Northern races occur, *C. f. borealis* in Manchuria, *C. f. koreana* in Korea.

The Polecats, subgenus *Putorius*, although placed nearer to the Weasels, are superficially somewhat similar to the Martens.

The size is large, and the long pelage is filled with scattered dark guard hairs; the underfur is pale as in some specimens of *Martes martes*. However, the ears are low and small as in the Weasels, and the number of upper premolars is two, instead of the three found in the Martens.

There are three species: *M. putorius*, the European Polecat (the type), *M. evermanni* of Asia, and *M. nigripes* of America.

The Masked Polecat, *Mustela (Putorius) evermanni*, originally found in western Siberia, occurs as slightly variant races, *M. e. tiarata* in Mongolia, Tibet, Shansi, and Szechwan, *M. e. larvata* in the Himalayas, and *M. e. talassicus* in eastern Siberia.

The Chinese animals have the terminal third of the tail, the throat, chest, fore and hind legs, and underparts blackish brown. The sides of the belly are buff. In the winter the top of the head and the sides of the face become whitish instead of brown. The head and body measures 15 to 16 inches, the tail 6 to 6½ inches, the hind foot 2½ in females to nearly 4 inches in males.

The True Weasels, genus *Mustela*, are small to very small carnivores with very long bodies and short legs. Some have quite long tails, others very short ones. The Polecats, *Putorius* (see above), excluded provisionally from *Mustela*, appear more like Martens than Weasels.

The typical species of Weasel is the Ermine, *M. erminea*, a member of one of the long-tailed groups. Other quite distinct species include *M. sibirica* and *M. altaica*, both long-tailed and fairly closely allied to *M. erminea*, the Minks, *M. vison* (not found in northern Asia), and the extremely short-tailed Least Weasels, *M. rixosa*, and Snow Weasels, *M. nivalis*. Although several long-tailed Weasels are known in the Asiatic tropics, the short-tailed Weasels are confined to the northern areas of Asia.

LONG-TAILED WEASELS

The Ermines or Stoats, *M. erminea*, of Europe are represented in eastern Asia by *M. E. mongolica*, the Mongolian

Ermine, found in Altai, Mongolia, northern China, and Amurland, *mekanii* from eastern Siberia, and *medigna* from Kamchatka.

In the Ermines the brown dorsal and pale ventral colors are always sharply delineated. The tip of the tail is black and the feet are brown. In winter all the pelage turns white except the black tip of the tail. The Ermines, together with the Yellow Weasel and Siberian Weasel or Kolinski, have been separated under the term *Kolonocus*. But since *erminea* is the type of *Mustela*, it follows that the latter must be used subgenerically as well as generically for the Ermines.

The Yellow Weasel or Kolinski, *M. sibirica*, is colored pale brown on the back, changing gradually to a paler, yellowish brown below. The tip of the tail is not black but may be a darker shade of brown than the rest. According to Ognev's distribution map, this species is found throughout eastern Asia, as far north as the north coast of the Sea of Okhotsk, and according to Allen, it extends as far to the south as Kwangtung in China. Westward in the south it stops at the edge of Tibet and the Gobi Desert; but north of the Gobi it reaches west to eastern European Russia. In Korea its representative race is *M. s. coreana*. In north China it is represented by the race *M. s. fontanieri*, and in southeast China by the race *M. s. davidiana*. In Formosa the form *M. s. taiwana* is blackish brown in the summer, paler in the winter. It is a mountain form. Kuroda gives the dimensions of the Formosan Weasel: length of head and body 10 to 13½ inches, tail 6 to 8½ inches, foot 2 to 2⅔ inches.

The Asiatic Alpine Weasels, *Mustela altaica*, belong with those Long-tailed Weasels which have the brown upper and paler under colors sharply separated. The tail has no black tip and is at least three times as long as the hind foot. The range extends from the Altai region east to Mongolia and the Khingan Mountains. A southern offshoot of this Weasel, *M. a. kathiah*, distinguished by its dark instead of whitish toes, is found along

the Himalayas and through Tonkin, Laos, and Yunnan to Fukien, where the local race has been named *auriventer*. The length of the head and body of the southern race is $6\frac{1}{2}$ to 7 inches, tail $5\frac{1}{2}$ to $6\frac{1}{2}$ inches, hind foot $1\frac{1}{4}$ to $1\frac{1}{2}$ inches. The same set of dimensions in the Altai race is somewhat greater.

The Tonkin Weasel, *M. tonkinensis*, related to the last, has been found recently among the mountains of northern Tonkin. The throat and chest are pure white and there are small white marks between the eyes and ears and on the back between the shoulders. This form may possibly grade into *M. strigidorsum*.

The Striped-backed Weasel, *Mustela strigidorsum*, is reddish brown with yellowish underparts. A narrow, clearly defined white line runs the length of the back. The tail is not tipped with black. Length of head and body 11 to 12 inches, tail 4 to 5 inches. First described from Sikkim, this Weasel has later been recorded from the Naga Hills, Arakan, and Laos.

The Malay or Bare-footed Weasel, *Mustela nudipes*, is a medium-sized species colored pale brown above and beneath, the greater part of its head, as well as sometimes its neck and throat, and the tip of its tail pale yellowish white. The hair of the tail is full like that of a mink. There may be indications of a pale dorsal line from the head to the middle of the back. The soles of the feet are stated by Brongersma and Junge to be completely naked. The measurements probably vary with the sex; head and body about $8\frac{3}{4}$ inches, tail $6\frac{1}{4}$ inches.

SHORT-TAILED WEASELS

The Least Weasels, *Mustela rixosa*, have the tail much less than three times as long as the hind foot and no black tip to the tail. As in the case of the Ermines there is in summer dress a sharply distinct line separating the dorsal and ventral colors. The fur becomes completely white in winter. This species extends from the European Alps, the Caucasus and Scandinavia

across to Siberia and into North America. The Eurasian Least Weasel, *M. r. pygmaea*, is a race from northern Siberia. Another race, *M. r. namiyei*, is present on Hondo, Japan. The length of head and body is from $5\frac{1}{2}$ to $6\frac{1}{2}$ inches, of the tail $\frac{3}{5}$ to $\frac{4}{5}$ inch, and of the foot, $\frac{4}{5}$ to 1 inch.

The Duke of Bedford's Least Weasel, *M. russelliana*, found in Szechwan, is yellow beneath and has the tail twice as long as the hind foot. Its head and body measure $5\frac{1}{2}$ inches.

The Snow Weasel, *M. nivalis*, a European species similar to but distinct from *rixosa*, according to Allen apparently fails to reach eastern Siberia.

THE FERRET BADGERS (SUBFAMILY HELICTIDINÆ)

This subfamily, containing only the genus *Helictis*, can be recognized by the long, narrow, cartilaginous muzzle, narrow feet, and the faint transverse stripes on the foot pads. The form of the shearing teeth suggests distant relationship to the Martens.

The general color scheme is brownish gray above, with white marks on the forehead, cheeks, tips of ears, and often on the nape and shoulders. There are 4 inguinal nipples.

Ferret Badgers, which are nocturnal burrowers, may be found both in woods and in grasslands. They are apparently omnivorous, eating birds, worms, fruit, and berries. At least 3 young are born. The genus is confined to the tropics and subtropics. There are three species groups in *Helictis*, the typical one being *H. moschata* of south China; *Helictis personata* is from lower Burma (Pegu) and *H. everetti* is Bornean. *Helictis moschata* has smaller teeth and narrower jaws than *H. personata*.

The Common Ferret Badger, *Helictis moschata*, varies in color from blackish gray to brownish gray. The marks on the face, cheeks, the neck stripe, and the underparts are yellowish white. The length of the head and body is 14 to 15 inches, of the

tail 6 to $7\frac{1}{2}$ inches. In the typical form there is a brown spot at the roots of the whiskers, and the hind foot measures $2\frac{1}{3}$ to $2\frac{2}{5}$ inches; in a smaller race, *H. m. sorella*, found in Fukien, the said spot is absent and the length of the foot is only $1\frac{3}{5}$ inches. A second small race, *H. m. taxilla*, is found in the hills of Laos and Tonkin. The race on Formosa is *H. m. subcaurantiaca*. Animals of unusually large size, *H. m. ferrogrisea*, which have the length of the hind foot $2\frac{4}{5}$ inches, occur in Hupeh



FIG. 32. Ferret Badger, *Helictis moschata*.

and Szechwan. The Burmese animals, distinguished as *H. m. millsii*, have the skulls of slightly different form. They are found between 3000 and 5000 feet.

The Large-toothed Ferret Badger, *Helictis personata*, sometimes split off as the subgenus *Mclogale*, varies from deep brown to pale fawn-brown. The whitish dorsal stripe with its edging of dark brown, contrary to that of *Helictis moschata*, extends from the crown at least to the middle of the back. The tail includes numerous white hairs. There is a whitish face "mask" that connects with the white underparts. The nose and eye patches are dark. A dark area crosses the head from ear to ear.

The length of the head and body varies from 13 to 16 inches,

of the tail from 7 to 9 inches; the hind foot measures from $2\frac{1}{2}$ to $2\frac{4}{5}$ inches. The range includes Assam, Manipur, and Arakan. In Cochinchina and Annam the race *H. p. pierrei* is found. In Nepal the race *H. p. nipalensis* apparently undergoes great seasonal variation in color. The Javan *H. orientalis* may be a race of *personata*.

THE BADGERS AND HOG BADGERS (SUBFAMILY MELINÆ)

These heavily built, rather long-snouted mustelids have the body short and broad, the tail short, the legs stout, and the broad paws equipped with long, strong digging claws. The color is characteristic: the upper parts are grayish; the underparts, legs, and feet are black; a dark mark, beginning at the whiskers, runs back through the eye to enclose the ear, which is pale like the back. Old World Badgers have much narrower heads than American Badgers, genus *Taxidea*.

Two genera belong in this subfamily, *Meles*, the True Badgers, and *Arctonyx*, the Hog Badgers. In the True Badgers the throat and chin are black like the feet; in *Arctonyx* the throat is white and there is a dark line extending from the corner of the mouth to the ear. In the former the nose pad is separated from the lip by a hairy area; in the latter the nose pad continues to the lip as a naked area.

The True Badgers, genus *Meles*, are represented in eastern Asia by one species, *Meles meles*. This species is restricted to the temperate zone except in southeast China, where the race *M. m. leptorhynchus* reaches Fukien, Hong Kong, and Hainan. The length of the head and body in this race is 22 inches, tail $4\frac{1}{2}$ inches, hind foot 4 inches. Farther west the southern limit of the Badgers is reached in the Himalayas and extreme northern Burma by the local race *M. m. leucurus*. The northern limit of the Chinese Badger, *M. m. leptorhynchus*, is mapped by Ognev as a little south of the northern tip of Sakhalin. It is thus

probably distributed throughout eastern China. The Badger of the Amur region has been distinguished as *M. m. amurensis*. Badgers live in burrows. They eat a wide variety of foods, ranging from mice to sweet potatoes.



FIG. 33. Old World Badger, *Meles meles*.

The Hog Badgers or Sand Badgers, *Arctonyx*, colored above much like Common Badgers, are easily distinguished from *Meles* by their white instead of black throats and much whiter and longer tails. The claws are pale instead of dark colored. The legs and the middle of the belly are black. There is a single species, *A. collaris*, comprising four subspecies. The Hog Badgers occur from Assam and Burma through Siam and Indo-China to southern China. They also extend south into the Malay Peninsula (Perak) and are found in the mountains of Sumatra. The length of the head and body in the Chinese race is about 26 inches, of the tail 6 inches, hind foot $3\frac{3}{4}$ inches.

The typical race is found in the Terai of Sikkim, Szechwan, and in Assam. In southern Burma the larger form, *A. collaris consul* occurs. The name *A. c. leucolæmus* has been given the

Hog Badger near Peking. The Chinese race, *A. c. albogularis*, occurs in Fukien and north of Hopei. An extremely large race, *A. c. dictator*, is found in Siam, Laos, Annam, and probably in the Malay Peninsula.

THE OTTERS (SUBFAMILY LUTRINÆ)

The Otters are moderately large, slim, glossy-furred weasel-like mammals with flat, broad heads, well-developed whiskers, small ears, long thick muscular tails, large hind feet more or less webbed, poorly developed foot pads, and claws small or very small. Practically all the external structures of Otters are modified to aid in swimming and in catching fish. The gait on land, though rapid, is clumsy.

Otters eat rats, frogs, water birds, and some fish. They breed in burrows near water, producing two or three "kittens." In America, at least, they make the well-known Otter-slides, down which they slide on the chest into the water. They are distributed throughout the world except in Madagascar, Australia, and Oceania. In eastern Asia three genera, *Lutra*, the Common Otters, *Lutrogale*, the Smooth Otters, and *Amblyonyx*, the Small-clawed Otters, are found. The Common and Smooth Otters have comparatively large webbed forefeet and moderately well-developed claws; the Small-clawed Otters have the forefeet proportionately smaller, less webbed, and the claws very small. The great degree of uniformity of color and pattern throughout the Otter family is noteworthy. The Common Otters have the head lower and flatter and the muzzle less extremely short than the Smooth Otters.

The Common Otters, genus *Lutra*, typified by the European Otter, are distributed through Eurasia, North Africa, North America, and a large part of South America. They are dark brown above, paler beneath. There are two species in Asia, *L. lutra* with several races, and the tropical *L. sumatrana*. The

representative of *L. lutra* in Assam is *L. l. monticola*. *Lutra l. barang* represents this species in Siam and Annam; and *L. l. chinensis* in Laos, Tonkin, southern China, Hainan, and Formosa. Much farther north *L. lutra* is recorded in Manchuria and Siberia and as far north as the Kolyma River, and in Sakhalin. A weakly separable species, *L. tarayensis*, occurring in upper Burma and possibly lower Yunnan, has the back of the

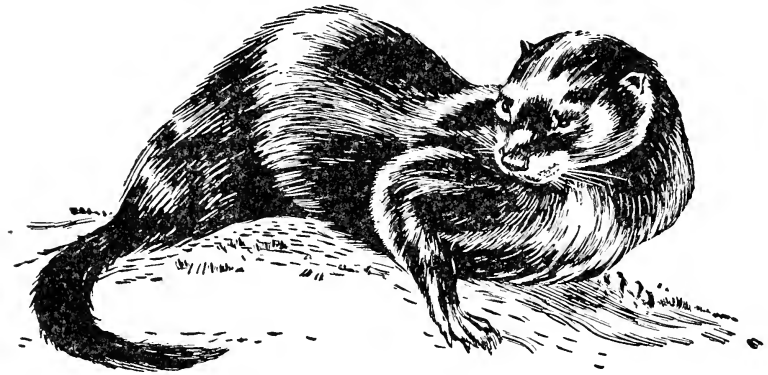


FIG. 34. Otter, *Lutra lutra*.

nose pad straight across instead of with the usual three nearly equal, pointed projections of glandular skin penetrating the furred area. *Lutra lutra* in the Burma-Indo-Chinese Peninsula overlaps the range of *L. sumatrana* but is somewhat smaller. The length of the head and body varies from 22 to 28 inches, and of the tail from 14 to 18 inches, the foot from 4 to 4½ inches. The color is brown above, whitish brown beneath, due to the white tips of the brown hairs of the underparts. The white throat and cheeks contrast sharply with the brown nape and crown.

The Hairy-nosed Otter, *Lutra sumatrana*, as its name implies, has the greater part of the nose pad covered with fine hairs. Only the lower edge and the margins of the nostrils are naked. The color is chocolate-brown, scarcely paler below; the cheeks.

upper lip, chin, and throat are whitish. The length of the head and body is about 2 feet 8 inches, of the tail 20 inches. The range of this Otter includes the whole of the Malay Peninsula, Siam, Annam, and Cochin-China. It occurs also on Sumatra, where it was first discovered, and on Borneo.

The Smooth Otter, *Lutrogale perspicillata*, differs from the True Otters by the higher, more massive head and heavier crushing teeth. The claws are fully developed, as in *Lutra*. Probably these characters will be found insufficient to maintain for *Lutrogale* higher than subgeneric rank. This is a large species characterized by its very smooth, sleek coat. The color above varies from dark brown to slightly reddish brown, lighter beneath. The upper lip, cheek to the eye and ear, sides of neck, chin, and throat are whitish. Two races occur, the typical one in Burma, Assam, and the Malay Peninsula and *L. p. sindica* in western India. The length of the head and body varies from 26 to 29 inches, of the tail 17 to 18 inches. The hind foot measures $5\frac{1}{2}$ inches.

The Small-clawed or "Clawless" Otters, *Amblyonyx*, differ from the two previously mentioned genera chiefly by the great reduction of the size of the claws, which are so short as to be much exceeded by the pads. In the young the claws are larger. In *Amblyonyx* the tiny first upper premolar is often absent but the crushing molar is proportionately even larger than in *Lutra* and *Lutrogale*.

There is one species, *A. cinerea*, typically of Java, but also found in Borneo, Sumatra, and the Malay Peninsula, with two other continental races, *A. c. concolor*, of Assam, upper Burma, Tonkin, Annam, and southern China and *A. c. nirnai* of India. The color is dark brown, sometimes with a reddish tinge. The grayish wash on the tips of the hairs, for which the name *cinerea* was given, is rarely seen. The underside is a paler brown or gray-brown, and the edge of the upper lips, the chin, cheeks, sides of the neck, and the throat are grayish white. The length of head and body is about 22 inches. The food is reputed to con-

sist of mussels, snails, and crabs, which the heavy teeth are well adapted to crush.

THE DOGS, WOLVES, FOXES (FAMILY CANIDÆ)

All the members of this family have a typically dog-like appearance except the odd-looking Raccoon Dog, *Nyctereutes*, which because of the large dark patches surrounding its eyes somewhat resembles a Raccoon.

The Dogs are long-nosed, slender-footed, lightly built running animals in which the canine and shearing teeth are strongly developed and are followed normally by one large and one small crushing molar. The senses of smell and hearing are especially acute, and of sight somewhat less so, although if objects move they are instantly perceived.

Five genera occur in eastern Asia: Arctic Foxes, *Alopex*, True or Red Foxes, *Vulpes*, Wolves and Jackals, *Canis*, Asiatic Wild or Red Dogs, *Cuon*, and Raccoon Dogs, *Nyctereutes*.

There are 5 or more pairs of nipples. Large litters may be produced. In the case of a domestic Dog recently, 23 pups were born at a single birth, and 10 more at the next birth.

The Arctic Fox, *Alopex lagopus*, is slaty brown, with chestnut-brown ears and whitish underparts in summer; it becomes pure white in winter. A bluish gray variety found in some areas is the much prized Blue Fox of the fur trade. The Arctic Fox is a comparatively small-sized Fox, the length of the head and body about 20 inches, of the tail about 10 inches. These Foxes, the most northerly of all the Foxes, are found in the arctic regions all around the world. In eastern Siberia they have been reported among other places from the lower Kolyma River, which empties into the Arctic Ocean, from Peginski Gulf, Marcova, and the Anadyr River.

The True or Red Foxes, genus *Vulpes*, are distinguished from the next genus, *Canis*, by the more flattened forehead, by the sharper cutting edges of the teeth, and by a deep, scent-

producing glandular pit in front of the central pad of the hind foot. Foxes are usually solitary in habit.

Red Foxes are graceful animals, with rather large ears and long heavily furred tails. Although this genus, like the Arctic Fox, encircles the globe, it extends less far northward and for a much greater distance to the south. The typical species, *Vulpes vulpes* of Europe, is subject to considerable color variation. Several geographical races occur, of which three are found in eastern Asia. *Vulpes v. thule* of south China is somewhat grayer than the European Fox and its feet are not so black. It is found in Fukien, Chekiang, Szechwan, Yunnan, and Hunan. *Vulpes v. tschiliensis* of North China, found in Hopei, Shensi, Shansi, and Kansu, is but little different from that of south China. The ears are brown instead of black. *Vulpes v. beringiana*, the Siberian Red Fox, occurs in the Kolyma and Anadyr Valleys, in Kamchatka, and widely through eastern Siberia. These northern Foxes are considerably larger than the European race and have larger teeth. The length of the head and body is about 27 inches, that of the tail 17 inches. The length of the hind foot is about 5½ inches. This last is a brightly colored form, generally orange-red, darker along the back, and slightly varied with gray on the head and hips. In Anadyr River specimens the sides of the nose are blackish and the upper lip is edged with white. The variety known as the Cross Fox occurs also in this northern race.

The Wolves and Jackals, genus *Canis*, have the forehead somewhat swollen and elevated in comparison with the Foxes. The tail is usually rather short and lacks the very heavy covering of hair seen in Foxes. The members of the genus *Canis* tend to be more gregarious than the Foxes and often hunt in packs.

There are two oriental species, *Canis lupus*, the Wolves (equivalent to American Timber Wolves), and *Canis aureus*, the Jackals. The smallest adult Wolves measure scarcely less than a yard in minimum length; the largest Jackals rarely exceed

30 inches. Wolves weigh not less than 36 pounds; Jackals not more than 25 pounds.

The Wolves, *Canis lupus*, ranged originally over practically the whole of the northern hemisphere, reaching even the Indian Peninsula but apparently fail to penetrate the Burmese-Indo-Chinese Peninsula, though they are found in southern China. Their southern limit in North America is Mexico.

The South Asiatic or Chinese Wolf, *Canis l. chanco*, originally from Chinese Tatory, is pale brownish, with a strong mixture of gray and black hairs. The head is grayish, with short black and gray hairs on the forehead. The inner side of the limbs and the belly are white or buffy white. The range of this Wolf includes all of Mongolia, northern Korea, and most of China. In parts of this area in China it is scarce; it still occurs in Shantung and Hopei but is rare near Peking. It is more or less common (Sowerby) in parts of Fukien, Kwangtung, and Kwangsi. The Wolves of these southern provinces are said to hunt singly or in very small groups. Westward this race extends into the Himalayas.

The Siberian Wolf, *Canis lupus dybowskii*, is variably colored, particularly in regard to the proportions of black and reddish. The ears are more or less yellowish brown. These Wolves are locally common along the west coast of the Okhotsk Sea. White specimens of Wolves occur occasionally in the Yenisei basin. In Japan a form of Wolf has been named *C. hodophylax*.

The Jackals, *Canis aureus*, sometimes separated from the Wolves subgenerically under the name *Thos*, though generally wolf-like in external appearance, are much smaller. The frontal area of the head is somewhat lower; and their geographical range lies more to the south, extending from southeastern Europe through India to Siam. The typical Jackals are found in Persia. The color is gray-brown, with the ears and legs buff or tan and the underparts whitish. The head and body measure

2 feet 6 inches to 2 feet 8 inches, the tail from 7 to 9 inches, the hind foot $5\frac{1}{2}$ to $6\frac{1}{2}$ inches.

Jackals are well-known scavengers, often finishing the remains of kills by Tigers and Leopards. They hunt singly or in pairs, and may attack lambs and poultry. They utter their peculiar yelping howl just after dark and before dawn. The time of gestation varies from 60 to 63 days. Three or 4 pups are born in a chamber at the end of a burrow or in some natural grotto.

The Himalayan Jackal, *C. a. indicus*, found along the Himalayas from 600 to 12,000 feet, extends into Assam, Burma, and Siam. The tail is usually somewhat longer than that of the Persian Jackal. The color is richer and darker, containing mixtures of black and of tan.

The Asiatic Wild or Red Dogs, *Cuon alpinus*, are at once distinguished from Wolves, Jackals, and Foxes by having one less molar tooth in the lower jaw. Externally they can be recognized by the bright reddish color of the coat and by their shorter, more rounded ears. The frontal region of the head is inflated, as in *Canis*, sometimes to a marked degree. The legs are rather short. The typical species is *Cuon primævus* (= *alpinus*) of Nepal in the Himalayas. This may be equal specifically to the *C. javanicus*, described some years earlier.

Wild Dogs hunt in large packs, even attacking animals as large as Sambar, Banting, and Gaur. They have been known to drive Leopards from their kills. The number of nipples may be as many as 16. The period of gestation is about 70 days (Pocock), and from 2 to 7 pups are born. The young at birth are colored dusky gray.

The range of *Cuon* includes central and eastern Asia from the Altai Mountains, Manchuria, and Amur south to the Indian and Malay Peninsulas. It is found also on Sumatra and Java. The typical race is found in the Amur district of Siberia (type locality restricted by Pocock). In northeast China Asiatic Wild Dogs are said to be extinct. The representative in south

China from Fukien to Annam is *C. a. lepturus*. South of China the race *C. a. adustus* extends from Tonkin, Annam, Laos, and Cochin-China westward to upper Burma and perhaps Assam. The form occurring in peninsular Siam and Tenasserim is named *C. a. infuscus*, and the one in the lower Malay Peninsula and Sumatra *C. a. sumatrensis*. These races, in some cases at least, grade into one another along their areas of contact and the distinctions between them are slight. Thus, Pocock distinguished the Tenasserim race from the Burmese chiefly by its smaller size and thinner pelage.

The Raccoon Dogs, *Nyctereutes procyonoides*, are small, short-muzzled canids, with the full complement of teeth of the Wolves and Foxes (there may sometimes be an extra upper molar), and a large blackish brown area beneath and partly surrounding each eye that makes them resemble Raccoons. They

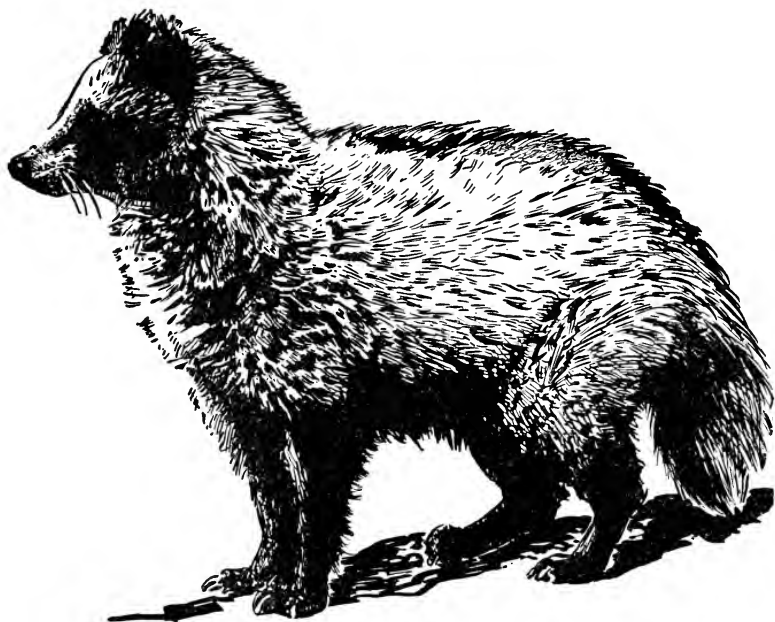


FIG. 35. Raccoon Dog, *Nyctereutes procyonoides*.

are otherwise somewhat fox-like, although the legs and tail are proportionately shorter.

The color is dull, a mixture of buff, gray, and black, with the back darker. The sides are buff, the underparts blackish, the feet blackish brown to chocolate-brown. The length of head and body is about 20 inches, of the tail $6\frac{1}{2}$ to 7 inches, of the hind foot $4\frac{1}{2}$ inches. *Nyctereutes* is reputed to inhabit grass and willow-covered flats and to make burrows in thickets near water. As many as 7 young may be born. At least part of the food eaten is fish. The typical race comes from near Canton and is distributed through Fukien and Chekiang west to Szechwan. Osgood records a specimen from Tonkin. A mountain-dwelling form, *N. p. orestes*, occurs in the Likiang Range of Yunnan. Northward a race, *N. p. ussuriensis*, inhabits the Ussuri and Amur districts of eastern Siberia, reaching north to the latitude of the middle of Sakhalin Island (Ognev); *N. p. koreensis* lives in Korea, and *N. p. viverrinus* in Japan.

THE RACCOONS AND THE LESSER PANDA
(FAMILY PROCYONIDÆ)

The two types of Pandas are commonly separated into two subfamilies or even two full families. In such case the Lesser Pandas typify the Ailurinæ or Ailuridæ. These animals, with the Bears and the very distinct Giant Panda, itself the sole representative of its family, form a group in which the molar-shaped teeth are all of crushing type and the sectorial teeth (shearing mechanism) are less developed. In the Procyonidæ the tail is always a well-developed organ, slightly shortened in the Raccoons of America but never approaching atrophy as in the Bears and the Giant Panda. The colors are strongly contrasting in the Lesser Panda and to a smaller degree in the Raccoons. (The Giant Panda also is strongly and contrastingly colored, though the Bears are not.) The members of the family are good climbers. The only Asiatic representative is *Ailurus*.

The Lesser Panda or Cat-bear, *Ailurus fulgens*, has a roundish head, large erect pointed ears, a long non-prehensile tail, feet with the soles almost entirely hairy, and semi-retractile claws. The color of the body varies from rusty to deep chestnut, darkest along the middle of the back. The tail is faintly ringed. There are small, dark-colored eye patches. The muzzle, lips,

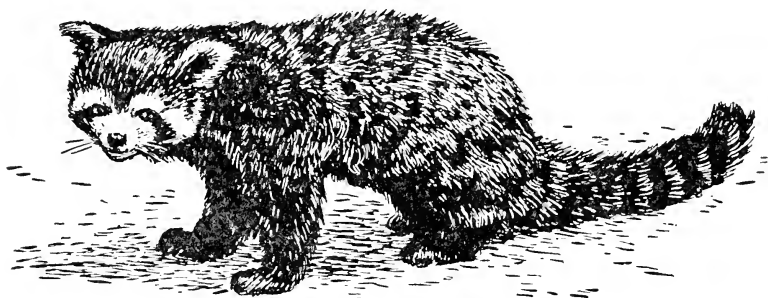


FIG. 36. Lesser Panda, *Ailurus fulgens*.

cheeks, and the edges of the ears, which have conspicuous long tufts of hairs, are white. The limbs, underparts, and the back of the ears are black. The typical race occurs in the Himalayas.

The Lesser Pandas behave very much like Raccoons. They readily sit up on their hind quarters; they seem to be more or less omnivorous, eating vegetable matter and an occasional bird or mouse.

The Chinese Lesser Panda, *A. f. styani*, is a race distinguished from the Himalayan form by its more convex forehead and larger size. The length of the head and body is 2 feet, of the tail 16 inches, of the hind foot $4\frac{1}{2}$ inches. It is found in Yunnan, Szechwan, and extreme northern Burma.

THE GIANT PANDA (FAMILY AILUROPODIDÆ)

The Giant Panda, *Ailuropoda melanoleucus*, the only living species of mammal contained in its family, represents an isolated

type standing in an intermediate position between the Bears and the Raccoons (and Lesser Panda). Its form is bear-like, as are its massive limbs, plantigrade feet, short tail, and lumbering gait, but certain characters of the genitalia indicate closer rela-



FIG. 37. Giant Panda, *Ailuropoda melanoleucus*.

tionship to the Raccoons. The skull is broad, short, massive, and equipped with heavy crushing teeth with which it masticates the bamboo upon which it feeds. The color is chiefly white, with the limbs brownish black. The black of the forelimb continues as a band up the shoulder to meet that of the opposite side; that of the hind limb ends at the knee. The ears and a small

patch around each eye are black. The length of the head and body is from $4\frac{1}{2}$ to 5 feet, the tail 5 inches. The weight may be well over 200 pounds.

This arresting mammal is found only in the mountains of Szechwan and Kansu between 6000 and 14,000 feet. It lives in bamboo jungles, feeding chiefly upon bamboo shoots up to $\frac{1}{2}$ inch in diameter. The droppings of adults, shaped like eggs 5 to 7 inches long, are composed of partly digested bamboo shoots. It may hibernate in winter. The litters consist of 1 or 2 cubs. The remains of a fossil relative, the Burmese Giant Panda, *Aelureidopus baconi*, have been found in a cave in upper Burma.

THE BEARS (FAMILY URSIDÆ)

These are medium to very large carnivores with heavily built, rather clumsy body and limbs, large, non-retractile claws, five-toed plantigrade feet (the heel being, as a rule, set flat to the ground, at least when walking erect), very small tail, and whiskers reduced to vestiges. The teeth, though large, are not specialized for meat eating; the cheek teeth are of crushing type, the specialized shearing mechanism seen in most carnivora, being weakly developed. Most kinds of Bears, though unable to leap and comparatively slow of movement—deceptively so, actually—are expert climbers.

Five genera of Bears are recognized in eastern Asia: the Polar Bear, *Thalassarctos*, the True Bears, *Ursus*, the Asiatic Black Bears, *Selenarctos*, the Sloth Bears, *Melursus*, and the Malay Bears, *Helarctos*. One of the most distinct of these is the semi-aquatic Polar Bear, which being highly carnivorous, has larger incisors and smaller last molars than the others, besides its whitish pelage and more hairy feet. The genera of land Bears are distinguished by more obscure characters.

The Polar Bear, *Thalassarctos maritimus* of the north polar regions, is represented in the extreme north of eastern Asia by the scarcely different geographical form *T. m. marinus*. The

color is yellowish white, the coat very dense and long, the feet heavily haired, the ears rounded and rather low. The neck is unusually long, the head in profile very flat. The length of head and body in full-grown males varies from $8\frac{1}{2}$ feet to 9 feet; the height at the shoulder is $4\frac{1}{2}$ feet; the weight may reach 1500 to 1600 pounds.

Polar Bears, which are expert swimmers, occur all along the coast of the Arctic Ocean and have been recorded in the Pacific as far south as the mouth of the Amur River (Schrank). Polar Bears are believed not to hibernate. Two young are born. The food consists chiefly of the flesh of seals, walrus, porpoise, fish, and sometimes the meat of stranded whales.

The True Bears, genus *Ursus*, typified by the Eurasian Brown Bear, *Ursus arctos*, are distinguished from the Sloth Bears and Malay Bears by the wrist pads of the forefoot. These are quite small and are reduced to a larger external pad and a small internal pad, both approximately the size of the finger pads instead of being very large, and, taken together, almost equal in size to the palmar pad (the main pad of the front part of the palm). There is no such marked distinction in the hind feet. Other well-marked identifying characters are based on the form of the ear and the nostrils. The True Bears are distinguished from the Sloth Bear by the presence on the forefoot of thick hair separating the finger pads from the palmar pad and the palmar pad from the wrist pads, that area being virtually naked in the Sloth Bear. In this last, too, the lips are markedly protrusible.

The Eurasian Brown Bears, *Ursus arctos*, comprise black as well as brown-colored Bears. They include the races *U. a. lasiotus* (= *mandchuricus*) of Manchuria; the Japanese Bear, *U. a. yesoensis* of Japan; the "Blue Bear" *U. a. pruinosus*, of Tibet and Kansu; and the "Red Bear," *U. a. isabellinus*, of the Himalayas. In Siberia various races that may not differ very markedly from each other have been named: *U. a. yeniseensis*, from the basin of the Yenisei River; *U. a. baikalensis*, from

near Lake Baikal; *U. a. kolymensis*, from the neighborhood of the Kolyma River; *U. a. beringianus* (= *piscator* = *collaris*), from Kamchatka and the Eastern Peninsula.

The "Blue Bears," *U. a. pruinosus* of Tibet and Kansu, has the back and flanks black with a wash of yellowish, the head variously marked with brown and cinnamon, across the chest a broad white band carried up in front of each shoulder. The limbs are black. From the nose to the tip of the tail is about 5 feet and the height at the shoulder amounts to 3 feet. The weight is at least 250 pounds.

The Manchurian Black Bear, *U. a. lasiotus*, is a large form of "Brown Bear," apparently becoming quite rare. The color is black, the nose brownish. There is no white mark on the throat or neck. This Bear has been estimated to weigh up to 600 pounds. The range includes Manchuria, northern Mongolia, and possibly parts of northern China.

The Japanese Brown Bear, from Yezo, northernmost island of Japan, is colored brown, rarely blackish. There is a yellowish collar beneath the neck.

The Eastern Siberian Brown Bear, *U. a. beringianus* (= *piscator*), grows to gigantic size, almost as large as the Alaska Brown Bear. The winter pelage is dark reddish brown, the limbs blackish brown. There is a yellowish shade on the head, neck, and shoulders. The range in Siberia includes Kamchatka.

The Sloth Bears, *Melursus ursinus*, are subtropical and tropical, being found throughout India and eastward into Assam. The characters by which they differ from *Ursus* are partly connected with methods of feeding. In the forefeet, the pads are arranged substantially as in *Ursus*, but the palms and areas between the pads are nearly naked instead of hairy and the pads of the fingertips are united by hairless webs. The claws are very long and are colored white. The lips and the tongue are markedly protrusible. The long straight fur is black; the muzzle

is whitish; on the chest there is often a whitish or buffy brown crescent- or V-shaped mark. The length of head and body is approximately 5 feet, of the tail 3 inches. The height at the shoulder is about 2 1/2 feet. The weight varies from 200 to 250 pounds.

The Sloth Bears inhabit rocky situations in jungle. They eat grain, sugar cane, fruit, and honey, with the addition of eggs, carrion, and various grubs and termites; they readily tear open the mounds of termites in order to get at the teeming insects inside. They are reputed actually to suck the termites out of their galleries. A separate race is found in Ceylon.

The Asiatic Black Bears, genus *Selenarctos* (meaning "moon-bear"), like the Sloth Bear, have the posterior pads of their front



FIG. 38. Asiatic Black Bear, *Selenarctos tibetanus*.

feet greatly enlarged and almost completely coalesced. There are 6 nipples, 2 of which are placed within the axils of the arms. The muzzle is shorter than in *Ursus* or *Melursus*. The range of these Bears includes southern and eastern Asia from the Himalayas east to Indo-China and thence northeast through South China to Hainan, Formosa, Manchuria, and Japan. The typical species is the Tibetan Black Bear, *Selenarctos thibetanus*.

The Himalayan or Tibetan Black Bears, *Selenarctos thibetanus*, have the hair of the neck and shoulders longer than that of the body. The general color is glossy black, with a variable amount of white at the chin and a prominent crescent-shaped mark on the chest. The upper lip and muzzle are brown. The length of head and body typically is about 5½ feet. The weight may be 250 pounds. The Japanese form (below) is smaller—only about 4 feet in length.

In the hilly country between Bengal and the Irrawaddy, the Himalayan Bear occurs between 1200 and 6000 feet. South and east it reaches peninsular Siam, Siam, and Annam. In China it extends through Kansu and Tibet to Shansi and Hopei. It is present on Formosa and Hainan as the race *S. t. melli*. In Mongolia and the Ussuri region another race, *S. t. ussuricus*, occurs, and in Japan *S. t. japonicus*. An island race, *S. t. formosanus*, occurs on Formosa.

The period of gestation is about 6 months. Usually 2 cubs are born.

The Malay Bear, *Helarctos malayanus*, is somewhat smaller than the others just described. The length of head and body is from 3½ to 4 feet, and the weight reaches about 100 pounds. The arrangement of the pads of the forefeet is substantially like those of *Selenarctos*, but the head is very short and broad and the number of teeth is often reduced. The ears are small and rounded. The lips and tongue, though more protrusible than in *Ursus* and *Selenarctos*, are less so than in the Sloth Bear. There are two whorls of hair on the upper shoulders and

another whorl at the center of the pale chest patch. The color is black, sometimes slightly washed with buff; the muzzle gray-tan above and below; the claws usually black.

Malay Bears are found throughout the Malay Peninsula, reaching Arakan and upper Burma, also possibly Szechwan. They occur also in Tonkin, Annam, Laos, and Siam. The typical locality is Sumatra. On Borneo the race *H. m. euryspilus* is found.

SUBORDER AELUROIDEA (=FELOIDEA SIMPSON)
THE CIVETS (FAMILY VIVERRIDÆ)

The Civets are aeluroid carnivores, distinguished from their distant relatives the Cats by their lengthened, fox-like muzzles, shorter limbs, and by the presence of five toes that all touch the ground when the animals walk. The number of teeth is greater than in the Cats. There is a tuft of whiskers beneath the chin. The viverrids, although relatives of the Hyænas, for practical purposes need scarcely be compared with those animals, which do not occur in our area except as fossils. From all members of the Weasel family except possibly some of the Badgers and Otters they can be distinguished by their unshortened faces. They appear as a rule longer-legged than the Mongooses. The sizes of Civets vary from rather larger than House Cats to little greater than large rats.

The viverrids fall naturally into six principal groups that can be treated for convenience as subfamilies of equal rank. These are the Linsangs, subfamily Prionodontinæ, the True Civets and allies, Viverrinæ, the Palm Civets and Binturong, Paradoxurinæ, the Banded Palm Civets, Hemigalinæ, the small-toothed Palm Civets, Arctogalidiinæ, and the Otter Civets, Cynogalinæ. The first, fourth, fifth, and sixth each contain but one genus in eastern Asia. The paradoxures and viverrines, on the contrary, each include several genera.

The Linsangs, genus *Prionodon*, only representatives of their subfamily, have completely retractile claws somewhat as the Cats. The central group of pads behind the digital pads is broken up into three distinct pads in the case of the hind foot and a curving chain of five pads in the forefoot. There are no scent glands. The tail is almost as long as the body. There are 2 pairs of nipples. Two very distinct species of Linsangs occur: the Spotted Linsang and the Banded Linsang.

The Banded Linsang, *Prionodon linsang*, is easily distinguished from the spotted species by the series of five broad, transverse black or deep brown bands across the back, one large

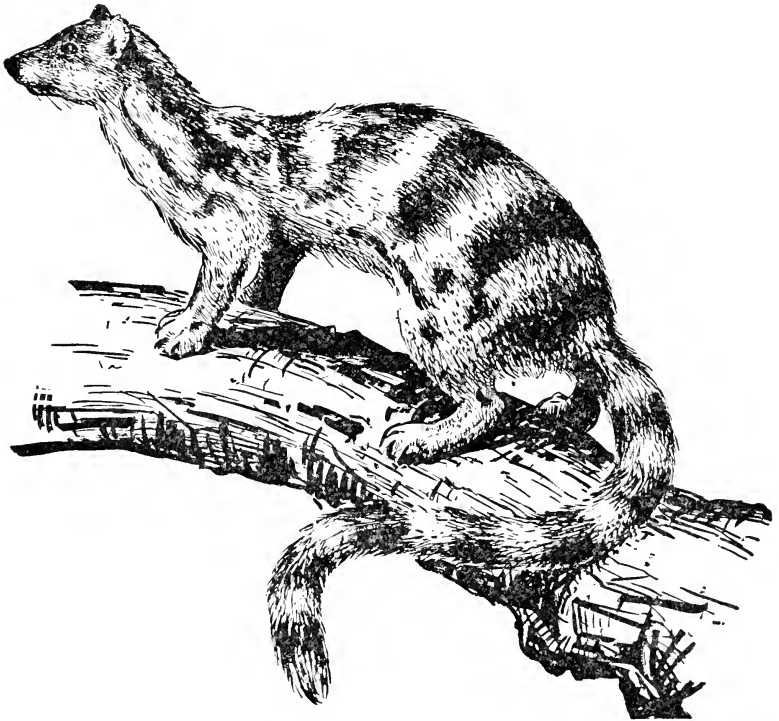


FIG. 39. Banded Linsang, *Prionodon linsang*.

stripe lengthwise on each side of the long neck, and the shorter ears. The tail is circular-banded. The ground color varies between whitish gray and light brownish gray, becoming creamy underneath. The length of the head and body ranges from 15 to $16\frac{3}{4}$ inches, tail $13\frac{1}{2}$ to 16 inches, hind foot 2 to $2\frac{4}{5}$ inches.

Banded Linsangs range from southern Burma and Siam south through the Malay Peninsula to Sumatra. A smaller race, *P. l. gracilis*, is found on Java and Borneo. The color pattern slightly resembles that of the Banded Palm Civet.

The Spotted Linsang, *Prionodon pardicolor*, has the body pattern composed of several rows of large, squarish, black-brown spots on a ground color that varies from brownish on the upper parts to bright buffy beneath. The spots become smaller and rounded on the limbs. Stripes are developed on the top of the head and neck, and encircling bands on the tail. The ears are rather large. The length of head and body varies from $13\frac{1}{2}$ to $15\frac{1}{2}$ inches, of the tail 12 to $14\frac{1}{2}$ inches, of the foot 2 to $2\frac{3}{4}$ inches.

The Spotted Linsang is found from Sikkim, Nepal, and Assam through Burma to Yunnan, Laos, and Tonkin. This is a solitary animal, at home in the trees or on the ground. It is said to produce 2 young in holes in the trees.

THE CIVETS AND LITTLE CIVETS (SUBFAMILY VIVERRINÆ)

The Civets proper are to be distinguished from the paradoxures, hemigales, and Arctogalidiæ by the character of their feet, adapted for running instead of climbing; the central pads are full and stout but much less extensive. They can be distinguished from the Mongooses, which have running-type feet, by their much larger and taller ears. Civets of both sexes have a peculiar scent pouch below the anus, from which the civet

scent of commerce is procured. The scent is secreted into the hair-lined pouch by special scent glands. The True Civets have the forehead relatively full and broad and the ears widely separated; the Little Civets (which are only slightly smaller) have the forehead narrower and the inner edges of the ears closer together. The Genets of Africa and south Europe are related to the Civets.

The True Civets, genus *Viverra*, comprise the Indian Civet, *V. zibetha*, the Large-spotted Civet, *V. megaspila*, the Malay Civet, *V. tangalunga*, and the Malabar Civet, *V. civettina* of southern India. The first is very widely distributed.

The Indian Civet, *Viverra zibetha*, is a gray or tawny animal with parts of the body pattern rather indistinct, but well marked on the back, head, and tail. A strong black line runs from behind the ear back almost to the shoulder and thence onto the chest. A second line beginning lower down on the neck also crosses the chest. A third crosses beneath the throat. These three lines are separated by areas of white. A well-defined crest of black hairs extends all along the back, and the tail is heavily ringed with black on white, the rings incomplete beneath. The length of the head and body is from 29 to 33 inches, of the tail from 15 to 19 inches, of the foot from 5 to 6½ inches.

The Indian Civet is found from northern India and southern China south to the Malay Peninsular. The typical race occurs in northeast India and Assam. In upper Burma and Laos the race *V. z. picta* is found. There are several other races: *V. z. pruinosa* in lower Burma, Tenasserim, and Siam; *V. z. sigillata* in the Malay Peninsula; and *V. z. ashtoni* in China. *Viverra zibetha* is also represented in Tonkin, Annam, and Cochin-China.

The Large-spotted Civet, *Viverra megaspila*, differs from the Indian Civet by having the areas of the palms and soles between the digital pads and the central pads nearly naked. The sheaths for retraction of the claws of the third and fourth

fingers, present in the Indian Civet, are absent in the present species. The system of spotting is much as in the Indian Civet. The length of the head and body is 30 to 32 inches, tail 13 to 15 inches, foot 5 to 5¼ inches. The range, more restricted than that of the Indian Civet, extends from lower Burma across Siam to Indo-China and Cochin-China, and through the Malay Peninsula. From 1 to 3 young are born.

The Malay or Tangalung Civet, *Viverra tangalunga*, patterned much like other species, has a continuous longitudinal

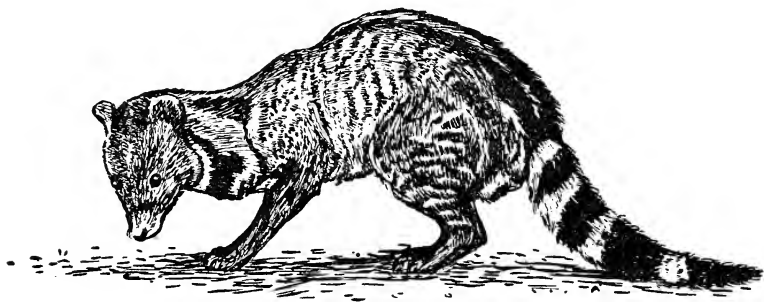


FIG. 40. Malay Civet, *Viverra tangalunga*.

black band along the upper surface of the tail; the rings are separated by white only on its lower half, the number of rings on the tail being more than ten. The length of the head and body (female) is 26 inches, tail 14 inches, hind foot 4 inches. The Malay Civet occurs through the Malay States, Sumatra, Borneo, Philippines, and several lesser islands.

The Little Civet, *Viverricula indica*, lacks the marked crest of hair along the middle of the back that is present in *Viverra*. It has the ears closer together, is definitely smaller, and has the tail shorter than has *Viverra*. The ground color is rather uniform buffy gray and the pattern of blackish brown varies in boldness. This last is composed of about six rows of spots along each side of the body, those on the back partly coalescing to

form nearly solid lines. The neck stripes, though similar to those of *Viverra*, are less defined. The tail is strongly banded with black, its tip white. The scent gland is less developed. The length of the head and body varies from 20 to 25 inches, according to race; of the tail from 13½ to 16½ inches; of the foot from 3½ to 4 inches.

Viverricula indica, characteristically of southern India, has several races in eastern Asia: *V. i. baptisiæ* in upper Bengal and Assam; *V. i. thai* in Burma, Siam, Tonkin, Indo-China, Cochinchina, and the Malay Peninsula; *V. i. pallida* in south China, from Yunnan and Szechwan to Fukien and Kiangsu; *V. i. malaccensis* in Malacca.

PALM CIVETS, MASKED PALM CIVETS, AND BINTURONG
(SUBFAMILY PARADOXURINÆ)

The paradoxures are distinguished from the Civets proper by having the pads of the short, broad feet of climbing type, not running type, and the pads of the palms and soles large. A special character is seen in the terminal pads of the third and fourth toes, which are united. The tail is very long: in the Binturong it is prehensile like those of the New World Kinkajous and Cebid Monkeys. The scent glands are extensive and are bordered by folds that can be turned in to form a closed scent pouch. The genus *Macrogalidia* of Celebes also belongs in this subfamily.

The Palm Civets or Toddy Cats, genus *Paradoxurus*, include three species, two of them restricted to India; one, *P. hermaphroditus*, ranges through India, Malaysia, Hainan, China, and almost throughout the East Indies. In all members of the genus there is a sometimes obscure pattern of spots and stripes on the body. The tail is about six times as long as the hind foot. There are 3 pairs of nipples.

The hairs on the neck in *P. hermaphroditus* are directed back-

ward (in two Indian species they are reversed), and there are long, shaggy guard hairs on the body. Irregular lines of spots extend along the sides and back. White marks on the head include a spot below the eye, white at the base of the ear, sometimes uniting with the opposite side across the forehead, and a



FIG. 41. Palm Civet, *Paradoxurus hermaphroditus*.

white spot on the upper lip; or all spots may be nearly absent. The rest of the face is blackish. The tail is blackish and almost unringed.

Typically from southern India, *P. hermaphroditus* has a number of local races, including *P. h. pallasii* in Assam and upper Burma, *P. h. laotum* in Burma, Siam, Indo-China, Cochin-China, and Hainan, *P. h. minor* in peninsular Siam and the Malay Peninsula, *P. h. cochinchensis* in Cochin-China, and *P. h. exitus* in southeastern China. The length of the head and

body varies from 20 to 24 inches, of the tail from $19\frac{1}{2}$ to 23 inches, of the hind foot from 3 to $3\frac{1}{2}$ inches. In *P. h. minor* the corresponding measurements are $17\frac{1}{2}$ to 19, 17 to 20, and $2\frac{3}{5}$ to 3 inches. Numerous island races have also been distinguished.

Palm Civets are expert climbers. They live mainly in forest, but nevertheless sometimes make their headquarters in the roofs of occupied houses. They eat fruit, mice, frogs, lizards, and insects. They are nocturnal, sleeping through the day. They can discharge a nauseating fluid from the anal glands when irritated.

The Masked Palm Civets, genus *Paguma*, altogether lack the spots and stripes on the bodies of other Civets, except sometimes in newly born young. The body color varies from gray to red-brown. On the head the contrasting black-and-white pattern, which gives the name "masked," is even more pronounced than in *Paradoxurus*. There are only 2 pairs of nipples. The second molars may be obsolescent.

The typical form of the Masked Palm Civet is *Paguma larvata*, found in southeast China as far north as lat. N. 42° , Hainan, and Formosa, whence it spreads to eastern Burma, the Malay Peninsula, Sumatra, and Borneo. A number of scarcely distinguishable races have been separated: *P. l. hainana* in Hainan Island, *P. l. neglecta* in Assam, *P. l. nigripes* in upper Burma, *P. l. intrudens* in southwest China, *P. l. robusta* in peninsular Siam, *P. l. janetta* in Tenasserim, *P. l. jourdanii* in the Malay Peninsula. These races differ chiefly by small details of the black-and-white patterns of the face. They may all condense into a northern and a southern form.

The length of the head and body in typical *P. larvata* of southeast China is about 18 inches, of the tail 15 inches, hind foot $3\frac{1}{4}$ inches. Most of the other races are larger. The head and body in the Assam form varies from 25 to 26 inches, in specimens from southwest China from 22 to 27 inches, in *P. l. robusta* of Siam from 25 to 30 inches.

Masked Palm Civets are omnivorous, nocturnal, tree-climb-

ing mammals that breed in holes in trees, where they produce 3 or 4 young at a time.

The **Binturong**, *Arctictis binturong*, is a freakish viverrid with long shaggy body hair, long tufts on the ears, and a long,



FIG. 42. Binturong, *Arctictis binturong*.

densely hairy tail which is prehensile at the tip. It looks little like a Civet. The sole of the hind foot is naked throughout. There are 2 pairs of nipples. The body color is mostly black with a few whitish hairs, which are sometimes plentiful enough to give the animal a grayish color. The head is finely speckled with gray and buff. The edges of the ears and the whiskers are white. The length of the head and body is from 29 to 31 inches, of the tail 24 to 27 inches, hind foot 4 to 5½ inches. The animals weigh from 20 to 25 pounds.

This is an animal of the dense forests, chiefly arboreal and nocturnal. When the Binturong descends branches head first, the prehensile tail is used as an extra hand. It eats fruit, eggs, small animals, and birds. It is found from northeast India, upper Burma, and Indo-China south to the Malay Peninsula, and on the Islands of Sumatra, Java, Borneo, and Palawan. A weakly distinguishable race, *A. b. albifrons*, meaning "with the forehead white," is found in Tonkin.

THE THREE-STRIPED OR SMALL-TOOTHED PALM CIVET
(SUBFAMILY ARCTOGALIDIINÆ)

Only the genus and species *Arctogalidia trivirgata* with its allies belongs in this subfamily. The ground color varies from reddish gray to ashy gray, and the underparts are whitish. The pattern is longitudinal; two or three rows of weakly defined spots appear on each side of the back, and a white streak on the nose. The feet are adapted for climbing as in the paradoxures, but the pads of the third and fourth hind toes remain separate. The tail, longer than the head and body, tapers only very gradually and is colored like the body. The ears may be black or tipped with white. The scent pouch, located in front of the genital opening, is present in the female only (Pocock).

The typical form from the Malay Peninsula has the ears tipped with black; all others have the tips white in varying degrees. The race *A. t. leucotis* (white-eared) is found in Tenasserim, lower Burma, and in Siam and Laos; a more northerly race, *A. t. millsii*, ranges across Assam and the Chindwin region; *A. t. major* is from peninsular Siam, Laos, and Tonkin, and *A. t. milleri* from Indo-China. Several island races occur.

The length of head and body is from 19 to 21 inches, tail 20 to 24 inches, hind foot $3\frac{1}{2}$ to 4 inches (in *A. t. major* the length of the head and body is as much as 27 inches).

THE BANDED PALM CIVETS (SUBFAMILY HEMIGALINÆ)

Derby's Banded Palm Civet, *Hemigalus derbyanus*, is the principal representative of this group in eastern Asia. The feet, as in *Arctogalidia*, are of scansorial type (climbing) and none of the toe pads are united. The scent pouch and scent glands are much less developed than in the Civets or in *Paradoxurus*, but well-developed anal glands are present. The fur is rather woolly.

The pattern, recalling that of the Banded Linsang, consists of a series of six or seven dark gray transverse bands succeeding each other along the back from the shoulders to the base of the tail, the tail itself being ringed proximally. Two irregular dark stripes extend down the nape to the shoulders. On the face is a median dark line and parallel to it, enclosing each eye, are two other broader lines. The ground color varies from buffy to gray. The underparts are paler. The length of head and body is from 20 to 21 inches, tail 12½ to 15 inches, foot 3 to 3¼ inches.

The range includes Tenasserim, Malay Peninsula, Sumatra, and Borneo.

Owston's Banded Palm Civet, *Chrotogale owstoni*, has the same type of banded pattern as *Hemigalus* and perhaps should be placed in the same genus. In addition, there is a series of black spots low on each side beyond the tips of the bands, and an ochraceous midventral line extending from the breast to the inguinal region. The terminal part of the tail is more bushy and the head is apparently narrower than in *Hemigalus*. There are certain distinguishing features of the skull and teeth.

This animal is rare, being known only from Tonkin and Laos. The length of the head and body of the original young specimen is 16 inches, of the tail 9½ inches, of the foot slightly less than 3 inches; these measurements, in adults obtained later, were 21 inches, 19½ inches, and 3¾ inches. Dr. Jean Delacour, who has

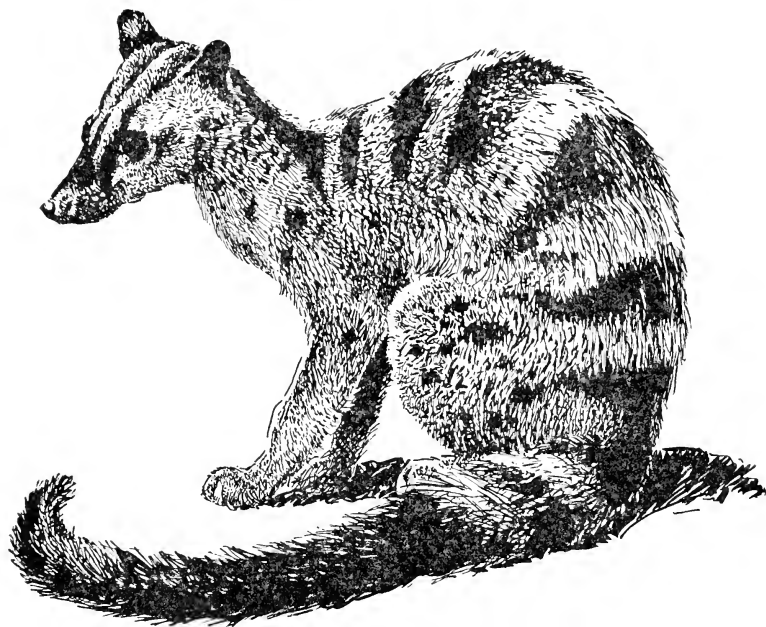


FIG. 43. Owston's Banded Civet, *Chrotogale owstoni*.

collected a number, informs me that they feed chiefly on earth-worms.

A third genus, *Diplogale*, represents the Hemigalinæ in Borneo.

THE OTTER CIVETS (SUBFAMILY CYNOGALINÆ)

These Civets, with their flat heads, tumid, otter-like upper lips, and aquatic habits, are singularly like the Otters of the Weasel family. The shortness of the tail distinguishes them. One genus containing two species is known.

Bennett's Otter Civet, *Cynogale bennettii*, of Borneo, Sumatra, and the Malay States, is brownish gray, grizzled with white; the underparts are blackish brown. A spot on either side

beneath each ear, the lips, and the tip of the tail are whitish. The head is flat and elongate, the muzzle low, broad, and otter-like. The whiskers are well developed; the toes slightly webbed. The length of the head and body is from 24 to 32 inches, of the tail from 5 to $9\frac{1}{2}$ inches, of the hind foot $3\frac{3}{4}$ to $4\frac{1}{4}$ inches. A civet-like smell is given off. The food seems to be composed mainly of meat and fish.

Lowe's Otter Civet, *Cynogale lowei*, is easily distinguished from *C. bennettii* by its white underparts set off from the dark brown upper color

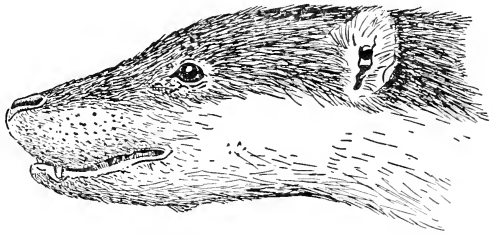


FIG. 44. Head of Lowe's Otter Civet, *Cynogale lowei*. Diagrammatic: after Pocock.

by a distinct line of demarcation that runs forward beneath the ear and eye to the nostril, leaving the upper lip and cheek white.

This species is known as yet from a single young specimen taken in Tonkin at 500 feet above sea-level.

THE MONGOUSES (FAMILY HERPESTIDÆ)

Formerly classed with the family Viverridæ, the Mongooses are now believed to be a separate offshoot of the extinct Miacid Creodont stem, from which all the aeluroid carnivores originated. They are characterized by long, slender, weasel-like bodies and moderately long tails. They have long tapered snouts, small low ears, feet with freely mobile digits, and slightly curved, non-retractile claws more or less suited for digging. There are no scent glands. The anus opens into a naked, glandular pouch that can be folded over it. The Mongooses are chiefly Asiatic and African. One species lives in Spain. In Asia only the one large genus *Herpestes* is found.

The Asiatic Mongooses, genus *Herpestes*, with type species *Herpestes ichneumon* of the Mediterranean, comprise a number of species distinguished from each other by relatively superficial characters. Several other distinct species which occur on the Sunda Islands are not known on the Asiatic mainland.

Two main divisions can be easily recognized: Mongooses marked with a conspicuous stripe each side on the neck and shoulder and with the head broad, including the Stripe-necked Mongoose of India and the Crab-eating Mongooses; and Mongooses without marks and with the head rather narrow, comprising several species or forms.

The Crab-eating Mongoose, *Herpestes urva*, is a large Mongoose with a horizontal white stripe on each side of the neck extending from under the throat, beneath the ear, to the shoulder. (The Stripe-necked Mongoose of India has a black stripe along the neck in much the same position.) The color of the back is gray, a blend of black and white, with the under-hair slightly reddish; the throat, chin, and chest are white, and the belly is brown. There is some black on the chest and lower throat, and the fore and hind legs and feet are black. The total color effect is badger-like. The length of the head and body is from 19 to 23 inches, of the tail from 12 to 16 inches; the hind foot measures about 4 inches. The weight varies from 4½ to 6 pounds.

The Crab-eating Mongoose undergoes comparatively little subspecific variation from Nepal and Assam through Burma to southern China, Hainan, Formosa, Indo-China, and the Malay Peninsula. In China the northern limit of its range is near the Yangtse River. Reputed to live near streams, this Mongoose feeds upon frogs, small mammals, birds, eggs, and crabs.

The several species of Mongooses which have no neck stripe are divisible into two classes: those with the color of the legs darker than the body, and those with the legs not darker than

the body. To the first belong the Indian Mongoose, *H. edwardsii*, a long-tailed species, and some other Indian species; to the second, the Javan Mongoose and its allies.

The Indian Mongoose, *Herpestes edwardsii*, is a medium-sized species that includes several races, chiefly Indian. The color typically is iron-gray, owing to black and white banding of the individual body hairs, but may be reddish. The tail is colored like the body except at the tip, which may be either whitish or reddish but never blackish. The legs, darker than the body, are blackish brown to reddish brown. Only one of the races, *H. e. nyula*, reaches Assam from the west. The length of the head and body in this race is from 14½ to 17½ inches, tail 13 to 16 inches, hind foot from 2½ to 4 inches. Chasen records the typical Indian Mongoose as introduced into the Malay Peninsula.

The Javan Mongoose, *Herpestes javanicus*, though found originally in Java, ranges northward through the Malay Peninsula, east to Indo-China and west to Persia. The pelage is grizzled gray, with a frequent tendency to reddish, especially on the head. The tail is proportionately short and the legs are not darker than the body. There are a number of races partly distinguished by differences in size. The form *H. j. perakensis* occurs in the lower Malay Peninsula; *H. j. peninsulæ* in peninsular Siam; *H. j. birmannicus* in Burma and Assam; *H. j. exilis* in eastern Siam and Annam; *H. j. rubrifrons* in Hainan, Fukien, and Kiangsu.

The measurements of the head and body, tail, and hind foot for *H. j. birmannicus* are respectively 13 to 15 inches, 10 to 11½ inches, and 2¼ to 2½ inches. The size of the Hainan or Rufous-faced race is somewhat less, but that of the Annamese Mongoose is greater. The equivalent dimensions in *H. j. peninsulæ* are 15, 11, and 2½ inches. The true Javan race is still larger.

Flower writes that a captive specimen from Siam killed snakes

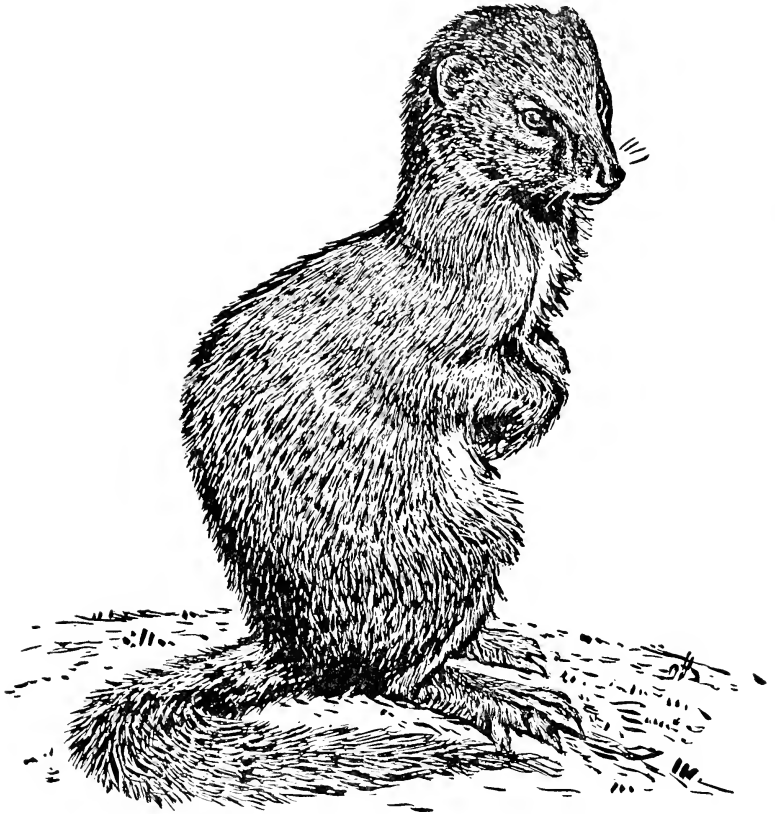


FIG. 45. Javan Mongoose, *Herpestes javanicus*.

up to 7 feet in length. It would devour them head first, stopping only when gorged. This Mongoose would then lie motionless on its back for several hours, finally resuming its meal. It was an expert rat-catcher.

The Short-tailed or Water Mongoose, *Herpestes brachyurus*, is grizzled with white and grayish; the underparts are brown, ticked here and there with white. There are faint marks on the sides of the neck. The length of the head and body is

16½ inches, of the tail only 9½ inches, of the hind foot 3½ inches. The typical form is a native of the lower Malay Peninsula, where it is thought to live in swamps; races on Sumatra and Borneo have the underparts blackish except on the throat and neck. This Mongoose is not known to occur in Java.

CATS, TIGERS, LYNXES (FAMILY FELIDÆ)

The Cats may generally be distinguished from the Civets and Mongooses by their short rounded heads and short muzzles. The claws are sharp and, as a rule, completely retractile within sheaths. An exception is seen in the Cheetahs of western India and Africa. Since retractile claws are also found in the Linsangs of the family Viverridæ, this character cannot be taken as wholly diagnostic. The eyes of the Cats have the well-known vertically contracting pupils. The second to the fifth toes of the front foot are arranged in a semicircle around the central pad. The first is raised above the ground and, with its claw, is partly opposable against the others. Only four toes appear on the hind foot. The whiskers are strongly developed, the ears rather large. There are from 2 to 4 pairs of nipples. The number of cheek teeth is much reduced, the strongly functional ones being the third and fourth upper premolars and in the lower jaw the fourth premolar and first molar. The scissor-like action of the carnassials is marked.

Pocock divides the Cats into two groups: Cats with a long elastic ligament forming a part of each side of the hyoid apparatus of the throat, presumably permitting large masses of food to be swallowed; and Cats in which the hyoid consists of the continuous series of small bones found in most mammals. To the first belong Tigers, Lions, Leopards, American Jaguars and Snow Leopards; to the second, the Lesser Cats and Lynxes. Cheetahs lack the elastic ligament. Pocock names the first group Pantherinæ, the second group Felinæ. In this respect at least,

the Pantherinæ can be thought of as a specialized division of the Cats.

THE CATS AND LYNXES (SUBFAMILY FELINÆ)

These are Cats with no special elastic ligament in the throat. For practical purposes those Cats with the ears high, pointed, and often tufted, such as the House Cats (to a small degree) and the Lynxes, will be separated from those with the ears low, rounded, and usually marked on the back with a large white spot. The pointed-eared group includes *Felis* (comprising a variety of Jungle Cats), *Caracal* and *Lynx*; the round-eared group contains the Leopard Cats, Marbled Cat, Temminck's Cat, Flat-headed Cat, Fishing Cat, and the Clouded Leopard. The number of nipples in *Felis domestica* is 8; in *Lynx*, 4, all abdominal (Seton).

The subgenus *Felis*, in a restricted sense,¹ includes House Cats, Indian Desert Cats, and Jungle Cats—Cats of medium to small size. The typical species is the Domestic Cat, *Felis catus*, regarded as derived from a North African species.

The Jungle Cats, *Felis chaus*, are not very well named; their range, although it includes the Indian and Indo-Chinese jungle regions, also extends northwest into the dry areas east of the Caspian Sea. A distinct crest of hairs appears along the back, and the ears are slightly tufted. The color varies from gray to tawny. The underparts and the area around the mouth are whitish; the tail, only moderately long, is slightly ringed. A few weakly defined spots and stripes appear on the chest, shoulder, and hind legs. The length of the head and body is from 2 to 2½ feet, of the tail from 10 to 10½ inches, of the hind foot about 6 inches.

Felis chaus proper is a native of Turkestan and Persia. The

¹ Sometimes all members of the Cat family except the Cheetahs are called *Felis*.

race *F. c. fulvidina* occurs in Annam, Tonkin, Siam, and Burma. The Indian race, *F. c. affinis*, extends into Yunnan. *Felis chaus* is not found in the Malay Peninsula.

The subgenus *Prionailurus* contains the Tiger Cats, *Felis bengalensis*, the Rusty-spotted Cats of India, *F. rubiginosus*, the Fishing Cats, *F. viverrinus*, and the Flat-headed Cat, *F. planiceps*, the last sometimes placed by itself in the subgenus *Ictailurus*.

The Leopard Cats, *Felis bengalensis*, are heavily spotted and striped. The ground color is buffy brown or reddish brown, the spots and stripes blackish. The length of the head and body is from 18 to 28 inches, the tail from 9 to 14 inches, hind feet $4\frac{1}{2}$ to 5 inches. The type locality is Bengal but the typical race extends into Burma, Yunnan, Siam, and Indo-China. Chasen records it in the Malay Peninsula. A related race, *F. b. chinensis*, occurs in Kwangtung, Fukien, and the islands of Hainan and Formosa, and *F. b. scripta* in Szechwan. In north China, Hopei, and Shensi, the local representative is *F. b. microtis*, shown by Ognev also to inhabit the Siberian Maritime Province and the northern side of the Amur River at least as far as lat. N. 50° . In Manchuria the local race near Mukden is named *F. b. manchurica*.

The Fishing Cat, *Felis viverrina*, has the tail proportionately shorter than have the Leopard Cats. It is heavily spotted, as in *F. bengalensis*. The ground color varies from deep olive-gray to yellowish gray or nearly ash-gray. The underparts are white, with the spotted pattern forming two collars across the throat and transverse bars on the chest. It is considerably larger than the Leopard Cat, the dimensions being: length of head and body about 28 inches, tail 10 to 12 inches, hind foot $5\frac{1}{2}$ to 7 inches. The habitat is tropical, from India to Cochin-China, the Malay Peninsula, and Java.

Although the Fishing Cat is said to prowl about reed beds

and marshes, its name may be misleading; Pocock states that it is not more addicted to a fish diet than are other Cats.

The Flat-headed Cat, *Felis planiceps*, is a small Cat of the Malay region, with the head longer than usual and with long narrow feet, rather large pads, and the greater part of the claws exposed. The color above is reddish gray, glossy on the back. There is white under the eyes and on the cheeks; the throat, neck, and underparts are white, the belly being marked with reddish spots. This extremely rare Cat occurs in Sumatra, Borneo, and the Malay Peninsula.

The subgenus *Profelis* contains in Asia only Temminck's Cat and its geographical races.

Temminck's Cat, *Felis temminckii*, first described from Sumatra, is even larger than the Fishing Cat. The head is relatively narrow and long. The ears are low, rounded, and lacking a white spot. The tip of the tail is white beneath. The ground color of the coat may be dark brown, reddish brown, or gray. The pattern of stripes on the back and of spots on the underparts may be either conspicuous or nearly obsolete. The typical race occurs from Assam to Laos and Tonkin, also down the Malay Peninsula to Sumatra. A second race, *F. t. tristis*, is found from Tibet, Szechwan, and possibly upper Burma to Fukien. The length of the head and body varies from 29 to 34 inches, tail 16 to 19 inches, hind foot about 7 inches. Temminck's Cat is reputed to produce two kittens at a birth.

The subgenus *Pardofelis* includes only the Marbled Cat.

The Marbled Cat, *Felis marmorata*, a species with the tail very long, has the pattern of the back and sides broken into several large blotches, edged with dark, and separated from each other by whitish, somewhat as in the Clouded Leopard. The backs of the ears are marked with white. The ground color varies from tawny to brownish gray. The spots on the tail,

limbs, and underparts are solid. Several dark lines run lengthwise along the crown of the head.

The size is about as in the Domestic Cat. The length of the head and body varies from 18 to 20 inches, tail 19 to 21½ inches, hind foot 4½ to 5 inches.

This nocturnal forest Cat was first found in Java. It extends north through the Malay Peninsula to Burma, Assam, and Annam; a race in the eastern Himalayas is named *F. m. charltoni*.

The subgenus *Neofelis* contains only the Clouded Leopard.

The Clouded Leopard, *Felis nebulosa*, is the largest of those Asiatic Cats that have the chain of hyoid bones in the throat unmodified; it is only a little smaller than the True Leopards. The tail is long, the legs rather short and stout, the feet heavy. The pattern on the sides consists of some six large narrow brown blotches, arranged parallel to the ribs, edged posteriorly with black, and separated from one another by pale areas. There is a chain of large open-centered spots along the back. The underparts are white, with few spots. The head, limbs, and tail have solid marks.

The length of the head and body in males reaches 42 inches (females much smaller), of the tail 36 inches. Originally from Kwangtung Province, this animal occurs in Fukien, Kwangsi, Tonkin, and on Formosa and Hainan Islands. A race, *F. n. macroselides*, has a much more extensive range—Assam, Burma, the Malay Peninsula, Sumatra, and Borneo.

The Lynxes, genus *Lynx*, are Cats notable for their very short tails and tall tufted ears. There are but two upper premolars. The powerful hind quarters are higher than the fore quarters, as is true also of the American Mountain Lion. The hairs of the feet are long and dense. In males there is a distinct ruff of hairs at the throat. Lynxes are close relatives of the Caracals of Africa and India.

The genus is circumpolar, being represented in America by the Canada Lynx and the Bay Lynx. The typical form is *Lynx lynx* of Sweden. The range in eastern Asia occupied by the race *L. l. orientalis*, is shown by Ognev to extend northward to about 68° and southward almost to 40° . A race found on Sakhalin

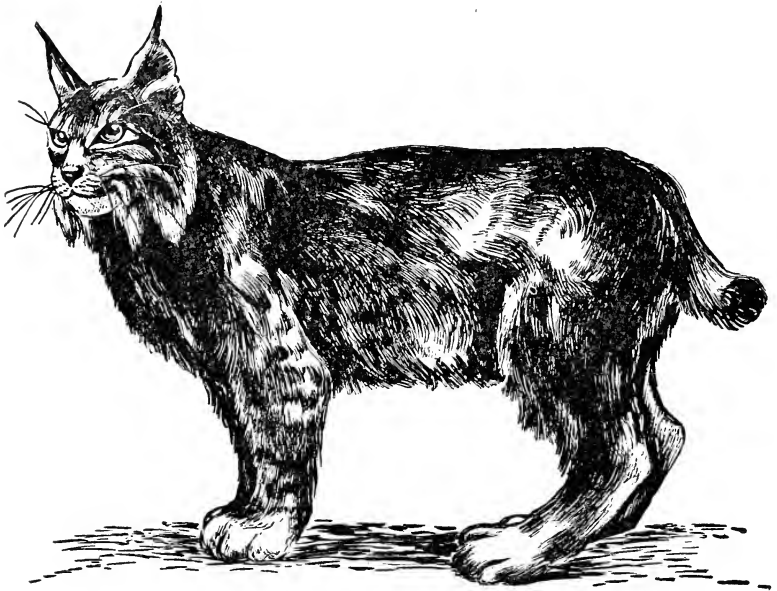


FIG. 46. Asiatic Lynx, *Lynx lynx isabellina*.

bears the name *L. l. borealis*. The form present in Mongolia, Hopei, Szechwan, Tibet, and westward to Turkestan is *L. l. isabellina*. The presence of *Lynx* in the extreme east cape of Siberia or in Kamchatka is not established.

The Chinese form *isabellina* is colored reddish above, with the hair tips frosted; beneath it is white, with a few black spots on the belly and inner sides of the forelimbs. The ear tufts and upperparts of the ears, a spot on the lower part of the cheek, and the tip of the tail are black. The length of head and body

may reach 3½ feet, of the tail nearly 7 inches. The weight is 60 pounds.

TIGERS AND LEOPARDS (SUBFAMILY PANTHERINÆ)

In the Pantherinæ—those large Cats with elastic throat ligaments—Pocock recognized two genera: *Panthera*, for the Lions, Tigers, and True Leopards, and *Uncia* for the Snow Leopard. In the first, the profile of the muzzle above is nearly straight; in the second, it is distinctly arched upward. Lions are not found east of western India.

The Tiger, *Panthera tigris*, with its distinctive color pattern of long narrow black stripes on a tawny ground, is well known. The underparts are white. The blackish ears are each backed by a large white spot. The typical form, the Indian Tiger, extends to Burma and down the Malay Peninsula. Small-sized races occur on Sumatra, Java, and Bali. In south China the local race is *P. t. amoyensis*; in Mongolia, Manchuria, Korea, and Siberia, *P. t. longipilis* (long-haired).

Tigers sometimes are partly white; a completely white specimen has been recorded. In such cases the stripes are brown or reddish black. Black Tigers are reputed to have been seen. The length of the head and body varies from 5 feet 8 inches to 7 feet 3 inches in males, from 5 feet 2 inches to 5 feet 9 inches in females. The tail measures 30 to 36 inches. The height at the shoulder (in life) is unlikely to exceed 3 feet. The weight varies from 350 to 650 pounds.

Tigers are extraordinarily powerful Cats that prey upon almost all large Asiatic game, including, according to Pocock, adult cow elephants. They can leap 15 to 20 feet up a vertical bank; they are good climbers and good swimmers. The gestation period varies from 100 to 112 days. Usually 2 or 3 but as many as 6 cubs may be born. One born in captivity recently weighed 2 pounds 12 ounces. It opened its eyes in 15 or 16 days.

The Manchurian Tiger, *P. t. longipilis*, is distinguished from the south China Tiger chiefly by its slightly paler, much longer and denser coat. The form in Korea, *P. t. coreensis*, has been recognized by Ognev as a distinct race. Sowerby quotes a measurement of 10 feet 5 inches from the nose to the base of the tail, taken on a freshly killed Manchurian Tiger.

The Leopard, *Panthera pardus*, is found through large tracts of Asia and Africa. The typical form came from Egypt. The Indian Leopard, *P. p. fusca*, extends eastward into Burma, the Malay Peninsula, and south China as far as Fukien. In north China the race *F. p. fontanierii* occurs, and in Siberia the paler-colored *F. p. orientalis*, the last extending into Amurland.

The open rosette-like black spots on the tawny ground of the Leopard's fur are familiar to many persons who wear furs. The back of each ear has a spot of white. The underparts are whitish, the spots there fewer and nearly solid. The length of the head and body of *P. p. fusca* ranges from 4 feet 2 inches to 4 feet 8 inches in males and 3 feet 5 inches to 4 feet in females; the length of the tail, from 2 feet 6 inches to 2 feet 10 inches.

Unlike the Tigers, Leopards frequently produce a black variety, known as the Black Leopard. In the Malay Peninsula these are more often found than the ordinary form. Both the black and the normally colored young appear in the same litter. Albinistic Leopards, on the contrary, though they do occur, are rare. In them the basic color may be cream, the spots tan.

A Leopard often has several dens or caves where it conceals itself by day. Usually 2 cubs are born; they stay with their mother for about 6 months. At birth a captive baby Leopard weighed only about 20 ounces. The food of Leopards consists of deer, game birds, and dogs, of which it is especially fond.

The Snow Leopard, *Uncia uncia*, is a cold-country animal, native to the highlands of the Himalayas and Tibet, north to the Altai.

The coat in winter is composed of long, dense, soft fur, on which the dark, rosette-like spots become somewhat indistinct. The general color is gray with a creamy or buffy wash. Some white appears about the eyes and upper lip. The usual white spot appears on the blackish ears. The underparts are white, with a few solid spots. The long, heavily furred tail is spotted above, white beneath. The length of head and body is from 3 feet 3 inches to 3 feet 8 inches; tail 2 feet 9 inches to 3 feet.

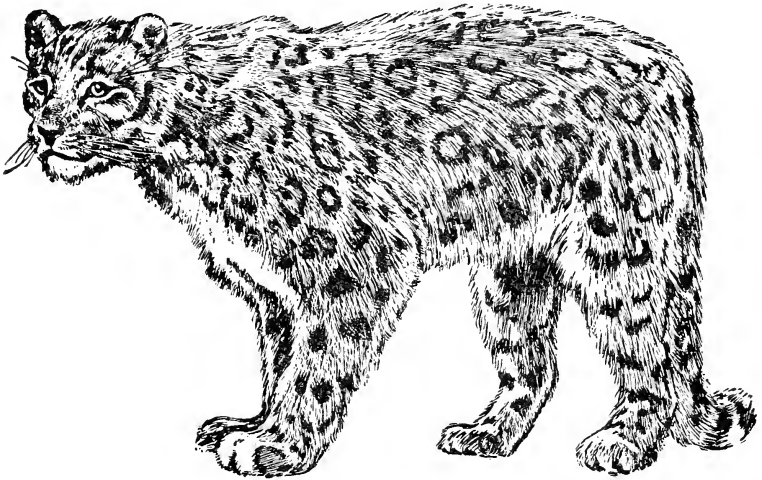


FIG. 47. Snow Leopard, *Uncia uncia*.

The reports of Snow Leopards in eastern Siberia appear to be erroneous. Possibly the long-haired local race of the True Leopard has been mistaken for the Snow Leopard.

THE WHALES, DOLPHINS, AND PORPOISES
(ORDER CETACEA)

The mammals of this order are fish-shaped, aquatic, and virtually hairless. The front limbs are converted into paddles;

the hind limbs are obsolete or represented by rudiments within the body; the tail is broadened horizontally into a transverse fin used for propulsion and for directing the body up or down in the water. The forelimbs are used in balancing and turning, as well as to help drive the Whale through waters. In most Whales the skull and neck bones are compressed and telescoped, thus eliminating the narrowing at the neck and providing the familiar torpedo-shaped outline. The eyes are much reduced for the size of the animals and the ears externally are obsolete. Breathing takes place in the Whalebone Whales through a double blow-hole; a single blow-hole, which can be closed before the Whale submerges and which is formed by the internal union of the two "nostrils," is found in the Toothed Whales. One of the internal air passages in certain kinds of Toothed Whales may be enlarged at the expense of the other. This internal asymmetry, coupled with special air sacs developed on one side only, is indicated externally by the blow-hole being off center.

Marine Whales normally come to the surface to breathe with frequencies dependent upon the species. Howell gives eight to twelve minutes for the Humpback, twelve to fifteen for the Bowhead, but thirty to sixty minutes for the Sperm Whale. River Porpoises probably surface much more frequently.

Whales produce one calf at a time. Being truly mammals, they give milk; the single pair of nipples is situated near the vent.

In the past, whaling has been a very important industry. Relentless hunting of Whales for the oil contained in their bodies, for the "whalebone" of the Whalebone Whales, and more recently for their flesh, to be made into fertilizer or even to be canned, has so greatly reduced their numbers that certain species are verging on extinction. Formerly they were killed with hand-thrown harpoons, later with harpoons shot from guns. More recently they have been slaughtered by the use of harpoons carrying electrical charges that are conducted through the cables attaching them to ships. But perhaps the most efficacious death-

dealer is the harpoon that explodes within the Whale's body, instantly killing the giant "fish."

Attempts have been made to check this slaughter; international conventions have assembled and agreements have been signed. Like many other international covenants, the whaling agreements have had no "teeth" and have depended for their success upon the good sense and good faith of those participating. The agreements have not always been consistently observed, so that the status of many a species of Whale is still precarious in the extreme.

Because this book is restricted to treatment of the mammals of continental eastern Asia, only those members of the Cetacea which enter the rivers will be discussed.¹

The Whales and their allies include two suborders: the Toothed Whales, Odontoceti, and the Whalebone Whales, Mysticoceti. The Toothed Whales, of which only a few are found in our area, comprise four families: Sperm Whales, Physteridæ; Beaked Whales, Ziphiidæ; River Dolphins, Platanistidæ; and the True Dolphins, Porpoises, White Whales, Narwhals, Black Fish, Grampus, all belonging in the Family Phocæidæ.

The Sperm Whales and Beaked Whales are all marine mammals. The River Dolphins are non-marine. Although most species of the Delphinidæ live in the sea, a few, including both beaked (Dolphins) and non-beaked (Porpoises) genera, are at home in fresh water.

THE RIVER DOLPHINS (FAMILY PLATANISTIDÆ)

The few Dolphins of this family, survivors of a once extensive group, are today all found in the fresh or brackish waters of rivers or lakes. Two genera, *Lipotes* and *Platanista*, occur in

¹ A brief review of the marine members of the order was given in *Mammals of the Pacific World*.

Asia; two others, *Inia* and *Stenodelphis*, in South America. "White" Dolphins occur both in this family and in the family Delphinidæ.

The River Dolphins are distinguished from the True Dolphins by having the vertebræ of the neck all distinct and separate, the skull squarish at the back, the jaws produced into a long narrow beak with many teeth in each side, and the line of junction or symphysis of the two halves of the lower jaws very long from front to back.

Of the two Asiatic genera mentioned above, *Platanista* is included in this book only because it goes far up the Brahmaputra River into Assam and is present in the Karnaphuli River, at Chittagong. Both of these streams enter the region treated.

The White-flag Dolphin, *Lipotes vexillifer*, first made known to science in 1914, is a long-snouted white Dolphin found in Lake Tungting, 600 miles up the Yangtse River, China. It bears a remarkably close resemblance to *Inia*, one of the fresh-water Dolphins of South American rivers. *Lipotes vexillifer* is colored above pale blue-gray, appearing whitish at a distance, and is white below. The length is about 8 feet in males, 7 feet in females; the weight 300 pounds. On the back is a low triangular fin, its base about twice as long as its height. The narrow part of the snout is about 14 inches long and only 4 inches broad. The flippers are about as long as the snout. The eyes are very small and the ear openings are like pin pricks. The blow-hole, longitudinal and somewhat rectangular, opens definitely on the left side of the head. It can be closed by a special valve. The small bony crests on the skull behind the rostrum are equivalent to the large "maxillary crests" of *Platanista*. Such crests are undeveloped in the South American *Inia*. The number of teeth on each side of the jaws is 32 to 33 above, 31 to 33 below.

The food is reported to consist largely of eel-shaped catfish which the Dolphins grub out of the lake mud with their beak-like snouts. The Dolphins swim in schools of ten or fifteen indi-

viduals, Lake Tungting is connected, at least during periods of high water, with the Yangtse River; consequently *Lipotes* may well be found sometimes in that river.

The Ganges River Dolphin, *Platanista gangeticus*, probably the most specialized of the few surviving platanistids, is found today only in and near the Ganges and Indus river systems of India. The color is dark gray. The snout is long and compressed. The mouth is armed with numerous strong teeth, the number of which on each side is usually one or two more in the lower jaw than in the upper: 28 to 32 in the upper jaw, 30 to 33 in the lower. The slightly vaulted forehead contains the peculiarly enlarged "maxillary crests," fan-shaped bony processes on the skull behind the beak. The blow-hole is median and longitudinal and the neck distinct (compare with most other Whales). The flippers are broad and abruptly truncated. On the back stands the merest suggestion of a dorsal fin. The length varies from 7 to 9½ feet. Males are slightly smaller and have shorter snouts than females. This Dolphin is supposed to be a bottom-feeder; the food consists of prawns and fish. One or rarely two young are produced at birth. The gestation period is about nine months. The nipples are close to the vent.

THE TRUE DOLPHINS (FAMILY DELPHINIDÆ)

This primarily marine family can be distinguished from the River Dolphins by a combination of characters, including the lack of an extremely long muzzle or "beak"; certain internal characters such as the tendency for the bones of the neck to become consolidated (except *Monodon* and *Delphinapterus*); the shortness of the symphysis of the lower jaws, even in those Dolphins with rather long beaks; the posterior profile of the skull.

When True wrote his monograph of the Delphinidæ, he distinguished the subfamilies Delphininæ, or Dolphins and Por-

poises, and the Delphinapterinæ, containing only the White Whale and the Narwhal. The first subfamily was further subdivided into True Dolphins, which have marked beaks, and Porpoises which lack beaks. He regarded the two genera *Lagenorhynchus* and *Cephalorhynchus* as intermediate in that respect. We have here to consider members of both subdivisions. The Beaked Dolphins include *Sotalia*; the Non-beaked Porpoises include *Orcella* and *Neomeris*.

The Chinese White Dolphin, *Sotalia chinensis*, is one of the white members of that long-snouted genus to which belong the White Dolphins of the Amazon River in South America. It is described as "milky white, with pinkish fins and black eyes" and is about $7\frac{1}{2}$ feet long. The number of teeth is 32 in each jaw, above and below. It is found rarely in the mouths of rivers at Amoy and Canton, China.

The Irrawaddy Porpoise, *Orcella fluminalis*, is a beakless, round-headed Porpoise with a small but distinct, slightly sickle-shaped dorsal fin and tapered, round-tipped flippers. The color, according to Anderson who named it, is pale slaty above, white beneath. The teeth are very few: from 12 to 14 in each jaw, above and below. The total length of adults varies from $7\frac{1}{2}$ to 9 feet. It is very closely related to the marine *Orcella brevirostris*, which, however, has the dorsal fin less falcate. It feeds on fish. The species occurs beyond Bhamo in the Irrawaddy River and for about 100 miles up the Chindwin.

The Black Finless Porpoise, *Neomeris phocaenoides*, is a blunt-headed animal in which the dorsal fin is replaced by a series of small round tubercles. The color is gray-black, scarcely at all paler beneath; but there is a small lighter gray area surrounding each ear opening. The number of teeth varies from 17 to 19 in each jaw. The total length is about 4 feet.

This Porpoise has a curious habitat pattern; it is known in Japan, China, India, and Cape of Good Hope. In China it enters the Yangtse River as far as the Ichang Gorge and also reaches

the Tungting Lake, the home of *Lipotes*. It feeds upon crustaceans.

THE RABBITS, HARES, AND PIKAS (ORDER LAGOMORPHA)

Though rodent-like in certain respects, the Rabbits and their allies may have descended from different lineage. The differences from the rodents displayed by Rabbits are found in various features of the anatomy and in certain types of behavior. Under the first heading come the extra set of small upper incisor teeth, which stand directly behind the main upper incisors; also the fact that comparatively soft, chalky cement fills the folds of the harder enamel in the teeth of the Rabbit Order. Under behavior comes the fact that in grinding up food the lower jaws are moved from side to side, not forward and backward as is usual in the rodents.

The Order Lagomorpha contains two families, the true Rabbits and Hares, family Leporidae, and the Pikas or Whistling Hares, family Ochotonidae, much smaller animals with short rounded ears.

RABBITS AND HARES (FAMILY LEPORIDÆ)

The Rabbits and Hares differ from their allies the Pikas (pronounced "peecka"), by their much larger size and larger, sometimes very large, ears. The hind limbs of Rabbits, unlike those of Pikas, are considerably lengthened. The tail, though reduced in some species to a fluffy tuft, is always distinct; in Pikas the tail is so much reduced as to be concealed in the body fur. Rabbits are virtually voiceless. They lack the power to produce the whistling call of the Pikas but are able to make a hoarse sound if injured.

With the exception of variations in body size, length of ears, and color, the animals of this family bear a remarkably close

likeness to one another, at least externally. They are found through most of the area being considered in this book except the Malay Peninsula.

Of the several Oriental genera of the Hare family that have been distinguished, most may be set aside as not occurring in our area. Among those that can be so neglected are the True Rabbits, *Oryctolagus*, of Europe and northern Africa (the American "Rabbits" are species of Hares), the peculiar Sumatran Hare, *Nesolagus*, and the Luchu Island Hare, *Pentalagus*. The young of the True Rabbits are born in a relatively undeveloped condition, with little or no hair, whereas those of all others, so far as known, are born with a good coat of hair.

Only two genera of Hares need be considered. These are the True Hares, genus *Lepus*, and the Harsh-furred Hare, genus *Caprolagus*. *Lepus* and *Caprolagus* are separated by characters of the skull and teeth that can best be appreciated when the skulls are compared. External characters of *Caprolagus* include relatively coarse fur, extraordinarily short ears (for Hares), short tail and feet, and generally reddish brown coloring. The Indian and Burmese groups of *Lepus* may also be somewhat reddish and have coarse fur, but although their feet are as short as in *Caprolagus* their ears are considerably longer.

All the Hares, whether *Caprolagus* or *Lepus*, have a groove down the front of each of the large upper incisor teeth. In the *Lepus timidus* group and the *L. europæus* group this groove is shallow and uncomplicated; but in a third group comprising most of the Hares of the Indian and Burmese lowlands, the groove is enlarged and deepened and its internal walls are fluted and channeled in a direction parallel with the main groove. The entire groove may be concealed by a filling of comparatively soft cement, just as is the case with the folds in the teeth of the horses and elephants. In America some of the Hares of Texas and Mexico also exhibit this folded tooth structure. Examples of the Hares that possess such deeply grooved teeth are the Black-naped Hare, *L. nigricollis*, of the Indian Peninsula; the

Red-tailed Hare, *L. ruficaudatus*, of northern India and Assam; the Burmese Hare, *L. peguensis*; and the Assam Hare, *L. sadiya*.

The Harsh-furred Hare, *Caprolagus hispidus*, of the east Himalayan foothills and Assam (whence came the specimen on which the genus was based), is the only known species of the genus *Caprolagus*.¹ The ears are unusually short, only 2 inches long, the feet are 3¾ inches long, and the tail, including the hairs, measures only 1½ inches. The skull, compared with *Lepus timidus* and *L. europæus*, is more massively built, even though the animal is actually much smaller; and the teeth, both the incisors and the molariform teeth, are extraordinarily thick and broad. The width of each incisor is more than ⅕ inch, compared with ⅛ inch in *Lepus hainanus* and *L. sinensis*. The groove on the face of each upper incisor has in section a simple V-shape without the complexities to be seen in *Lepus hainanus* or the Indian Hare group; the groove is filled with cement.

The color of the Harsh-furred Hare is rather dark, a mixture of dull brown, blackish, and numerous scattered whitish bristly hairs; the underparts are buffy gray, the feet and hands dull brown, and the ears lack the light-colored fringes commonly seen in *Lepus*. The tail is brown, without white beneath. The length of head and body is only 15 to 20 inches. The number of nipples has been reported to vary from 6 to 10. The animals are reputed to make burrows but the claws seem too long and slender for digging.

The True Hares, genus *Lepus*, can be distinguished from *Caprolagus* by their proportionately narrower incisor teeth and larger ears. For practical treatment the oriental forms are divisible into four groups: the *timidus* group, the *europæus* group, the *hainanus* group, and the *ruficaudatus* group. The last two groups have the grooves in the upper incisor teeth moderately complex and very complex respectively, as stated previously. The other

¹ Contrary to the view expressed by Allen, the Hares of south China are not referable to *Caprolagus*; their teeth and skulls are like those of *Lepus*.

groups have the grooves simple, as in *Caprolagus*, but not filled with cement.

The North Eurasian Hares allied to *timidus*, the typical species of *Lepus*, are distinguished easily from those related to *L. europæus* by the tail being much shorter than the hind foot, while in the latter the tail, including the terminal hairs, is about equal in length to the hind foot. The number of nipples in females of *L. timidus* is eight, while in *L. europæus* it is six. The ear is shorter generally in the *timidus* group than in the *europæus* group. Finally, the upper surface of the tail in *timidus* is gray or brown, in *europæus* blue-black (except the Himalayan Hares).

The *L. timidus* group in the far East includes three minor divisions: the large-footed Siberian Snow Hares, related to the Alaskan Snow Hare, *L. othus*; the Japanese Hare, *L. brachyurus*, and its mainland allies; and the South China Hares, *L. sinensis* and relatives.

The Snow Hares of eastern Siberia belong to four weakly separable races, *Lepus timidus mordeni* from the Maritime Province of Siberia, *L. t. gichiganus* from the region northwest of the Sea of Okhotsk, *L. t. tschukschorum* from extreme northeastern Siberia, and *L. t. kolymensis* from the mouth of the Kolyma River, on the Arctic Ocean. All four of them turn snow-white in winter, with the exception of the black tips of their rather short ears. They weigh from $7\frac{1}{2}$ to $8\frac{1}{2}$ pounds. *Lepus t. orii* from Sakhalin, a large Hare, like *gichiganus* may also turn white in winter; likewise *L. t. abei* of the south Kurile Islands and *L. t. ainu* of Yezo.

The Snow Hares of Greenland are reported to be markedly social in winter, gathering in groups of thirty or forty individuals to feed upon whatever scanty vegetation they can discover among the rocks and snow. It is not improbable that the same kind of behavior will be noticed in the case of the Siberian Snow Hares.

The Japanese Hare, *L. t. brachyurus* (meaning "short-tailed"), and its mainland relative *L. t. coreanus* from Korea agree with the Snow Hares in having short ears (3 to 4 inches) and tails ($2\frac{1}{2}$ to $3\frac{1}{2}$ inches), but their feet are even shorter ($4\frac{3}{4}$ to 5 inches instead of 6 to 7 inches). The color of *brachyurus* is rather plain dull brown mixed with blackish, the top of the tail black, its underside smoky white.

The South China Hares, *Lepus sinensis*, found from Chekiang and Fukien to Hunan and Canton, have been associated by Allen with the Hispid Hare, *Caprolagus*. Their fur is undoubtedly harsher than that of most northern Hares but it is by no means as firm as in *C. hispidus*. More cogent is the fact that the teeth and the anatomy of the skull are so different from the skull of *Caprolagus*. The Formosan Hare, *L. formosus*, is believed to be closely related to *sinensis*, although somewhat paler. The South China Hares constitute a very distinct group of *Lepus*, resembling the *hainanus* group externally but with the grooves of the incisor teeth uncomplicated and free from any filling of cement. The ear, tail, and foot are all small— $2\frac{3}{4}$ to $3\frac{1}{4}$ inches, 2 to $2\frac{1}{4}$ inches, and $3\frac{1}{4}$ to 4 inches, respectively. They may be an offshoot of the short-tailed *brachyurus* group.

The South Eurasian Field Hares, *Lepus europæus*, extend eastward also but tend to keep farther south; eastern representatives are the Tolai Hare, *L. e. tolai* of the Gobi, *L. e. mandshuricus* from Manchuria, *L. e. aurigineus* from the basin of the middle Yangtse. These are large grayish brown Hares with moderately large ears and feet and rather long tails. Although the animals do not turn white in winter, scattered white hairs appear along the sides of *tolai*.

The length of head and body in *L. e. swinhoei* is about 20 inches, tail 3 inches, hind foot 5 to $5\frac{1}{2}$ inches, ear $3\frac{1}{2}$ inches; of *L. e. aurigineus* somewhat more. Sowerby gives the dimensions of *L. e. mandshuricus* as $19\frac{1}{2}$ inches, $3\frac{2}{3}$ to $4\frac{1}{4}$ inches, $4\frac{7}{8}$ to $5\frac{1}{4}$ inches.

The Woolly Himalayan Hares and Gray-tailed Hares, *Lepus oiostalus* and allied races, also relatives of the *L. europæus* group, are remarkable for the length of their ears, which, as in *europæus*, may reach 5 inches. These are beautiful big Hares with the color tone of the fur a mixture of brown and much silvery gray. The tail, which is $4\frac{1}{2}$ inches long, has the upper surface virtually white. The foot is long as in *europæus*. This species occurs in Tibet, north of Nepal and Sikkim, at elevations as high as 16,000 feet and just reaches the extreme southwest of China. Two Chinese races found at somewhat lower levels are *L. o. grahamsi* from Szechwan, 10,000 feet, and *L. o. comus* from Yunnan, southern Szechwan, and extreme northern Burma at 6000 feet. The tail of *grahamsi* is dark gray above, gray or white beneath; of *comus* brown above, elsewhere gray.

The Hainan Hare group includes *Lepus hainanus* from Hainan Island, *Lepus vassali* from sea level in Annam and Cochin-China, and *Lepus siamensis* from Siam and Laos. All have the grooves of the teeth moderately complex but less than in the Indian and Burmese species that follow. All are rather small, with small ears and feet and moderately shortened tails. The color of *hainanus* is tawny brown mixed with blackish, the ear fringes white, the top of the tail blackish, its underparts white, the feet pale brown with white marks, a whitish mark in front of each eye. The underparts of *L. hainanus* are snow-white from the chest to the vent and under the chin, tawny on the neck and throat. Length of head and body about 18 inches, tail $2\frac{1}{2}$ inches, foot 3 to $3\frac{1}{2}$ inches, ear 3 to $3\frac{1}{2}$ inches. *Lepus vassali* and *L. siamensis* are very similar; perhaps they are races of *hainanus*.

Of the Indian Hares—those with complexly grooved incisor teeth—three forms exist in southeast Asia: the Red-tailed Hare, the Burmese Hare, and the Assam Hare.

The Red-Tailed Hare, *Lepus ruficaudatus*, is a north Indian species found along the foothills of the Himalayas and into Assam. The color of the tail above is reddish brown, beneath white. There are 6 nipples. Two young are reputed born at a time (?). The length of the ear varies from $4\frac{1}{3}$ to $4\frac{3}{4}$ inches, of the hind foot (with claws) $4\frac{1}{2}$ to $4\frac{2}{3}$ inches (Waterhouse).

The Burmese Hare, *Lepus peguensis*, a lowland form, has the dorsal surface of the tail black, the general color of the body reddish gray mixed with black, becoming ashy on the rump. The tips of the ears are black, the underparts white. The length of head and body is about 21 inches, the tail with terminal hair 4 inches, the ear $4\frac{1}{4}$ inches, hind foot the same. This animal is known from southern Burma—the lower Irrawaddy Valley and the Thoungyin Valley, but not near the coast.

The Assam Hare, *Lepus sadiya*, is colored much as *L. peguensis* but is paler, and the tail is suffused with reddish. The tops of the hind feet are white. It occurs in northeast Assam.

THE PIKAS, MOUSE HARES OR WHISTLING HARES (FAMILY OCHOTONIDÆ)

The Pikas are soft-furred animals from 6 to 9 inches long, somewhat like tiny Rabbits, with short rounded ears; they look perhaps even more like large tailless meadow mice. The hind legs, compared with those of the Hares, are short. The toe pads appear as naked black spots in the midst of the densely hairy soles. The tail is nearly obsolete.

The word "Pika" is derived from *Peeka*, a word of the Tunguric dialect of Siberia. Pikas are found from Europe to Japan and in eastern Asia from northern Siberia to the Himalayas and northern Burma. They occur also in western North America. In the southern part of their range, the Himalayas, they are found only in the mountains, from 8000 to 18,000 feet, but in northern Siberia and in Sakhalin they descend nearly to

sea level. Their fossil remains are found in England, France, and Germany.

Certain of the Asiatic Pikas excavate burrows; others, including those of North America, live in natural crevices among rocks, where their little mounds of cut vegetation or "hay" are often almost the only indication of their presence in the region.

Various classifications of the Pikas have been proposed, almost all based upon the form of the openings in the front of the bony palate of the skull. For our purposes two divisions are easily recognized: the first with the two openings very long, typical of *Ochotona* proper; the second with the openings short and coalescing to make a single more or less oval hole in the palate, indicative of the subgenus *Pika*. External characters are not very helpful in deciding to which of these two subgenera a given kind of *Pika* belongs.

The subgenus *Ochotona*, which is the typical part of the genus *Ochotona*, extends from the Altai Mountains in central Siberia south through Mongolia, Kansu, and Shansi into Tibet and the Himalaya Mountains. The Dahurian Pika, *Ochotona dahurica*, of Mongolia may be considered the type species. Allied forms within the geographical scope of the present work are *O. tibetana forresti* from the Likiang Ranges in southwestern Yunnan; *O. t. osgoodi* from northeastern Burma, 8000 to 9000 feet; *O. cansa* and *O. c. stevensi*, both from Szechwan.

Certain allied species, which are separated by some writers under the subgeneric term *Ogotoma*, typified by *O. pallasii* of Mongolia, have a central Asiatic pattern of distribution. They are represented in Ladak in the Himalayas at very high altitudes by *O. ladacensis*. These are larger animals with proportionately larger ears and feet. The color of *ladacensis* is light brownish gray, with reddish on the head, the underparts yellowish white. The length of the head and body is 9 inches, of the ear $1\frac{1}{8}$ inches, of the foot almost $1\frac{1}{2}$ inches. The species is found from 14,000 to 18,000 feet in the Himalayas.

The subgenus *Pika*, which includes the three American Pikas, has a more easterly and northeasterly range than true *Ochotona* and reaches the Arctic Ocean in extreme northeastern Siberia. The principal species is *Ochotona alpina*. An allied species, *hyperborea*, has many races in the east: *O. h. kolymensis* at the Arctic Ocean (Kolyma River) and southward, *O. h. littoralis* in the Tschuktshi region, *O. h. mantschurica* in the Khingan Mountains, *O. h. cinereo-fusca* in Amur, *O. h. coreana* from Korea at about 3000 feet.

Other related species inhabit the interior of Asia from the Altai Mountains southward to Tibet, Szechwan, and Kansu at about 10,000 feet, where the rather large Red-eared Pika, *P. erythrotis*, is found.

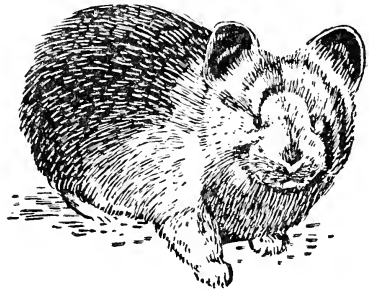


FIG. 48. Asiatic Pika, *Ochotona hyperborea*.

The Red-eared Pika is colored drabby gray, with the ears bright rusty red and a tuft of white hairs at their bases in front. The underparts are whitish, with a slightly different buff color and buff wash reaching back along the middle of the body. The feet are white. This is the winter color; in summer the dorsal fur is reddish throughout. The length of the head and body is 8 to 9 inches, hind foot $1\frac{1}{2}$ inches.

The Manchurian Pika, *O. hyperborea mantschurica*, is said to live in crevices and burrows among basaltic rocks, and to conceal stocks of hay in hollows and crevices instead of assembling it in heaps in the open like the Dahurian Pika. It is social and may sometimes be found in large colonies. Long, well-worn runways are used. The voice is a sharp, short whistle, in marked contrast to the modulated, almost musical tones of the Dahurian Pika. This Pika lives in moss-hung forests of larch and rhododendron. It is subject to parasitism by the fly *Hypoderma*, which

also attacks Hares, the maggots forming cells in the animals' skins.

The summer fur is mixed gray and russet with gray bases, the underparts dull white with gray bases. In winter the coat becomes grayer, a mixture of ochraceous and black, the underparts buffy white, gray based. The length of head and body is 7 inches, ear $\frac{3}{4}$ inch, hind foot $1\frac{1}{8}$ inches. The color of the races found farther north is substantially the same. Members of this group are found on Sakhalin and the Japanese islands Yezo and Hokkaido, also on Kamchatka Peninsula.

The Yezo or Hokkaido Pika, from 600 to nearly 7000 feet up the mountains, stores sixteen kinds of Japanese alpine plants in its "haystacks" under rocks. Most of the plants are woody, like willow, huckleberry, and crowberry; not a single kind of grass has been found.

The Sakhalin Pika lives in communities among rocks in alpine meadows at 2400 feet and lower in the south-central part of the island. In its storage heaps larch, maple, blackberry, mosses, and grasses have been identified.

The Kolyma River Pika, *Ochotona h. kolymensis*, has soft pelage colored yellow-brown, varied with black on the back, underparts yellowish white with gray bases. The length of head and body is about 6 inches, hind foot 1 inch. This Pika, one of the smallest forms, and the most northerly of all, is found in rocky places almost at sea level.

THE GNAWING MAMMALS OR RODENTS (ORDER RODENTIA)

Many years ago it was customary to divide the rodents into four principal groups: Hares, Squirrels, Rats, and Porcupines. Since then the Hares (and Rabbits) have been recognized as distinct from the others both in structure and in function. Although Hares also possess large upper and lower front cutting teeth on each side, those teeth are employed more for clipping twigs and shoots than for persistent gnawing of nuts or wood.

Moreover, directly behind this upper pair of clipping teeth is a pair of much smaller teeth, the like of which is found in no true rodent. Numerous other important differences contribute to the view that Hares and their allies are at best remotely related to Squirrels, Rats, and Porcupines.

Even leaving aside the Hares, the three groups of True Rodents are divided from one another by gulfs of structural difference. Many millions of years ago the Sciuromorpha or "squirrel-shaped," the Hystricomorpha or "porcupine-shaped," and the Myomorpha or "mouse-shaped" rodents were already completely distinct. There are numbers of seeming exceptions to this classification in each of the suborders, due to the use of the word "shaped"; there exist, for example, mouse-shaped Sciuromorpha and Hystricomorpha, but the detailed anatomy of such animals proves their true affinities.

SQUIRREL-LIKE RODENTS AND RELATIVES
(SUBORDER SCIUROMORPHA)

This suborder comprises the superfamily Sciuroidea, Squirrels and Beavers; the American Pocket Gophers and relatives, superfamily Geomyoidea; and the American Mountain Beavers, Aplodontoidea.

SUPERFAMILY APLODONTOIDEA

The Sewellels or Mountain Beavers of the American Pacific coast are no longer found in Asia. That they existed there formerly is proved by discovery in Mongolia of the fossil form, *Aplodontia asiatica*.

THE SQUIRRELS AND BEAVERS
(SUPERFAMILY SCIUROIDEA)

The idea that Squirrels, Woodchucks, and Beavers are built on the same broad structural plan and are more closely related

to one another than to other rodents, may at first thought seem strange. Yet everyone realizes that Ground Squirrels are without question merely short-tailed Squirrels with burrowing habits. A moment's thought will show that a Woodchuck is just a thick-bodied, oversized kind of Ground Squirrel. Beavers also are essentially large Squirrels, although they manifest many peculiar adaptations that fit them for life in water, including the broadened paddle-like form of the tail. Study of fossil Beavers has shown that much experimental evolution took place in the Beaver world before the present-day Beaver came upon the scene.

The Flying Squirrels, sometimes considered a subfamily of the Sciuridæ, are here treated as a family, the Pteromidæ.

SQUIRRELS AND MARMOTS (FAMILY SCIURIDÆ)

It is difficult to offer a succinct list of the squirrel-like forms belonging to this family. But in very broad terms the following is a synopsis of the Squirrels of eastern Asia: Tufted-eared Squirrels of the north (true *Sciurus*); Striped Squirrels of the warmer parts (*Lariscus*, *Menetes*, and *Tamioops*); usually unstriped, typically squirrel-like genera (*Ratufa*, *Callosciurus*); Long-nosed Squirrels (*Dremomys*, *Rhinosciurus*); Chipmunks and Rock Squirrels (*Eutamias*, *Sciurotamias*, *Rupestes*); the extremely short-tailed Susliks (*Citellus*) and Woodchucks (*Marmota*). The largest of the genera listed is *Callosciurus*, a genus of often brilliantly colored, medium-sized Tree Squirrels found mainly in the oriental tropics.

The Eurasian or True Squirrels, genus *Sciurus*, contain, according to modern views, only the typical species *S. vulgaris*, and *S. anomalus* of southwestern Asia, which is sometimes treated as a distinct subgenus, *Tenes*. The entire system of the American Tree Squirrels is also thought to be related to *Sciurus*. The name "*Sciurus*" has at various times been employed for the major part of the Squirrels of the world, which is readily

understandable when the close general resemblance of all the Squirrels to one another is considered. As used in this book, however, *Sciurus* is restricted to the tufted-eared *S. vulgaris* of the Old World temperate zone.

Sciurus vulgaris, originally described from Upsala, Sweden, by the zoologist Linnæus, is a red Squirrel, with the underparts whitish. A chiefly southern color phase is essentially dark brown instead of red. The ears, especially in winter, have tufts of hair colored like the body. The red tail may be somewhat grizzled. Females have 4 pairs of nipples. The length of the head and body is about 8½ inches, of the tail about 7 inches, of the foot 2¼ inches.

Many races of this Squirrel are known both in Europe and in Asia, where they tend to be darker than the European form. In the extreme east of Asia the following races are known: *S. v. manchuricus* from Manchuria, *S. v. orientis* from Korea and Yezo, *S. v. chiliensis* from seventy-five miles northeast of Peking, *S. v. lis* from Japan; *S. v. rupestris* from the lands bordering the Sea of Okhotsk, from Sakhalin and adjoining continental areas; still farther north *S. v. jacutensis* reaches the north coast of the Okhotsk Sea from inner Siberia and continues east to Kamchatka. It is shown by Ognev as present on most of that peninsula, and a special offshoot, *anadyrensis*, is marked as occupying far eastern Siberia between long. E. 170° and 180° and just outside the Arctic Circle. Bergman has indicated that the arrival of this Squirrel in Kamchatka is a recent event. The color of the Chihli Tufted-eared Squirrel is dark gray in the winter, mixed red and blackish in summer. The Manchurian race is depicted by Ognev with a lateral band of bright tawny separating the smoky gray dorsal color from the white of the underparts.

Of the color variability of *S. vulgaris*, Serebrennikov asserts that the darker the forest (the more cedar and fir), the damper the climate, and the greater the elevation of the land, the darker are the Squirrels; and conversely, in light, open pine forests the

Squirrels are paler colored. He found tendencies toward albinism in east Siberian Squirrels, exhibited in some by a white girdle around the body and partial whitening of the tail, hands, and feet.

The Three-striped Palm Squirrel, genus *Lariscus*, often associated with the Long-nosed Squirrels, is thought by Zahn to be a subgenus of the Indian Palm Squirrels, *Funambulus*. The type species is *Lariscus insignis* from Sumatra. The generic range includes the Sunda Islands and lower half of the Malay Peninsula. There are several island races; *Lariscus i. meridionalis* occurs at Singapore and *L. i. jalorensis* from the lower Malay Peninsula to Trang in peninsular Siam.

Mainland *Lariscus i. jalorensis* of the Malay Peninsula are gray, with some reddish on the thighs and shoulders. There are three black dorsal stripes, the center one from the crown of the head. The underparts are white or buff except the insides of the thighs, which are yellowish. The feet are dark brown. The tail is mixed black and tawny. The number of nipples in the type species is 6. The length of the head and body is approximately 8 inches, tail $4\frac{1}{2}$ inches, hind foot $1\frac{4}{5}$ inches.

The Multi-striped Palm Squirrel, genus *Menetes*, has the general color grizzled black and orange. A median pale central stripe along the back is margined by black stripes, beneath which conspicuous yellowish white stripes extend from the shoulders to the thighs. Beneath this comes a second black stripe, another pale stripe, and a dusky shade that passes into the yellowish white of the underparts. The head is washed with reddish. The whitish underparts pass into the reddish of the underside of the tail. The incisor teeth are deep orange. There are 6 nipples. The lateral and median dorsal stripes appear to be developed only seasonally in some of the races.

The head and body measure $7\frac{1}{2}$ inches, the tail 6 inches, the hind foot $1\frac{3}{8}$ inches.

The type and only species, *M. berdmorei*, chiefly ground-living, was first made known from the Isthmus of Kra, Malay

Peninsula. This genus, found from east of the lower Irrawaddy River in Burma to Indo-China and Cochin-China, and through the upper half of the Malay Peninsula, is replaced in the lower Malay Peninsula by *Lariscus*. Races of *M. berdmorei* include *M. b. koratensis* from eastern Siam; *M. b. mouhotei* from Cambodia, southern Annam, and Cochin-China; *M. b. moeres-*



FIG. 49. Multi-striped Palm Squirrel, *Menetes berdmorei*.

cens, doubtfully distinct, from Annam; *M. b. consularis* from northern Siam; *M. b. decoratus* from Mt. Popa, Burma.

The Giant Squirrels, genus *Ratufa*, the largest of the Squirrels, have broad forefeet, unshortened bushy tail, and ears tufted or untufted according to species. A large number of forms of this conspicuous group of Squirrels have been described, but a recent revision by Zahn reduces them all to three species: the Long-tailed Black Giant Squirrels, the Pale Giant Squirrels, and the Hip-marked Giant Squirrels. The first of these is Indian, stretching across Burma and northern Indo-China to southern China and Hainan. The second is found from Arakan to the Malay Peninsula and Cochin-China, as well as on Sumatra and Java. The third belongs in the Sunda region and the lower half of the Malay Peninsula.

In Ellerman's view, the genus does not readily divide into groups. He lists instead nine full species.

The type is *Ratufa indica* of Bombay.

The Long-tailed Giant Squirrels, *Ratufa macrura*, are the largest of the Giant Squirrels, attaining in one form a head and



FIG. 50. Long-tailed Giant Squirrel, *Ratufa macrura*.

body length of almost 18 inches. The color above is dark brown, black, or red. There are no color marks on the thighs. Bicoloring of the tail, if present at all, is indistinct. The ears are short-tufted and there are oblique stripes on the cheeks.

The typical race of this Giant Squirrel lives in Ceylon; several others are found in India. In the area to which this book is devoted are found six very distinct forms, treated by Ellerman as subspecies of *R. gigantea*, which he considers a species distinct from *macrura*: *Ratufa m. gigantea* of Assam; *R. m. lutrina* of the west side of the upper Chindwin River, Burma;

R. m. felli of the lower Chindwin River; *R. m. stigmosa* of northern Siam; and *R. m. hainana* of the Island of Hainan.

Ratufa macrura stigmosa of Siam is black or reddish black all over the upperparts and tail. The underparts are yellowish brown, with the bases of the hairs gray, the yellowish color extending along the insides of the limbs to the wrists and ankles, and forward on the neck, beneath the ears and eyes to the cheeks, sides of nose, throat, and chin. The underside of the tail is black. *Ratufa m. gigantea* of Assam has substantially the same color scheme, but the color of the underparts is often whiter. *Ratufa m. hainana* of Hainan Island, China, on the contrary, is colored beneath deep orange-brown.

The length of head and body in *R. m. stigmosa* is 16½ inches, of the tail 18½ inches, of the hind foot 3½ inches. Miller gives the dimensions of *gigantea* as: head and body 16½ inches, tail 24 inches, hind foot with claws 3¾ inches.

The Pallid Giant Squirrels, *Ratufa bicolor*, also large members of the genus, are divided into a large number of races, most of them confined to the Sunda Islands and others. The ears are untufted and the cheeks unstriped. The general color is ash-brown and there are no marks on the thighs. According to Ellerman, this Squirrel can be separated into three full species on the mainland: *bicolor* proper, *phæopepla* (gray-coated forms), and *melanopepla* (black-coated forms). True *R. bicolor* and its races seem confined to the islands but its continental representative *melanopepla* appears as several mainland races: true *melanopepla* in southern Siam, *peninsulæ* and *phæopepla* in Tenasserim and peninsular Siam, *marana* at Mount Popa, Burma, and *smithi* in south Annam.

The back in *R. bicolor* is pale ashy brown, slightly darker along the center, and becoming dark brown on the shoulders, head, and limbs. The underparts are brownish white (brown hair bases showing through white tips), the inner sides of the limbs entirely white. The hands and feet are blackish brown.

The tail is dark brown, with a long white tip to each hair, the entire tail being transversely banded with brownish and whitish. The proportion of brown to white in the dorsal body hairs is variable; greatly worn specimens are dark, while those in fresh coats are nearly white. This is a strictly arboreal Squirrel that lives in the tops of the highest trees in the forest.

Ratufa m. melanopepla of lower Siam has untufted ears, the upper surface blackish, the underparts tawny yellow. No black stripe appears on the face behind the whiskers. The length of the head and body is $14\frac{1}{2}$ inches, tail $17\frac{1}{4}$ inches, hind foot $3\frac{1}{2}$ inches. In *R. b. smithi* from Langbian Mountains, southern Annam, the back is buffy, the tail hairs black, tipped with rusty brown, and the yellow of the limbs sharply margined. The feet and hands are black.

The Hip-marked Giant Squirrels, *Ratufa affinis*, are markedly smaller than either *macrura* or *bicolor*, the length of head and body only 14 inches or less. The general color of the body is pale, never black. The tail is bicolored, and there are pale marks on the thighs. This Squirrel was first recorded from Singapore. It is represented northward to Siam, and there are many island races. The mainland forms of *R. affinis* are *auri-venter* of Malacca, Johore (Ellerman), *interposita* of Selangor, *frontalis* of Perak, and *pyrsonota* of Trang, lower Siam.

Ratufa affinis pyrsonota from Siam is light grayish brown on the head, body, limbs, and tail, with the hands and feet brownish black. The underparts are clear orange-brown except the chin. The chin, cheeks, and sides of the head are clad with short white hairs; the sides of the nose in front of the whiskers are also white, and a large irregular whitish area appears on each thigh. The underside of the tail has extremely short hairs, leaving exposed to view the pale buff-colored bases of the long brown lateral hairs. The tip of the tail is brownish gray.

Ratufa affinis affinis of Singapore varies from drab to gray-brown above. Its other coloring is much as in *R. a. pyrsonota*,

except the feet, which are white or buff instead of blackish. The length of the head and body is 13½ inches, of the tail 15 inches, hind foot 3 inches.

The Oriental Tree Squirrels, including the Forest, Prevost's, Red-bellied, Malay, Black-striped, White, Plantain, and Lesser Tree Squirrels, genus *Callosciurus*, are an enormous group of Squirrels of southeastern Asia and the East Indies, which show extraordinary divergence in color pattern and represent, according to Ellerman, some twelve distinct species groups, of which two, *Tamiops* and *Tomeutes*, are separately treated in this book. The extreme variability in color between one race and the next has been pointed out by Carter and others. In the Chindwin Valley alone the former records three distinct races of *Callosciurus* on the west bank and eight races on the east.

The Oriental Tree Squirrels, with the exception of the Lesser Tree Squirrels and Lowe's Tree Squirrels, are of moderate size. They have untufted ears and extremely complex male sexual organs. Blanford states that many species have 2 pairs of nipples, 1 pectoral, 1 inguinal, but Allen writes that the two pairs are abdominal. Few young are born. The northern limit of the genus is about lat. N. 32° in China (*C. erythræus*) or as far north as Hopei if *Tamiops* is included.

The type species of *Callosciurus* is Prevost's Squirrel of the Malay Peninsula.

The Prevost's Tree Squirrels, *Callosciurus prevosti*, those ornate Squirrels of Malacca that induced Gray to propose the name *Callosciurus* (meaning "beautiful squirrel"), are believed by Ellerman to consist of only a single species, although in that species he places no less than thirty-eight races, almost all of which are island forms. Prevost's Squirrel is essentially black above, deep chestnut below, with a broad white stripe along the sides from the cheeks to the thighs. A short, rather variable black stripe runs between the shoulders and thighs immediately

beneath the white stripe. The tail is black. The length of the head and body is about 10 inches, of the tail nearly 11 inches, of the hind foot about $2\frac{1}{3}$ inches.

Typical *C. prevosti* came from Malacca. The form *C. p. humei* is from Selangor, *C. p. wrayi* from Pahang. In *humei* the red of the underparts spreads up over the shoulders and a white spot appears behind the ear.

The Red-bellied Tree Squirrels, *Callosciurus erythræus*, are representative of a large group occupying most of southern China from a little north of the Yangtse, south and west to Siam, Assam, and into India. The type locality of *C. erythræus* is unknown, but it must lie within the regions named.

The color pattern in *erythræus* typically includes reddish underparts and a trace of a line along the middle of the underside of the body. On the back the color is uniform olivaceous, a mixture of greenish gray and reddish. The ears, cheeks, chin, and muzzle are grayer, and the backs of the hands and feet blackish. The tail is like the body, except the tip, which becomes whitish. This description applies chiefly to the race *C. e. castaneiventris* of Hainan. The length of the head and body is from 8 to 9 inches, of the tail 7 to 8 inches, hind foot about 2 inches.

A considerable number of other races or species related to *C. erythræus* are known. In China, all forms have the tip of the tail reddish instead of whitish. The northeastern Chinese race, *C. e. styani*, from Anhwei at the mouth of the Yangtse, has the ears colored like the back, the underparts grayish white washed with buff instead of red. The form found between Chekiang and Kwangtung, *C. e. ningpoensis*, is as the last but the belly is red. Farther west two races have reddish ears, *C. e. michianus* from northern Yunnan with the dorsal surface evenly colored, and *C. e. gordonii* from southwest Yunnan and northern Burma with the mid-dorsal area paler than the sides. No less than four names have been given the Red-bellied Squirrels found in Formosa.

To the south of China the species *erythræus* is continued

through a number of other representative races: *hendeei* in the mountains of Tonkin, *rubeculus* in peninsular Siam and *youngi* in Pahang, Malay Peninsula; in Burma occur *gordoni* of upper Burma, *kinneari* of the upper Chindwin River, *crotalius* of the lower Chindwin and *hyperthrus* from Tenasserim, while in the Jaintia Hills, Assam, are found the forms *wellsi*, *aquilo*, and *nagarum* (both from Sadiya), *intermedius* and *punctatissimus* (from Cachar). All of the foregoing are races of *erythræus*, to which they bear a close general likeness.

Besides the races of *erythræus* already described, at least nine full species of *Callosciurus* are members of the Red-bellied Squirrel group, even though the underparts of many are not red. These include *C. flavimanus* of Annam, *C. sladeni* of Burma, *C. ferrugineus* of Siam and Cambodia, *C. cockerelli* of northern Siam, *C. finlaysoni* of Siam, *C. bocourtii* of Siam, *C. atridorsalis* of Siam and lower Burma, and *C. griseimanus* of Annam, Cambodia, and Cochin-China.

The Yellow-handed Tree Squirrel, *Callosciurus flavimanus*, has the upper surface and the limbs grizzled gray and the underparts maroon-red. The hands and feet, muzzle and ears are buffy yellowish. The tail has the tip buffy. There is no mark on the flank. The length of the head and body is 9 inches, of the tail 8 inches, of the hind foot slightly less than 2 inches. Lost sight of since it was described in 1832, this species was rediscovered about 1927 by Delacour at Col des Nuages, central Annam. Its general distribution includes the central hills of Annam and parts of Laos. Several additional races of this Squirrel are now known: *C. f. dactylinus* from Dakto, south of Hué, Annam, and *C. f. contumâx* from Kontoum, 30 miles farther south than Dakto, both regions of the Annam plateau at 3000 feet. From Hué, Annam, and Napé, Laos, comes the race *S. f. pirata*, and *C. f. bolovensis* is from Bolovens Plateau, southern Laos. There is yet another form, *C. f. quantulus*, from Laos and Annam.

Sladen's Tree Squirrel, *Callosciurus sladeni*, is typically colored grizzled olive-gray on the back. The muzzle and face are reddish orange almost to the ears, the feet and hands also orange, with the tips of the fingers and toes black. The ears are buffy, mixed with black. The tail is like the body except its tip,



FIG. 51. Sladen's Tree Squirrel, *Callosciurus sladeni*.

which is red. The underparts are orange. The length of the head and body is 10 inches, of the tail 8 inches. The typical form occurs at Thizyain and Kindat, both on the Chindwin River, Burma.

Callosciurus sladeni is perhaps the most highly variable species of Tree Squirrel known. The numerous many-colored races include *C. s. midas* from Myitkina, in which the red of the face does not reach the forehead and the feet are more rufous; *C. s. bartoni* from fifty miles east of Homalin, which has black lateral stripes and the muzzle and feet cream-colored; *C. s. short-*

ridgei from the upper Chindwin, mottled gray as in *sladeni*, but with the face gray and the hands and feet straw-color; *C. s. fryanus*, with face, hands, and feet buffy white; *C. s. careyi*, with body color generally light straw-brown and hands and feet whitish. *Callosciurus sladeni haringtoni* from the Chindwin Valley has the upperparts cream-buff, the underparts also buffy. A distinct black line along the side separates the upper from the under color. The elbows, knees, fingers, and toes are blackish; *C. s. solutus*, also from that valley, lacks the black lateral stripes; *C. s. millardi* is dark yellowish gray with the face, hands, and feet white, the fingers, toes, elbows, and knees blackish, and the tail straw-colored; *C. s. rubex* is strongly reddish along the middle of the back, head and face, hands and feet. The sides are russet-brindled and the tail a mixture of red and black. *C. s. vernayi*, originally from Tapa Hka (26° 9' N., 96° 16' E.), is less ferruginous than *rubex*, but olive-gray with a brown wash, and the tail is colored throughout like the body; the underparts are reddish. All these forms of *sladeni* come from Burma.

The Russet Tree Squirrels, *Callosciurus ferrugineus*, are colored reddish brown above, the underparts orange-red; the tail at the base is like the back but the distal half is orange rufous. The length of the head and body is from 8 to 9½ inches, tail from 6½ to 8 inches, the foot about 2 inches. The typical Russet Tree Squirrel is from Pegu, lower Burma. Its several races include *C. f. williamsoni* from Mekong River, Laos; *C. f. herberti* from southeastern Siam; *C. f. phanrangis* from southern Annam; *C. f. splendens* and *C. f. cinnamoneus* from Cambodia; *C. f. primus* from Mt. Souket, northern Siam; *C. f. menamicus* from northern Siam; *C. f. annellatus* from Angkor, Cambodia, and Laos west of the Mekong; *C. f. splendens*, also from Cambodia.

Osgood points out that in *williamsoni*, the nearest relative of which is *menamicus*, the underparts, at least in some pelages (seasonal?), are darker than the upperparts.

Cockerell's Tree Squirrel, *Callosciurus cockerelli*, is a small species with bright red back, gray sides, and white underparts. The edges of the ears are white, the limbs and feet grizzled gray. The basal part of the tail is mixed red and white, the terminal half almost completely white. The length of the head and body is $8\frac{1}{4}$ inches, of the tail $8\frac{3}{4}$ inches, hind foot slightly less than 2 inches. This Tree Squirrel is known only from northern Siam.

The Siamese White Tree Squirrel, *Callosciurus finlaysoni*, has the fur nearly white with gray bases, the tail also white, with a few black hairs added. The length of the head and body is about $8\frac{1}{2}$ inches, of the tail $8\frac{1}{2}$ inches, of the foot just under 2 inches. Although the form originally described from Siam was white, this Squirrel is known to be almost as variable as *C. sladeni*. Specimens are often taken that have patches of red on the white, or even have red predominating and the white reduced to a few spots. Osgood records the species from Kratie, Cambodia. White examples of this Squirrel are remarkably similar to *C. sladeni haringtoni* of Burma.

The Siamese Black Tree Squirrel, *Callosciurus bocourtii*, has the hairs of the body and limbs black, tipped with red, and the underparts and inner sides of the limbs yellowish white. The head is reddish brown, the ears brown with a few white hairs, the face, cheeks, and throat whitish. The tail basally is colored like the body but terminally is strongly reddish, and beneath somewhat yellow. The head and body, and the tail each measure about 11 inches (Milne-Edwards). This Squirrel is found in the neighborhood of Ayutha, Siam. Other races are *C. b. sinistralis* of central Siam, *C. b. dextralis* of the lower Me-Ping Valley, Siam, *C. b. grutei* and *C. b. lylei* both of northern Siam, and *C. b. floweri* of Bangkok.

The Siamese Black-backed Tree Squirrel, *Callosciurus atridorsalis*, is generally colored a shade of gray, composed of buff and black, which becomes whitish on the limbs. The middle

of the back is blackish and around the eyes reddish, the underparts reddish chestnut, the chin and throat buffy gray, the tail blackish. The length of the head and body is about $8\frac{3}{4}$ inches, of the tail $7\frac{1}{2}$ inches, hind foot almost 2 inches. The typical form is reported from Moulmein, Burma (Ellerman). Known races are *C. a. thai* of central Siam, *C. a. shanicus* from north Shan States, *C. a. zimmeensis* from north Siam. In the last named the black area of the back is almost obsolete. The species also reaches Laos and Cochin-China.

The Gray-handed Tree Squirrel, *Callosciurus griseimanus*, was compared originally with the Yellow-handed Tree Squirrel. The body color is a grizzle of light gray and black, the underparts bright red, though the red is not continued to the throat. The hands and feet are clear yellowish gray. The head and muzzle are grizzled like the back. The length of the head and body is 8 inches, tail 7 inches, hind foot 2 inches. This Squirrel was first described from Saigon, Cochin-China. There are races of doubtful validity, *C. g. leucopus* from Cambodia and *C. g. vassali* from Ninh Hoa, Annam.

The Gray-headed Tree Squirrels, *Callosciurus caniceps*, with type from northern Tenasserim (Ellerman), are chiefly members of a single widely distributed species. The normal color is gray, with the top of the head, the feet, and the underparts paler gray. The tip of the tail is black. According to Bonhote, this species puts on a bright dress for the breeding season, just as many birds do. At that time (January) the back becomes deep orange and the underparts, limbs, tail, and face become reddish, the hairs being red-tipped with black bases. The length of the head and body is about $8\frac{1}{2}$ inches, of the tail 8 inches, of the foot $1\frac{3}{4}$ inches.

The *caniceps* group is closely related to the *erythraeus* group. Many forms have been described from comparatively restricted areas. Several mainland races are recognized, though most occur on nearby islands. The races of the Malay Peninsula include

concolor from Malacca, *davisoni* from Tenasserim, and *milleri* from Trang, peninsular Siam. Apparently only 1 young one is born.

The species *C. imitator*, a plainly colored Squirrel from Tonkin, northern Laos, and northern Annam is related to *caniceps*. Its upperparts, including the ears, face, and crown, are reddish cinnamon, underparts "blue-gray," the sides grayish cinnamon, hands and feet gray, tail grizzled black and yellowish, the tip black. The length of the head and body is $8\frac{1}{2}$ inches, tail $7\frac{3}{4}$ inches, hind foot $1\frac{3}{4}$ inches.

The Plantain or Striped, and Black-banded Tree Squirrels, *Callosciurus notatus* and allies, a group greatly developed on the Sunda Islands, are represented on the mainland as far north as Siam by comparatively few forms.

The general color plan in the *notatus* group includes a dorsal color of red-tipped black hairs, and reddish feet; the face and a ring around the eye are generally reddish. The underparts vary from chestnut to reddish orange. There is a pale stripe, beneath which is a pure black stripe, along each side. The ears are somewhat reddish. The length of the head and body is about $8\frac{1}{2}$ inches, of the tail 7 inches, of the hind foot $1\frac{1}{2}$ inches (Bonhote).

The Plantain Squirrel, *C. notatus*, originally of Java, is represented by the races *singaporensis* of Singapore, *subluteus* of Johore, *peninsularis* of Pahang; in Trang, peninsular Siam, and south to Johore the race *miniatus* is found.

The Black-banded Tree Squirrels, *C. nigrovittatus* of Java, appear on the Malay Peninsula as *C. n. johorensis* and farther north as *C. n. bilimitatus*. The general color of *C. nigrovittatus* is black, finely speckled with red, each hair gray at the base, reddish near the tip, and black at the tip. The face is reddish brown. The underparts are pale smoky gray, dark at the hair bases, hoary at the tips. There is a pale, rather yellowish lateral line. A black line is also present on each side. This species is distin-

guished from the previous one by its gray instead of red underparts. The length of the head and body is about 8 inches, of the tail $7\frac{3}{4}$ inches, of the foot $1\frac{3}{5}$ inches.

The Bushy-tailed Tree Squirrels, *Callosciurus hippurus*, are essentially a Sunda Islands group. Only one form, the typical race, *C. h. hippurus*, is found in the lower part of the Malay Peninsula, extending from around Malacca, as far north as Trang, peninsular Siam. The group is well represented, also, in the Philippines. The color of the back, sides, top of neck, and tail is a grizzle of black and tawny yellow. The top and sides of the head and the outer sides of the limbs are grizzled black and white. The feet are blackish, the underparts pale brown. The tail is black, slightly grizzled at the base. The length of the head and body is about 11 inches, of the tail 10 inches, hind foot $2\frac{2}{5}$ inches.

The Lesser Tree Squirrels, *Callosciurus tenuis*, are unusually small compared with most members of the genus, and the tail is narrower and more thinly haired. The hind foot is less than $1\frac{1}{2}$ inches long. The typical species is from Singapore. The back and limbs are colored grayish brown, with a yellow mark on the outside of the thigh. There is a trace of reddish on the sides. The underparts are pale yellowish gray. The tips of the hairs of the tail are yellowish.

Three races of *tenuis* are recognized on the mainland: the race *C. t. tahan* is found in Pahang, *C. t. gunong* in Bandon, peninsular Siam, and *C. t. surdus* in Trang, peninsular Siam. Three other species are found on the Sunda Islands.

Lowe's Tree Squirrels, *Callosciurus lowei*, small-sized like *tenuis*, with the length of the foot less than $1\frac{1}{2}$ inches, are found chiefly on Sumatra and Borneo. The typical race comes from Borneo. On the mainland two forms are known, *C. l. robinsoni* from Patani and *C. l. alacris* from the Selangor-Pahang boundary, both in the Malay States.

The former, the larger of the two, is grizzled black and red,

becoming grayer and lighter on the flanks and sides of face. Its underparts are buffy white with a trace of reddish on the hind limbs. The tail above is like the back, below reddish. The length of head and body is $5\frac{1}{4}$ inches, of the tail $3\frac{3}{4}$ inches, hind foot $1\frac{1}{4}$ inches. The dimensions of the smaller but otherwise very similar *C. l. alacris* are: head and body $4\frac{1}{4}$ inches, tail $3\frac{2}{3}$ inches, foot $1\frac{1}{4}$ inches.

The Striped-bellied Tree Squirrels, *Callosciurus quinquestriatus*, form a natural group in which the ventral surface has three longitudinal dark stripes, one in the center, separated from each other by white stripes. They are found in northern Burma and Yunnan. There is one species with three indistinct races. The typical form is olive-gray, washed with red along the back, the underparts striped from the chest backward as stated above, the tail colored like the back with the tip black, the toes blackish. The length of the head and body is $9\frac{1}{2}$ inches, tail 7 inches, hind foot almost 2 inches.

The forms *C. q. imarius* from north Burma and *C. q. sylvester* from western Yunnan have been distinguished. The typical form came from the Kakhyen Hills, the Burma-Yunnan border.

The Hoary-bellied Squirrels, *Callosciurus (Tomeutes) lokroides*, in the opinion of Ellerman, is a group of four or five small-sized Squirrels found only in Burma, Assam, Bengal, and Sikkim. The color of *Callosciurus lokroides* is brown, with the hairs orange-tipped; the underparts reddish gray. The tail is rather narrow. The hips are grizzled gray and have a prominent whitish hip patch. There are only 6 nipples in the female. The length of the head and body is about $8\frac{1}{2}$ inches, tail 8 inches, foot $1\frac{3}{4}$ inches.

The Hoary-bellied Squirrels are represented in the upper Chindwin Valley by *C. l. owensi*. A distinct species found only in the Chindwin area is *C. blythi*, with four races. Upper Assam is the home of *C. stevensi*. Burma contains two species, *C.*

phayrei and *C. pygerythrus*, each with a northern and a southern race.

The Striped Tree Squirrels, *Tamiops*, made by Ellerman a subgenus of *Callosciurus* but regarded by Zahn as close relatives of the Indian Palm Squirrels, *Funambulus*, resemble Chipmunks in their striped color pattern of pale and black stripes, but they have no stripes on the face. The ears are slightly tufted with white. The tail is slender, thinly haired, and rather short. The female has 6 pairs of mammæ. The typical species is *T. macclellandi* of Assam. Unlike Chipmunks, these Squirrels are seldom on the ground.

McClelland's Striped Tree Squirrel, *T. macclellandi*, of which several species and many races are known, is yellowish brown above, with three black dorsal lines extending from the nape to the root of the tail, separated by paler stripes. The lateral dark stripes are margined outwardly by yellowish stripes that start from the nose and pass beneath the eye and ear to the tail. The underparts are yellowish gray. The length of the head and body is $5\frac{1}{4}$ inches, of the tail $3\frac{3}{5}$ inches.

From Manipur comes the race *T. m. manipurensis*. Two more races just reach southwestern China: *T. m. barbei*, which enters southwestern Yunnan from northern Burma, and *T. m. inconstans*, found along the southeast border of Yunnan with Indo-China. The race *T. m. kongensis* is found in southwest Laos, *T. m. dolphioides* in Cambodia, *T. m. rodolphi* in Cochin-China, and *T. m. leucotis* in the Malay Peninsula. *Tamiops monticolus* from Fukien and *T. m. olivaceus* from Tonkin, at 8000 to 10,000 feet, are treated by Osgood as a single full species.

The Chinese Striped Tree Squirrel, *Tamiops swinhoei*, characteristic of southern China, is found in Szechwan and Yunnan. *Tamiops s. clarkei* occurs in the Yangtse Valley and northern Yunnan. Races from eastern China include the denser-furred *T. s. vestitus* of Hopei and Kansu, the grayish *T. maritimus* of Fukien, *T. m. hainanus* from the island of Hainan, and *T. m.*

formosanus of Formosa. The measurements of the Formosan race are: length of head and body $5\frac{1}{2}$ to $6\frac{1}{3}$ inches, tail 4 to $4\frac{1}{2}$ inches, hind foot 1 to $1\frac{1}{4}$ inches. Osgood regards *T. maritimus*, *hainanus*, *moi* from southern Annam, and a race from Laos, *laotum*, as constituting a species distinct from *macclerlandi*.

The Continental Long-nosed Tree Squirrels, *Dremomys*, are less specialized than the Sunda Islands Long-nosed Squirrels; the head is less narrowed and the rostrum less elongated. There are 3 pairs of nipples. These Squirrels have an extensive continental range, including Burma, China, Malay Peninsula, Hainan, and Formosa. The type species is *D. pernyi* of Szechwan.

There are three main species groups in *Dremomys*: the type group *D. pernyi* of China, ranging from Fukien up the Yangtse to Szechwan and thence southwest into Burma, has the muzzle moderately lengthened, the underparts white, and the tail rusty beneath at the base only; the *D. lokriah* group has the muzzle short, the underparts yellow, and is found from Burma and Assam to Sikkim and Nepal; the *D. rufigenis* group, found from Burma, Yunnan, and Szechwan to the Malay Peninsula, Annam, and Hainan, has the muzzle extremely long, the cheeks red, and the whole of the underside of the tail red.

Perny's Long-nosed Tree Squirrel, *Dremomys pernyi*, is olive-brown, slightly touched with reddish on the back and shoulders. The underparts to the throat are pure white. The cheeks, like the body, are olive and behind the base of each ear is a spot of tan. The forefeet are olive, the hind feet brown with a trace of reddish. The tail is blackish brown above, tan beneath at the base, the same color appearing on the backs of the thighs. The length of the head and body is about 8 inches, of the tail $6\frac{1}{2}$ to 7 inches, of the hind foot $1\frac{3}{4}$ inches.

There are eight races of the species *pernyi*, of which typical *D. p. pernyi*, *D. p. senex*, and *D. p. modestus* occur along the

course of the upper Yangtse Valley; *D. p. calidior* is found in the coastal Province of Fukien, *D. p. griselda* in Szechwan, *D. p. flavior* in northern Yunnan, *D. p. howelli* in southwest Yunnan and northern Burma, *D. p. mentosus* in the Chin Hills, Burma, and *D. p. inus* in Mt. Imaw Bum, Burma. The Formosan species, *D. owstoni* from Mt. Arizan, is dark olive with a buff spot behind the ear, the tips of the fingers and toes blackish, and the underparts dull yellowish. The length of the head and body is from 7 to $7\frac{3}{4}$ inches, of the hind foot about $1\frac{3}{4}$ inches, of the tail from $5\frac{1}{2}$ to $6\frac{1}{2}$ inches. In winter blackish hairs develop along the middle of the back in *owstoni*.

The Lokriah Long-nosed Squirrels, *Dremomys lokriah*, are dark brown, the hairs tipped with orange. There is a pale mark behind the ear. The tail is colored much as the body, and the underparts and thighs are deep orange. There are 3 pairs of mammæ, 1 pectoral, 2 inguinal. The Squirrels are found usually at altitudes of 6000 to 8000 feet above sea-level. The length of head and body is 8 inches, of the tail $6\frac{1}{2}$ inches, hind foot $1\frac{3}{4}$ inches. The weight is 8 ounces. *Dremomys lokriah* was described from Nepal.

East of Bengal *Dremomys lokriah* is represented by only two geographical races: *D. l. macmillani* of the upper Chindwin River, Burma, and *D. l. garonum* of the Garo Hills, Assam. *Dremomys l. macmillani* is said to have a black median dorsal stripe. The length of its head and body is $7\frac{1}{4}$ inches, of the tail $6\frac{1}{4}$ inches, hind foot $1\frac{3}{4}$ inches.

The Red-cheeked Long-nosed Tree Squirrels, *Dremomys rufigenis*, are colored olive-brown, a color composed of a grizzle of black and dark yellow. There is a white spot behind the ear. The sides of the head and muzzle are light reddish brown, as is the underside of the tail. The underparts are white, the hands and feet dull brown, and the upper surface of the tail is blackish brown, each hair with a white ring and white tip. The length of head and body is from $7\frac{1}{2}$ to 8 inches, of the tail from $5\frac{3}{4}$

to $6\frac{1}{2}$ inches, of the hind foot from $1\frac{3}{4}$ to $1\frac{4}{5}$ inches. This Squirrel was first taken in the mountains east of Moulmein, southern Burma, between 5000 and 6000 feet above sea-level.

A number of forms of *D. rufigenis* are known. Northwest of the type region, Tenasserim, are several races: *D. r. adamsoni*

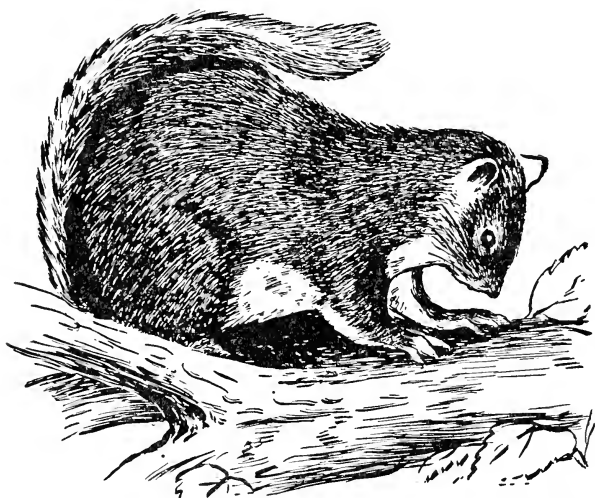


FIG. 52. Long-nosed Squirrel, *Dremomys rufigenis belfieldi*.

from Maymo, Burma; far to the north, *D. r. ornatus* of Yunnan, Tonkin, and northern Laos, *D. r. lentus* of Szechwan, and *D. r. pyrrhomerus* of the Yangtse Valley; southward, in Selangor, Malay Peninsula, *D. r. belfieldi*; and east and northeast, *D. r. laomache* in Laos, *D. r. fuscus* in central Annam, *D. r. gularis* in Tonkin from 5000 to 8000 feet, and *D. r. opimus* in Ichang, Yangtse Valley, China. *Dremomys r. riudonensis* occurs on Hainan Island.

The Malayan race, *D. r. belfieldi* (Fig. 52) is a beautiful little animal, olive-brown, with white underparts and the bases of the ears white; the top of the tail is dark brown, its underside

bright russet. The cheeks and sides of the nose are tan. The head and body measure 8 inches, the tail $5\frac{3}{4}$ inches, the foot $1\frac{3}{5}$ inches.

The Sunda Islands Long-nosed Tree Squirrels, genus *Rhinosciurus*, and the Continental Long-nosed Squirrels, *Dremomys*, are regarded by Zahn as related subgenera. Pocock associates them with *Lariscus*. Ellerman places *Rhinosciurus* and *Lariscus* with *Menetes* in his "*Lariscus* section" but acknowledges this to be an "unnatural" group.

The Sunda Islands Long-nosed Squirrels, *Rhinosciurus*, have the rostrum greatly drawn out so as to give the head the form of a large Rat's head. The tail is quite short. The typical species, *R. laticaudatus* of Borneo, is represented by *R. l. tupaoides* (meaning "like a tree-shrew") on the southern half of the Malay Peninsula. This mainland race is colored dull reddish brown above, buffy on the flanks, and whitish beneath. The tail is gray with its hairs white-tipped. The length of the head and body is about 8 inches, of the tail about $3\frac{3}{5}$ inches, of the hind foot $1\frac{3}{5}$ inches,

David's Rock Squirrels, genus *Sciurotamias*, have the tail only slightly shorter than the head and body, small cheek pouches, the snout somewhat lengthened, the soles of the feet densely hair-clad from the heels to the rounded pads at the bases of the toes. The females have 3 pairs of nipples. The single species, *S. davidianus*, is colored gray, the result of an even mixture of black and pale buffy reddish, the limbs and tail much the same. A pale buff ring surrounds the eye. The untufted ears are somewhat blackish. The underparts are white, tinted with buff. The length of the head and body is from 8 to 9 inches, of the tail 8 inches, hind foot 2 to $2\frac{1}{5}$ inches.

This Rock Squirrel is found through Hopei and Shantung, and extends west to Kansu. In Honan, Shensi, and Hupeh it is represented by the brown-backed race *S. d. saltitans*; in Szechwan by the black-footed *S. d. consobrinus*. This species, though

well able to climb trees, is a rock- and cliff-dwelling animal, making its nest in crevices.

Forrest's Rock Squirrel, *Rupestes forresti*, differs from David's Rock Squirrel by the partly naked condition of the sole of the hind foot, in which only the hinder part is hairy. The front claws are elongated and blunt. The number of nipples is similarly 3 pairs. Ellerman considers *Rupestes* a subgenus of *Sciurotamias*.

The color is dark grayish brown, with a narrow indistinct whitish line beneath which is a dark line, on each side from shoulder to hips. The underparts are pale reddish brown, the flanks reddish; from the chest to the chin is white. The tail is like the back, slightly darker at the tip. The head and body measure from 8 to 9 inches, the tail 6 to 7 inches, the hind foot about 2 inches. This species is known only from Yunnan near the valley of the Yangtse. It prefers cliffy places at about 10,000 feet above sea-level.

The Asiatic Chipmunks, genus *Eutamias*, are small chipmunk-like Squirrels with five well-marked black lines, interspersed with paler areas, along the back. Distinct stripes appear on the face. The ears are not tufted as in *Tamioops*. The cheek pouches are large. There are 4 pairs of nipples. The type and only species is *E. sibiricus*.

The genus is represented in western North America but the True American Chipmunks, *Tamias*, are not found in Asia. Ellerman believes *Eutamias*, which has an extra pair of cheek teeth, to be a subgenus of *Tamias*.

Chipmunks are small active terrestrial Squirrels living in burrows.

The Asiatic Chipmunk, *E. sibiricus*, first recorded from near Tomsk, Siberia, has been divided into many geographical races, several of which are found along the eastern edge of the continent. The most northerly race is *E. s. jacutensis*, which occupies the land north of the Sea of Okhotsk, reaching west into

north-central Siberia, and east beyond the base of the Kamchatka Peninsula. Northward this form extends well beyond the Arctic Circle, according to a map by Ognev. *Eutamias s. uthensis* is from the Uda River, eastern Siberia, *E. s. orientalis* from Ussuri and Korea, *E. s. lineatus* from northern Japan, Sakhalin, and the mainland from lat. N. 45° to Gichiga, at the northwest



FIG. 53. Asiatic Chipmunk,
Eutamias sibiricus.

corner of the Sea of Okhotsk, and *E. s. senescens* from Hopei, China.

The length of the head and body in *senescens* is from 6 to 6½ inches, of the tail 4 to 5 inches, of the hind foot about 1½ inches. The race *senescens* has the rump washed with reddish; the northern forms are grayer.

The Ground Squirrels and Susliks, genus *Citellus*, comprise a large assemblage of forms, and are found under a number of subgenera in both hemispheres. The Ground Squirrels are strictly ground-dwellers, making burrows in loose soil. They favor plains areas with arid climates, and they hibernate. Their ears are very short and low, the claws powerfully developed for digging, and the tail is short, from one-half to one-fifth the

length of the head and body. The nipple count is high for Squirrels—4, 5, or 6 pairs (Ellerman).

The Old World Ground Squirrels that must here be discussed are all members of the subgeneric group *Citellus*, and furthermore are members of only two species groups, the *citellus* group and the *eversmanni* group. Old World *Citellus* has its headquarters in eastern Europe and western and central Asia.

The Ground Squirrels of the *citellus* group have the soles of the feet hairy, the tail varying in length from one-fifth to one-third of the head and body, and the interorbital region of the head (between the eyes) narrow; those of the *eversmanni* group also have hairy soles, but the tail from one-third to one-half of the head and body, and the space between the eyes broad.

The Eversmann Ground Squirrels, *Citellus eversmanni*, with headquarters in western Siberia, have several representative forms on the eastern coast of the Asiatic continent, *C. e. stejnegeri* from Kamchatka, *C. e. leucostictus* from the Okhotsk River and Gichiga region, *C. e. transbaikalicus*, *C. e. menzbieri* from the Amur River, and *C. e. buxtoni* from east Siberia.

The color is a blend of black and light gray, with a tendency to form pale spots or speckles on the entire middle area of the back. The crown of the head and the back of the neck are buffy gray; the tail basally is colored like the body; terminally the longer, more tufted hairs are a mixture of black, buffy, and some white. The lips and throat are white, the underparts buff with the bases of the hairs gray-brown. The winter pelage is much paler. The length of the head and body is from 8 to 9½ inches, of the tail from 4 to 4½ inches, of the hind foot 1¾ to 2 inches. The ear is only ⅔ inch high.

These Ground Squirrels occur in large colonies, often located in grassy valleys between patches of forest.

The Dahurian Ground Squirrel, *Citellus dauricus*, typically from the Dahurian region of Transbaikalia, is represented near

the eastern Asiatic coast by *C. d. mongolicus* of Hopei, western Manchuria, and Mongolia, and by *C. d. ramosus* of the province of Kirin.

The Chinese form, *mongolicus*, is reddish buff, produced by a mixture of gray-based hairs with a subterminal reddish ring and a whitish tip, also a few black hairs. The head is reddish buff, the neck gray. The tail has the color of the back, with the

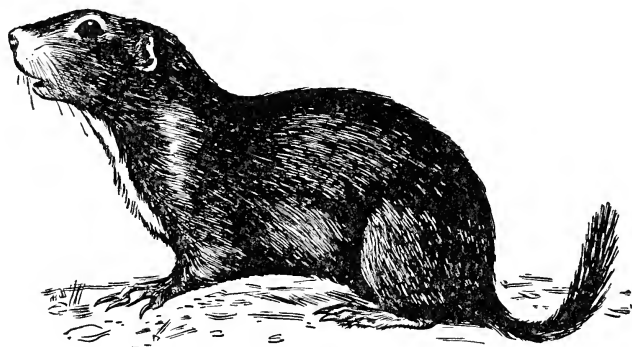


FIG. 54. Dahurian Suslik or Ground Squirrel, *Citellus dauricus*.

tip whitish. The color of the underparts is chiefly reddish buff. The sides are yellowish and the lips, chin, and eye ring are white. Winter skins are more pallid. The length of the head and body varies from $7\frac{3}{4}$ to $8\frac{1}{4}$ inches, of the tail only $2\frac{1}{4}$ to $2\frac{1}{2}$ inches, of the hind foot $1\frac{1}{2}$ inches.

Like the North American species, these oriental Ground Squirrels may work considerable damage in grain fields. They sit upright on the mounds of earth taken from their burrows, keeping a sharp lookout for danger. About 5 young are born in June.

The Marmots or Woodchucks, genus *Marmota*, are thick-set, short-tailed, coarse-haired, clumsy rodents weighing from 10 to 12 pounds. The ears are short, the head low and flat, the feet thick and powerful with strong claws for digging, and the

tail is short. The number of nipples, depending upon species, varies from 8 to 12. The Marmots are hibernators. The typical species is *Marmota marmota* of the Alps of Europe.

Of the several species groups, one, *caligata*, is represented in northwestern North America, Alaska, and Siberia. A second, *bobak*, extends from central Europe to the Himalayas, Szechwan, and Transbaikalia.

The Hoary Marmots, *Marmota caligata* of Alaska, are represented by *M. c. camtschatica* of Kamchatka and *M. c. bungei* of the Verhoyansk Mountains, as well as races in the Baikal area and in Yakutsk. The Siberian Hoary Marmots are found also near Gichiga and on the Kolyma River.

The upperparts are rich buffy with a whitish grizzle, the head black on top, the sides of the face whitish, the underparts dull white. The tail is buffy on top, tipped with brown, beneath darker brown. The hands and feet are blackish brown, whence the name *caligata*, meaning "booted." The length of the head and body varies from 27 to 28 inches, tail $7\frac{1}{2}$ to $8\frac{1}{2}$ inches, hind foot $3\frac{3}{4}$ to 4 inches.

The Tarbagan Marmot, *Marmota bobak*, represented in Transbaikal and Mongolia by *M. b. sibirica*, was described by Radde as brownish red rather than light yellowish gray; the underparts rusty yellow. He mentioned exceptionally pale and dark individuals. This is a gregarious Marmot about the size of a badger, inhabiting grassy areas and avoiding drier sandy wastes. Hibernation lasts from September to March; from two to four animals occupy the especially deep winter burrows. Young Marmots are found in July.

The Himalayan Marmot, *Marmota himalayana*, spreading as a local form, *M. h. robusta*, into Szechwan, is also a member of the *bobak* group. The color of the back is reddish gray mottled with black, fading to reddish yellow beneath. The limbs and ears are brownish gray, and the tail and the top of the nose are dark brown. The form found in Szechwan has the ears bright rufous and the tail tipped with black. There are 6 pairs

of nipples (Blanford). The length of head and body is 23 inches, of the tail 6 inches, hind foot $3\frac{1}{2}$ inches, or more than half the length of the tail.

This Marmot lives at very high altitudes, 14,000 to 15,000 feet. It is an element of the Tibetan fauna that just reaches Szechwan and Yunnan.

THE FLYING SQUIRRELS (FAMILY PTEROMYIDÆ)

The Flying Squirrels, known in America only by the single genus *Glaucomys* with its two species *volans* and *sabrinus*, are greatly developed in southern Asia, their present headquarters. Only the genus *Pteromys* (= *Sciuropterus*) reaches Europe, and True Flying Squirrels are unknown in Africa.

Flying Squirrels, though they have squirrel-like heads, bodies, and tails, possess also lateral fur-clad membranes that stretch from the front to the hind limbs and in some genera to the neck and tail also. At the outside of the wrist, the membrane is carried on a stiff rod of cartilage that acts as a spreader. The membranes contain sheets of muscles that can be tensed or relaxed at the will of the animals. Most of the genera are tropical. Some can scarcely be distinguished from one another except by minute characters of the skull. All species, so far as known, are nocturnal, and are reputed to sleep by day in holes in trees. They feed upon fruit, nuts, fresh bark, and grubs. The large species are said to be able to glide through the air for 60 yards or so. Little is known about the habits of individual species.

Probably the most convenient way to distinguish the Flying Squirrels from one another is by size. There are four large-sized genera, in which the length of the head and body equals or exceeds 10 inches. These are *Petaurista* (southeast Asia), *Trogopterus* (China), *Aeromys* (Malay Peninsula), and *Aeretes* (northern China).

The remaining seven eastern Asiatic genera have the head

and body shorter than 10 inches (*Pteromyscus pulverulentus* attains this length; it should be compared with *Aeromys*). The Pigmy Flying Squirrels, *Petaurillus*, of the Malay Peninsula, the smallest of all, have the length of the head and body only $3\frac{1}{2}$ inches.

LARGER FLYING SQUIRRELS

The Giant Flying Squirrels, genus *Petaurista*, found from India to Java, Formosa, Korea, and Japan, include the largest of the Flying Squirrels. The head and body may attain a length

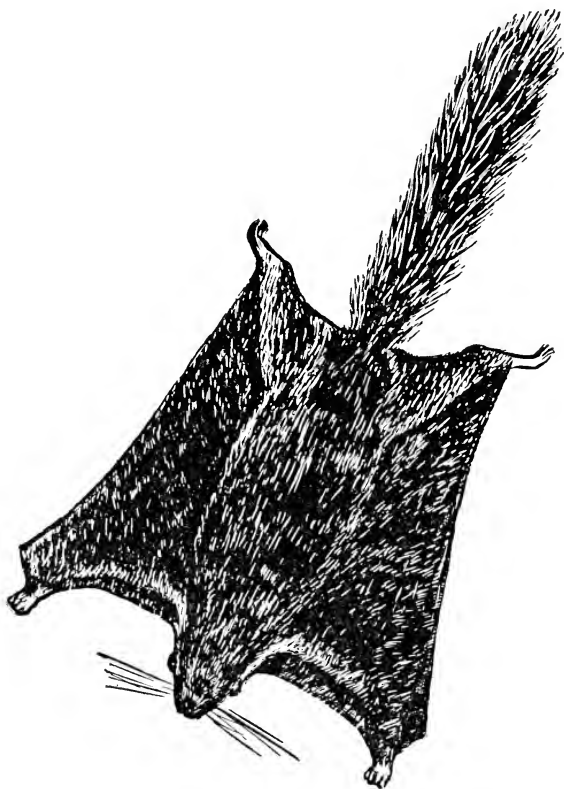


FIG. 55. Giant Flying Squirrel, *Petaurista*.

of 18 inches. They have short, broad heads, very complex tooth patterns in the molars, and very wide post-orbital processes on the skulls. The flying membrane is continued forward from the forearm to the neck and backward from the hind legs to the base of the tail, which is usually longer than the head and body. The type species is *P. petaurista* from Java.

Ellerman recognizes several groups of species of *Petaurista*. The first, containing the type, is short-furred, and colored more or less uniformly deep red or black, not grizzled.

The Red Giant Flying Squirrels, *Petaurista petaurista*, are represented on the Malay Peninsula by *P. p. melanotus*, in insular Siam by *P. p. cicur*, in Fukien, China, by *P. p. rufipes*, in Szechwan by *P. p. rubicundus*, and in Formosa by *P. grandis*. The Malayan race *Petaurista p. melanotus* is bright reddish, the cheeks and underparts pale reddish. The feet, tip of muzzle, posterior half of the ears, and the tip of the tail are blackish brown. *Petaurista p. cicur* of southeast China is clad in black-tipped chestnut hairs, the head paler. The muzzle, eye ring, and half of ears, the hands and feet, the edge of the membranes are all black. The tail basally is blackish, distally orange-red, with the tip black. The undersurface of the body is reddish orange. The length of head and body is 16½ inches, tail 19 inches, foot 3 inches.

The Formosan Red Flying Squirrel, *Petaurista p. grandis*, has the back dark chestnut-red, mixed with some black hairs, and the underparts orange-red. The tail is black. The young are more blackish than the adults. The length of the head and body in adults is 14½ to 15½ inches, tail 16 to 17 inches, foot 2¾ to 3 inches.

The Flying Squirrels of the species *P. petaurista* are particularly fond of the fruit of the Durian (Cantor) and of coconuts (Ridley).

The White-headed Giant Flying Squirrels, *Petaurista alborufus*, typical of the second group, are large, densely furred Flying Squirrels having the body deep red, sometimes with a

dorsal mark, but the head and chest white. The hands and feet are also red, only slightly darker than the body. The white of the face reaches the bases of the ears and that of the throat extends upward in front of each shoulder. The underparts, light reddish, are touched with white along the middle. The length of the head and body is 23 inches, tail 17 inches, hind foot $3\frac{2}{5}$ inches.

The typical race, native of Szechwan, is represented elsewhere by *P. a. castaneus* of the upper Yangtse Valley, *P. a. leucocephalus* of Tibet, *P. a. ochraspis* of Yunnan, *P. a. lena* of Formosa. These races have blackish hands and feet; *castaneus* virtually lacks the white tips of the red ventral hairs; *ochraspis* has a light patch at the base of the tail, the underparts strongly whitish, and the pure white of the throat extending onto the chest.

The Formosan White-headed Flying Squirrel, *Petaurista a. lena*, is red above, yellowish white beneath. The head and hands are white and the feet are touched with white. The tail is mixed red and black, its tip black or black and white. The length of the head and body is 17 inches, tail 18 inches, hind foot 3 inches.

The Spotted Flying Squirrels, *Petaurista punctatus*, occur as several races in the lower Malay Peninsula and in Burma, Yunnan, and Borneo.

The Malay Spotted Flying Squirrel, *P. p. punctatus*, from Malacca, was briefly made known as "bright bay; back ornamented with white spots." The two Squirrels next mentioned may be races of *punctatus*.

The Yunnan Spotted Flying Squirrel, *Petaurista marica*, is olive-brown, becoming more reddish on the membranes, and darkening on the crown of the head to black. The thirty-odd white spots vary from $\frac{1}{4}$ to $\frac{1}{2}$ inch across. The undersurface is bright orange-red, chin dark brown, the hands dark brown, feet rufous, tail blackish red with the tip blacker. The length

of the head and body is 15 inches, tail $15\frac{1}{2}$ inches, foot $2\frac{1}{2}$ inches. This form occurs in Tonkin and Laos, as well as in Yunnan.

The Chin Hills Spotted Flying Squirrel, *Petaurista sybilla*, has very few white spots, and the head is red like the back. The membrane above is brilliant chestnut. The hands, feet, and tail are rufous, the tip of the last with some black hairs. The length of head and body is 14 inches, tail 14 inches, foot $2\frac{1}{2}$ inches.

The Hoary Giant Flying Squirrels, members of the *P. philippinensis* section (*philippinensis*, incidentally, is from India, not the Philippines), comprise two species of eastern Asia: *P. cineraceus* of Arakan and northern Siam and *P. lylei* of Burma, Siam, and Tonkin.

Petaurista cineraceus is drab-colored, grizzled with white, the bases of the hairs brown. The underparts are white. The tail is gray with the tip black, and the hands and feet are blackish brown. The length of the head and body is $18\frac{1}{2}$ inches, tail 22 inches, foot $3\frac{1}{2}$ inches. A race, *P. c. stockleyi*, is distinguished in northwestern Siam.

Petaurista lylei is hoary, with the dorsal hairs brown washed with white, the bases of the hairs dark gray. The tips of the ears are orange-red, a tuft of hair behind each ear black. The edge of the flying membrane is orange, the tail black touched with red, the underparts rich chestnut, the throat hazel. The chin, hands, and feet are black. This Squirrel is found in northern Siam. The length of the head and body is from 18 to 20 inches, tail 23 inches, foot $3\frac{3}{5}$ inches. A race of *lylei* from the south Shan States, *P. l. venningi*, has the undersurface browner, less reddish. Another race, from Tonkin, Laos, and Annam, *P. l. badius*, is less hoary, and has the flying membrane almost wholly rufous.

The White-backed Giant Flying Squirrels, relatives of *P. albiventer* of Nepal, comprise several species: *P. annamensis*

of Annam, Siam, and Yunnan, *P. candidulus* of upper Burma, *P. taylori* of Tenasserim, and *P. clarkei* of Yunnan.

The color of *Petaurista candidulus* is white, with brown hair bases, the edges of the flying membrane touched with red. The underparts are white. There is a gray patch in front of the ears, the tips of which are white, and another brown patch behind them. The terminal half of the back of the ear is white. The tail is gray with the tip black. The length of the head and body is $16\frac{1}{4}$ inches, tail 24 inches, foot $3\frac{1}{2}$ inches.

The Annamese Giant Flying Squirrel, *Petaurista annamensis*, is reddish with the tips of the hairs white, the muzzle and cheeks grayish white, the underside pale rufous, and the chin, hands, and feet black. The back and base of the ears are black. The tail is colored like the body for three-fourths of its length, then blackish. The length of the head and body is 18 inches. This Squirrel is a native of southern Annam and Cochin-China. A race, *P. a. barroni* from southeast Siam, differs by having a blackish ring around each eye, the throat white, and the tail black on its distal third only.

Anderson's Giant Flying Squirrel, *Petaurista yunnanensis*, is chestnut with the hair tips white, especially on the hinder part of the back. The sides of the face are yellowish gray, the hands and feet black. The tail is chestnut, touched with black, its terminal part black. The underparts are yellowish white or chestnut-yellow. The length of the head and body is 24 inches, tail 24 inches. Found in Yunnan.

Taylor's Giant Flying Squirrel, *Petaurista taylori* from Tenasserim, differs from *P. candidulus* by reduction in length of the white hair tips, giving it a more rufous color; also by its black ear patches. From *annamensis* it is distinguished by its whitish tail.

Clark's Giant Flying Squirrel, *Petaurista clarkei* from the Mekong Valley, Yunnan, is a gray-headed form with buff patches behind the ears. The body hairs are slaty black with

buffy tips, becoming reddish toward the membranes. The undersurface is buffy white, also touched with reddish toward the membranes. The ears are black, with a chestnut patch at the base, and the hands and feet are reddish. The color of the tail is mixed buffy and black, the tip black. The length of head and body amounts to 13 inches, tail 15 inches, and foot $2\frac{3}{8}$ inches.

The White-cheeked Giant Flying Squirrels, *Petaurista leucogenys* and allies, of Japan and the adjoining mainland, form a thoroughly distinct group within the genus *Petaurista*:

The Japanese White-cheeked Flying Squirrel, *Petaurista leucogenys*, the first of its group ever described, has the upper surface smoky gray, with the hairs white-tipped. A gray-white cheek patch on either side of the head passes between the eye and the ear and extends onto the side of the neck. The throat and underparts are white, becoming russet-tinged on the membranes and the inner sides of the limbs. The tail is gray. The length of the head and body is about 17 inches, the tail \pm 14 inches. Several other forms on various of the Japanese islands are distinguished by variations in the size and shape of the white cheek mark, of the body color, and by differences in the proportion of the tail length to the length of the head and body.

The Korean White-cheeked Flying Squirrel, *P. l. hintoni*, is colored a more reddish brown than the Japanese form, and its tail is shorter. The color of the tail is paler than the back. The underparts are white, becoming reddish toward the edges of the membranes. The length of the head and body is 19 inches, of the tail only $9\frac{1}{2}$ inches, hind foot $2\frac{1}{3}$ inches.

The Manchurian White-cheeked Flying Squirrel, *Petaurista watasei* of southern Manchuria, has a longer tail than *P. l. hintoni* and is grayish brown. The underparts are grayish white, becoming salmon-buff on the membranes. The length of the head and body is $17\frac{1}{2}$ inches, tail $13\frac{1}{2}$ inches, foot $2\frac{1}{3}$ inches.

The Orange-footed Flying Squirrels, *Trogopterus*, with typical species *T. xanthipes*, are medium-sized Flying Squirrels found only in China. They have a black tuft of hairs at the base of each ear. The body color is chestnut, with the bases of the hairs slate, and there is an admixture of some all-black hairs. The muzzle and the eye rings are red, the underparts of the body whitish. The membranes and the front and hind feet are orange-red, whence perhaps the specific name. The length of the head and body is $10\frac{1}{2}$ inches, of the tail $10\frac{1}{2}$ inches, hind foot $2\frac{1}{5}$ inches. The type species is from Hopei. Two other forms known in eastern Asia are *T. x. edithae* from Yunnan and *T. x. mordax* from Szechwan and Hupeh. The former is a grayish race from the Likiang Range, the latter a brighter-colored race with reddish feet, from the upper Yangtse Valley. There is yet another race, *T. x. himalaicus*, in Tibet.

The Black Giant Flying Squirrel, *Aeromys*, like *Petaurista*, has the membrane continued between the forearms and neck, and the hind legs and the tail. Robinson and Kloss distinguished it from *Petaurista* mainly by characters of the teeth and skull. The digits are hairy beneath. The type species of *Aeromys* is *A. tephromelas*, with the body and tail black and the bases of the body hairs gray. The underparts of the body and the flying membranes are gray-brown. The length from the nose to the base of the tail is 10 inches, of the tail 11 inches. This animal, first described from Penang Island, is also recorded from Malacca (Gray). Two other species are known, *A. phæomelas* from Borneo and *A. bartelsi* from northern Sumatra.

The Grooved-toothed Giant Flying Squirrel, *Aeretes melanopterus* (= *sulcatus*) has the hairs of the back dull brown with lead-colored bases, those of the membranes blackish brown. The head is lighter and grayer than the back. The hands and feet are blackish. The undersurface is gray, tipped with buffy except the throat and hind belly, where the hairs have white tips. The length of the head and body is $12\frac{1}{2}$ inches, tail 13 to

14 inches, foot $2\frac{1}{2}$ inches. The upper incisors are very broad and each has a well-defined groove. This Squirrel is found in Hopei, China.

SMALLER FLYING SQUIRRELS

The Tufted Flying Squirrels, genus *Belomys*, are distinguished by the tuft of fine hairs growing at the base of each ear and the rather large size of the ears themselves. The cheek teeth are extremely complex. The type is *B. pearsoni* from Darjiling near Sikkim. The back and the top of the head of *B. pearsoni* are reddish brown finely mixed with black, the flying membranes blackish brown washed with reddish. The undersurface is light reddish (white in the race *trichotis*). The length of the head and body is about 8 inches, of the tail 6 inches, hind foot $1\frac{1}{3}$ inches.

There are several local races: *B. p. villosus* from Assam, *B. p. trichotis* from Manipur, *B. p. blandus* from Tonkin, and *B. p. kaleensis* from Formosa. The Formosan *Belomys p. kaleensis* has the upperparts reddish buff, mottled with brown; the underparts pale buff. The fur is silky.

The Smoky Flying Squirrels, *Pteromyscus pulverulentus*, known hitherto from Penang and Borneo, will probably be discovered on the Malay mainland. The small ears have no tufts at the base. The color of the Penang race is blackish brown touched with pale reflections from the whitish subterminal hair bands. The underparts are buffy white, the chest yellowish, the pre-anal region orange. The fingers and toes are pale brown and the tail brownish gray. The length of the head and body is 10 inches, tail $8\frac{1}{2}$ inches, foot $1\frac{3}{5}$ inches.

The Eurasian Flying Squirrels, *Pteromys volans* and allies, are colored above light silvery gray or buffy gray, the bases of the hairs slaty. A narrow eye ring is blackish. The underparts and inner surfaces of the limbs and membranes are dull buffy

white. The tail is gray, its tip dusky. The ears have no basal tufts of hairs. The cheek teeth are not greatly complicated. The number of nipples is 8. The length of the head and body is $6\frac{3}{4}$ inches, tail $4\frac{1}{2}$ inches, hind foot $1\frac{1}{3}$ inches.

This group of Flying Squirrels is found from Russia across northern Asia to Siberia and south along the coast of the Pacific to northern China. The following races are shown by Ognev to inhabit the coastal portions of eastern Asia: *P. v. anadyrensis*, extreme eastern Siberia near the base of the Kamchatka Peninsula; *P. v. incanus*, Siberia, north of the Sea of Okhotsk to beyond the Arctic Circle and westward to the Yenisei River; *P. v. athene*, the west coast of the Sea of Okhotsk, Sakhalin, and Yezo (= Hokkaido) Islands, and Maritime Province of Siberia south to lat. 45° ; *P. v. arsenjevi*, the southern part of the Siberian Maritime Province and eastern Manchuria to the north shores of the Gulf of Pechili and northern Hopei; *P. v. momonga*, Japan, excluding Yezo; *P. v. aluco*, Korea, Hopei, Shantung. Allen admits two other races: *P. v. buechneri* from Kansu, China, and *P. v. wulungshanensis* from Mt. Wuling (Wulung), southern Jehol. The *Pteromys* of Hokkaido, Japan, have been divided into several local races.

The Arrow-tailed Flying Squirrels, *Hylopetes*, closely related to *Pteromys* and perhaps only a subgenus, have the tail broad and feather-shaped. The audital capsules are enlarged. The number of nipples is 6 (Thomas). The typical species is *H. everetti* of the Natuna Islands. The genus, widely distributed from Burma and Laos to the Sunda and Philippine Islands, can be separated into two size groups: the typical small-sized *everetti*, *sagitta*, and *phayrei*, and the considerably larger *alboniger* and *leonardi*.

Hylopetes sagitta, recorded first from Java, is shown by Chasen to be represented on the Malay Peninsula by *H. s. platyurus* and in Arakan and northern Malay by *H. s. spadiceus*.

Hylopetes s. platyurus has the upper surface clothed with

chestnut-tipped slate-based hairs, paler on the membranes, the underparts pure white except those of the belly and insides of the hind legs, which have dark bases. The tail, light brownish gray, is distinctly distichous as in *sagitta*. The length of the head and body is $5\frac{1}{4}$ inches, tail 4 inches, foot 1 inch.

Hylopetes s. spadiceus has the upper surface reddish brown, with the bases of the hairs gray, and the membranes, limbs, and tail dusky. The basal fourth of the tail beneath is reddish. The underparts are dull white. The length of the head and body is 5 inches, tail $4\frac{1}{2}$ inches, foot 1 inch. This form, native to Arakan, has been recorded from Annam and Laos.

Hylopetes phayrei, the slightly larger species from near Rangoon, also reddish gray, has the tail rather more slender. The length of the head and body is from 6 to $6\frac{1}{2}$ inches, tail $5\frac{1}{4}$ inches, hind foot $1\frac{1}{4}$ inches. The races of *H. phayrei* are *H. p. probus* from Mt. Popa, Burma, and *H. p. laotum* from the mountains of Laos and Siam. The former has the feet wholly white; the latter is larger, the length of its hind foot $1\frac{1}{3}$ inches.

Hylopetes alboniger is dark gray, with the hair bases almost black. The outer edge of the membrane is black, narrowly edged with white for 1 inch behind the wrist. The hands and feet are dark gray, the hind toes white. The tail, only slightly flattened on top, is smoky gray with the tips of the hairs black. The underparts are white, touched with drab on the belly; the hairs of the chin and throat are white to the roots. This Squirrel, first found in Nepal, is recorded by Osgood from Tonkin, Laos, and Annam. The race *H. a. orinus* from Yunnan is slightly larger. The length of its head and body is 8 inches, tail $7\frac{1}{2}$ inches, hind foot $\pm 1\frac{3}{4}$ inches. It apparently inhabits the mixed forests of the temperate zone at about 11,000 feet above sea-level.

A smaller related species with longer ears, *H. leonardi*, from Kachin Province, northern Burma, has blackish hands and feet, "pinkish buff" underparts, and a strong external resemblance

to *Belomys pearsoni*, the Tufted Flying Squirrel. The length of the head and body is $7\frac{1}{4}$ inches, tail 5 inches, hind foot $1\frac{1}{2}$ inches.

A new subgenus of *Pteromys*, *Olisthomys* Carter, containing the species *morrisi* Carter from Dalu (Taro, $26^{\circ} 21' N.$, $96^{\circ} 11' E.$), northern Burma, is stated to be related to *Hylopetes* but to have the low, spreading audital capsules of *Petinomys* and to have unsculptured teeth. The tips of the body hairs are reddish buff, the bases blackish; the underparts and cheeks are white. The tail is blackish above, paler beneath, the feet blackish. The length of the head and body is $5\frac{1}{2}$ inches, tail 5 inches, hind foot 1 inch.

The Lesser Flying Squirrels, *Petinomys*, are much like *Hylopetes* externally and are perhaps quite as closely related to *Pteromys*. But in place of the full, rounded audital capsules of *Hylopetes*, those of *Petinomys* are low and flat. The number of nipples is from 4 to 6 (Thomas). The type species is *P. lugens* from Sipora Island, near Sumatra.

Four groups of *Petinomys* are recognized by Ellerman, two of which, the *setosus* and *genibarbis* groups, occur on continental Asia. The typical group is restricted to Sumatra and the Philippines, and the fourth, the *fuscocapillus* group, is found in southern India and Ceylon.

Phipson's Lesser Flying Squirrel, *Petinomys phipsoni*, has the usual cinnamon color of the small Flying Squirrels and the usual deep gray bases showing when the fur is ruffled. The undersurface is creamy. The ears are very small, with tufts of black hairs growing from their bases in front and behind. The tail, smoky buff, becoming darker toward the tip, is, as usual, distichous (like a feather). The length of the head and body is 5 inches, tail $4\frac{3}{5}$ inches, foot 1 inch. This animal is from Tenasserim. According to Ellerman, it is a member of the same group as the tiny Sumatran species, *P. setosus*.

The Bearded Lesser Flying Squirrels, *Petinomys genibarbis* of Java, are represented on the Malay mainland by *P. g. malaccanus*, colored chestnut dorsally, the bases of the hairs slate. The head and fore quarters are grayish brown, the under-surface buffy, the tail dark brown above and somewhat reddish beneath. The length of the tail is $3\frac{3}{5}$ inches, foot $1\frac{1}{5}$ inches.

The Hainan Lesser Flying Squirrel, *Petinomys electilis*, also a member of the *genibarbis* group, has the hairs cinnamon-tipped and fuscous-based; they are gray-tipped on the membrane, which appears blackish brown edged with white. The hind feet and toes are partly white. The lips are white; this color is projected behind the ear as a whitish streak. The underparts are pure white to the bases of the hairs, with a wash of cinnamon along the sides. The distichous tail is brown, becoming black at the tip. The length of head and body is $6\frac{7}{8}$ inches, tail $6\frac{1}{3}$ inches, foot $1\frac{1}{5}$ inches.

The Pigmy Flying Squirrels, genus *Petaurillus*, are typically fawn-colored, with the hair bases dark gray. In the type, *P. hosei* of Borneo, there is a white spot behind the base of each long, narrow ear. The undersurface is dull white. The tip of the gray-brown tail is white. The teeth are uncomplicated, the ear capsules large. There are 4 nipples (Thomas). Two young are born. The length of the head and body in the Bornean type species is only $3\frac{1}{2}$ inches, the tail almost 4 inches, the foot $\frac{4}{5}$ inch.

The Selangor Pigmy Flying Squirrel, *Petaurillus kinlochii*, like *P. hosei* has a white spot behind the base of each ear and the tip of the tail is white. The length of head and body is $3\frac{1}{2}$ inches, tail $3\frac{1}{3}$ inches, hind foot $\frac{4}{5}$ inch.

Horsfield's Flying Squirrel, *Iomys horsfieldi*, continental race *davisoni*, is a rusty brown Flying Squirrel with the blackish hair bases showing through; the flying membrane is bright russet. The markedly distichous tail is brown above, bright chestnut beneath. The underparts are pale orange. The ears are

large and relatively naked. The length of head and body is about $5\frac{3}{4}$ inches, tail $6\frac{3}{4}$ inches, foot $1\frac{1}{2}$ inches.

Horsfield's Flying Squirrel was first made known from Java or Sumatra. One continental race, *davisoni*, occurs in Malacca at the southern end of the Malay Peninsula and a second, *penangensis*, from Penang Island. Other related forms are Bornean.

SUPERFAMILY CASTOROIDEA
THE BEAVERS (FAMILY CASTORIDÆ)

The single living genus of Beavers, *Castor*, circumpolar in distribution, is found in the temperate parts of America, Europe, and Asia, though not near the extreme northeastern coasts of Asia. Beavers look a little like aquatic Woodchucks with broad, flat, paddle-like tails. The hind feet are completely webbed. The fourth hind claw, which seems to be double, may be used in combing the fur. The forefeet, though small, have

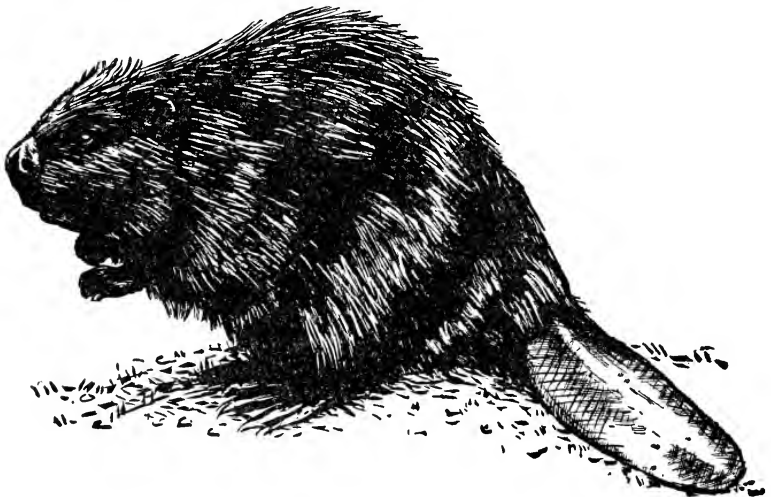


FIG. 56. Beaver, *Castor fiber*.

strong digging claws. The cutting teeth are provided with very hard enamel on their front faces and are used for gnawing through the trees, commonly aspen, which the Beavers use for building their remarkable dams and for food.

The Beavers have special social instincts developed to a high degree. They seem better capable of communal planning and "forethought" than most other animals. The result invariably aimed at by nature when she experiments with Beaver instinct is the raising of Beaver families in reasonable safety. First, the Beaver dam is made of mud and heavy sticks. This dam backs up the stream across which it is built, to form a deep pond which may cover several acres. In the pond the dome-like Beaver "lodges" are constructed of mud and wood, with their entrances under water. The young are born and raised on a platform in the lodge just above the level of the water.

The Mongolian Beaver, *Castor fiber birulai*, looks to the uninitiated exactly like any Beaver in the United States. It is found rather locally in western Mongolia, and so in the strictest sense it is out of our territory. Beavers are reported also along the tributaries of the Kolyma River, which flows into the Arctic Ocean in eastern Siberia. A fossil Beaver, *C. zdanskegi*, has been found in Shansi, China.

In prehistoric times there lived Beaver relatives, probably with unflattened tails, which burrowed as Woodchucks and Prairie-dogs do. Their burrows were spiral. Some of those burrows filled up with debris, which became fossilized into rock harder than the earth around it. Such spiral casts of burrows long remained without explanation and even received a scientific name, *Daimonelix* (devil's spiral).

RAT-LIKE RODENTS (SUBORDER MYOMORPHA)

Just as the Squirrel suborder, the Sciuromorpha, contains such surprises as the Pocket Gophers and Beavers, so the Myomorpha includes, besides the Rats and Mice, such mammals

as the Dormice and the Jerboas. The former appear somewhat squirrel-like; many of the latter have long legs like tiny kangaroos.

Within the Asiatic members of the Myomorph suborder, three superfamilies are recognized. The first, the Muroidea, contains the most rat-like animals of all; the second, the Gliroidea, contains the squirrel-like Dormice and the Spiny Dormice that somewhat resemble tree-shrews; the third, the Dipodoidea, contains not only the kangaroo-like Jerboas but the Jumping Mice and the much more mouse-like Birch Mice, *Sicista*.

SUPERFAMILY MUROIDEA

Most of the mammals belonging in this superfamily clearly look the part. The Rats, Mice, Field Mice are fairly unmistakable. But the Gerbils resemble the Jerboas, while the Bamboo Rats appear a good deal like the Pocket Gophers, though they lack the "pockets." The superfamily contains four families, Cricetidæ, Spalacidæ (none in our area), Rhizomyidæ, and Muridæ. The first and last are very large families; the second and third comprise but a handful of genera each.

THE HAMSTERS, VOLES, AND GERBILS (FAMILY CRICETIDÆ)

As the three names above suggest, three distinct subfamilies appear in this family: The Hamsters and Mole Rats, subfamily Cricetinae, the Gerbils, subfamily Gerbillinae (none occur in our region), and the Voles and Meadow Mice, subfamily Microtinae.

The Hamsters are thickset in body form and have very short tails. In the New World their relatives, although highly varied in structure, are often much more mouse-like; they include most of the native Rats and Mice of the Americas. The Gerbils

are long-legged, hopping animals with a strong likeness to the kangaroo-like Jerboas. The Voles, like the Hamsters, are short-tailed. Most of them strongly resemble our common Meadow Mice.

THE HAMSTERS (AND MOST WILD AMERICAN LONG-TAILED MICE) (SUBFAMILY CRICETINÆ)

The Hamsters are typically chunky in body form and have very short tails. They, therefore, somewhat resemble the Voles and Meadow Mice. They have the tubercles of the molariform



FIG. 57. Upper Right Teeth of (a) Cricetine, (b) Murine, and (c) Microtine Rats

teeth arranged in two primary longitudinal rows (Fig. 57, a). In Asia they are found chiefly north of the Himalayas.

In the New World the Cricetines, which extend to the southern tip of South America, are much more mouse-like. Only a few genera there have the tail shortened to any considerable degree. A cricetine of this more generalized type, *Calomyscus* of Persia, is extraordinarily similar to our American Deer Mice of the genus *Peromyscus*. It is interesting to note further that a fossil, *Sigmodon atavus*, representative of the American Cotton Rats, has been found in Mongolia. The True Hamsters, *Cricetus*, of Europe and western Asia, are unknown in eastern Asia. The Cricetine Mole Rats, *Myospalax*, represent an Old World branch of the subfamily that has gone in for subterranean existence.

The Little Hamsters, *Cricetulus*, include many species and races. They occur neither south of the Himalaya Mountains nor farther north than southern Siberia. Their general appearance

is like American White-footed Mice with the exception of the tail, which is much shorter. In some the back is striped. Cheek pouches are present. Five species with twelve subspecies occur in China, but of these only three come within the scope of this work.

East Asiatic *Cricetulus*, of which *C. griseus* is the type, with head and body $4\frac{1}{4}$ inches, tail $1\frac{2}{5}$ inches, hind foot $\frac{3}{5}$ inch, is separable into several groups based upon size. In the typical size group may be placed *C. g. fumatus* from Manchuria, *C. longicaudatus* from Peking, *C. alticola* from Ladak and Tibet, and *C. manchuricus* from northern Manchuria. *C. longicaudatus* is colored buffy drab above; the underparts are white with gray hair bases; the hands, feet, and underside of the tail are pure white, and the ears blackish.

A second size group, in which the tail is longer though the feet remain small, includes the white-footed *C. triton*, distributed from Shantung and Honan to Chihli, and *C. kamensis* from northeastern Tibet. In these the length of the tail exceeds 2 inches. In the third size group the hind foot is also proportionately larger. Here are included *C. nestor* from Korea and *C. arenosus* from northeast Jehol, which has the basal parts of the feet dark.

The Mice of the genus *Cricetulus* make burrows. In their cheek pouches they carry seeds and bits of leaf, which are stored in large underground chambers.

The Least Hamsters, *Cricetiscus songarus campbelli* from northeastern Mongolia, and *C. crepidatus* from the Altai, are small Hamsters related to *Cricetulus*. In *Cricetulus* the white of the underparts extends upward as conspicuous white patches in front of and behind the shoulders. The upperparts are ochraceous and buffy gray. A line along the back is blackish. In *C. campbelli*, the length of head and body is $3\frac{1}{2}$ inches, of the tail only $\frac{1}{4}$ inch, hind foot $\frac{1}{2}$ inch. *C. crepidatus* is larger; the head and body measure 4 inches, the tail and foot both $\frac{1}{2}$ inch.

The cheek pouches of *Cricetiscus* often contain seeds. The animals are sometimes active in the afternoon.

Miller's Hamsters, *Phodopus*, are small desert-living species with the feet short and the tail even shorter. The species of eastern Asia are *P. bedfordiæ* from Shensi and northwest and *P. prædilectus* from central Manchuria. The color of *P. bedfordiæ* is drab gray with pure white underparts; the length of its head and body is 3 inches, tail $\frac{2}{5}$ inch, hind foot $\frac{1}{2}$ inch. *P. prædilectus*, smaller in size, is said to have a prominent white patch over the ear and the eye, and the posterior half of each ear white. The head and body measure $2\frac{1}{6}$ inches, tail $\frac{1}{3}$ inch, hind foot $\frac{2}{5}$ inch. Like the previously mentioned Little Hamsters, *Phodopus* have capacious internal cheek pouches, which they pack full of seeds. The pouches are emptied by pressing with the paws.

The Korean Hamsters, *Asiocricetus hampensis* and *yamashinæ*, were reported by the Japanese mammalogist Kishida. We know little about them.

The Cricetine Mole Rats of the subfamily Myospalacinae, like the Bamboo Rats, bear a strong external resemblance to our American Pocket Gophers. They are believed by some authors to be close relatives of the Cricetines, by others to be derived from the same stock as the Meadow Mice, Microtinae. In either case they are specialized for subterranean life. The entire skeleton is massive and strengthened. The skull is broad and the incisor teeth very heavy. Only one genus, *Myospalax*, is recognized. It is a native of China, Manchuria, and southern Siberia.

The Cricetine Mole Rats, as we may term these animals, in order to distinguish them from the True Mole Rats, *Spalax* (not found in our area), include several species. Their bodies are thick and chunky, the limbs short, powerful, and armed with immense digging claws; the tail is very short; the eyes

are much reduced; and the external ear is obsolete. In the fore-foot the third claw is the biggest, the fourth considerably shorter and very stout, while the second, though not so short, is much slenderer.

The species occurring in China are *M. myospalax*, *M. armandia*, *M. fontanierii*, *M. rothschildi*, and *M. smithii*. The first of these, represented by a special race, *psilurus*, is the only

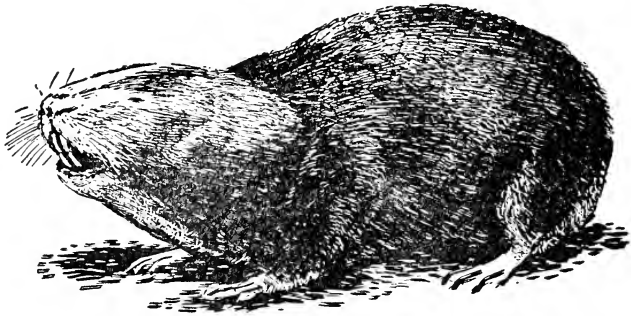


FIG. 58. Cricetine Mole Rat, *Myospalax myospalax*.

species likely to be encountered in the extreme East. It occurs in Jehol, Hopei, and Shantung. In eastern Siberia *M. dybowski* is found, and in southern Manchuria *M. komurai*. *Myospalax m. psilurus* lives in the Kinghan Mountains, Manchuria.

The color in *M. m. psilurus* is reddish gray above, slightly paler below; the cheeks and forehead are ashy fawn; there is a small white spot on the back of the head. The length of the head and body is approximately 10 inches, tail $1\frac{1}{2}$ inches, hind foot, with claw, a little less than 2 inches. *M. komurai* is much smaller, the same set of measurements being $8\frac{1}{2}$ inches, $1\frac{1}{2}$ inches, $1\frac{1}{4}$ inches.

These are savage little animals and powerful diggers, making galleries that may attain lengths of 40 meters. The diet consists of roots and grain.

VOLES, MEADOW MICE, AND LEMMINGS
(SUBFAMILY MICROTINÆ)

The members of this large subfamily live for the most part in the cooler parts of the northern hemisphere. They are small, heavy-bodied Mice with short tails. If the teeth can be examined, it will be seen that the enamel pattern of the surface of the molars takes a more or less zig-zag course from front to rear (Fig. 57, c). The appearance of these teeth has been said to resemble a chain of prisms in end view.

The Voles are customarily divided into two groups, a smaller and a larger. The first group, the Lemmini (Simpson), contains four genera of Lemmings, of which three are found in eastern Asia. The second group, the Microti, includes all remaining genera—a very large assemblage. These two groups are distinguished by technical characters, including the positions of the roots of the lower incisor teeth within the bone of the lower jaw, in relation to the roots of the cheek teeth. The claws of True Lemmings become very large in winter, perhaps to aid them in scratching in the snow and ice for food. The Lemmings are confined to the northern parts of each hemisphere. Only the American genus *Synaptomys* extends southward for some hundreds of miles, chiefly along mountain ranges.

The Collared Lemmings, genus *Dicrostonyx*, are a circumpolar genus of thick-bodied, often short-tailed Voles. The ears are reduced to mere vestiges, and the openings can be closed by muscular contraction. The colors are mixtures of reddish and gray. The “collar” is often inconspicuous and may be absent. There is often a dark line along the middle of the back. The fur becomes white in winter.

In this genus the typical species is the American *D. hudsonius* from Labrador. The best-known species from the Old World is *D. torquatus*, extending from Lapland through northern Asia

for an unknown distance. In the Kolyma River region northwest of the Okhotsk Sea, *D. chionopæus* is found. This last is smaller than *torquatus*, the length of head and body $4\frac{1}{2}$ inches, tail $\frac{1}{2}$ inch, hind foot $\frac{4}{5}$ inch. A specimen collected in October had already nearly completed its transformation into white winter pelage. The color was entirely white except for a patch of hazel on the top of the head and nape, and one on the chest.

The Red-backed or Gray Lemmings, *Myopus*, are a genus of relatively unspecialized, thick-set lemming-like Voles, lacking the bright colors of *Lemmus*, the collar of *Dicrostonyx*, and the grooved upper incisor teeth of *Synaptomys*. The ear, though small, has a distinct valve to regulate the size of the ear opening. The feet lack the special features of *Lemmus* and are slender, with no unusual growth of hair. These Lemmings occur in the fir forests of northern Eurasia, from Scandinavia to eastern Siberia. The typical species is *M. schisticolor* of northern Europe.

In Siberia occur *M. middendorfi* from the west coast of the Okhotsk Sea and *M. thayeri* from the neighborhood of the Kolyma River, north of the former. *Myopus thayeri* is deep gray with a mixture of whitish hairs which are dominant on the undersurface, a faint tinge of russet on the back, the feet silvery drab. A cluster of stiff whitish hairs grows at the wrist. In *M. middendorfi* the red on the back is much accentuated and may extend from the forehead to the base of the tail. The head of this form is said to be larger than that of *M. thayeri*. The lengths of head and body in *M. thayeri* are $4\frac{1}{2}$ inches, tail $\frac{3}{5}$ inch, hind foot $\frac{3}{4}$ inch; of *middendorfi* $3\frac{3}{4}$ inches, $\frac{2}{5}$ inch, $\frac{3}{5}$ inch.

The True Lemmings, genus *Lemmus*, have won fame by their occasional periods of extraordinary abundance in Scandinavia, when after eating everything they can find they move outward from the center of scarcity which they have created, eventually reaching and swimming out into the sea where they perish. The ears of Lemmings, though hidden by their long fur,

are much less reduced than in *Dicrostonyx*, and are unprovided with valves for opening and closing the ear openings. Lemmings are broad-headed, heavy-bodied Voles with very short muscular tails, large anterior claws that enlarge in winter, and a large, strap-shaped nail on the thumb. The palms are furry to the bases of the fingers. A dark dorsal stripe may be present. *Lemmus* lacks the "collar" of the Collared Lemmings. It too becomes white in the winter. The range of the genus is circumpolar; the typical species, *Lemmus lemmus*, is native to the mountains of the Scandinavian peninsula.

In eastern Asia *Lemmus* is represented by the Yellow-bellied Lemming, *L. chrysogaster*, a close relative of the Alaska Lemming, by the Little Kolyma Lemming, *L. paulus* from the Kolyma River area, and by *L. amurensis* from the Amur River region. The summer color of *L. chrysogaster* is yellow-brown varied with black, grayer on the head and neck, becoming reddish on the hind back and rump; the undersurface is orange-brown, the chin and sides of mouth whitish, the feet gray-brown, the tail dark above, its undersurface and tuft of long hairs grayish white. The length of head and body reaches 3 inches, tail $\frac{2}{5}$ inch, hind foot $\frac{3}{5}$ inch.

The summer pelage of *L. paulus* is buffy, mixed with blackish on the head, becoming clearer posteriorly and on the sides; underparts are ochraceous, chin, throat, and anal region whitish, tail pale buff, feet silvery with a dusky tinge. The length of head and body is $4\frac{1}{4}$ inches, tail $\frac{3}{5}$ inch, hind foot $\frac{3}{5}$ inch. The measurements of these two forms are as given in their original descriptions.

Lemmus amurensis, colored much as *L. chrysogaster*, is uniform brown tinged with russet on head and rump, underparts cinnamon. The length of its head and body is 4 inches, tail $\frac{2}{5}$ inch, hind foot $\frac{1}{2}$ inch.

The east Asiatic Microti, or those Meadow Mouse genera which are not closely related to the Lemmings, comprise the

following genera: the Red-backed Mice, *Clethrionomys*, with *Aschizomys* and *Neoaschizomys*; the Dawn Meadow Mice, *Eothenomys*; the Himalayan Mice, *Alticola*; the True Meadow Mice, *Microtus*; the Rabbit-tailed Mice, *Lagurus*; the Mole-like Meadow Mice, *Ellobius*; and the peculiar *Proedromys*. These are all derived from common ancestry. The differences between them, not easily defined, depend chiefly upon tooth structure. But other characters aid in their distinction; the number of nipples in the females may assist in determination (8 in *Microtus*, 4 in *Eothenomys*), also the length of the ears and tail and the form of the feet, including the number of pads and the types of claws.

Clethrionomys, *Lagurus*, and *Microtus* are essentially northern genera; *Eothenomys* and *Alticola*, on the other hand, are centered around the Himalayan Mountains, many of them at great altitudes. *Ellobius* is a genus which reaches greatest development in central Asia.

The Red-backed Mice, *Clethrionomys*, are widely distributed in the cold temperate regions around the world. For the most part, they live in woods and often in cold, mossy or rocky forests. The general form is that of a Meadow Mouse. The color above is some shade of reddish brown, becoming paler on the sides, and gray beneath. The molar teeth have roots, instead of growing from persistent pulps.

Of the four main divisions of this genus defined by Hinton, only the smaller-sized *rutilus* group and the larger-sized *rufocanus* group occur in eastern Asia. The *C. rutilus* group (*rutilus* typifies the entire genus) contains, besides *rutilus* and its races from Europe to the Sea of Okhotsk, *baikalensis* and others from Lake Baikal eastward, *irkutensis*, *laticeps*, and *parvidens* from Irkutsk Province, *C. r. jacutensis* from Yakutsk, *wosnesenskii* from Kamchatka, *jochelsoni* from the Kolyma River region in northeastern Siberia, *amurensis* from Amur and Sakhalin, and *mikado* from Hokkaido Island, Japan. The Mice

belonging to this group have the length of the head and body about 4 inches, often less, tail 1 to $1\frac{1}{4}$ inches, hind foot $\frac{3}{5}$ to $\frac{4}{5}$ inch.

The *C. rufocanus* group includes *rufocanus* proper, extending from Europe to Kamchatka, *C. r. kolymensis* from Kolyma River region, *C. r. shanseius* from Shansi, China, *C. r. regulus* from Korea, *C. r. smithii* from Japan, *C. arsenjevi* from Vladivostok, *C. r. latastei* from Kamchatka, *C. r. kurilensis* from the Kurile Islands, *ussuriensis* from Ussuri.

These are robust Red-backed Mice with the length of the head and body 4 to 5 inches, tail 1 to $1\frac{1}{2}$ inches, hind foot from $\frac{3}{5}$ to $\frac{4}{5}$ inch (without the claws).

Aschizomys, with typical species *A. lemminus*, from Plover Bay, on the Bering Strait, Siberia, is closely related to *Clethrionomys*, but the teeth grow from persistent pulps as in *Microtus*. Though treated as intermediate between those two genera, it may also be related to *Eothenomys* of southern Asia or to *Alticola*. The dense silky fur is colored a fine grizzle of sepia and yellowish brown, the underparts straw-yellow; in front of each ear is a tuft of white hairs. The tail has a distinct hair pencil. The hands and feet are straw-yellow (these colors from specimens in alcohol). The length of head and body reaches $3\frac{2}{5}$ inches, tail $\frac{3}{5}$ inch, hind foot $\frac{3}{5}$ inch.

Neoaschizomys, a northeast Asiatic species, also appearing related to *Clethrionomys*, has been distinguished. The type, *N. sikotanensis*, from one of the southern Kurile Islands, has dense, soft, reddish orange fur on the back, gradually changing to light buff underparts. The hands and feet are dark gray, their soles hairy behind the tubercles. The length of the head and body is 5 inches, tail $2\frac{1}{4}$ inches, hind foot $\frac{4}{5}$ inch.

The Dawn Meadow Mice, *Eothenomys*, are a genus of Meadow Mice intermediate in character between the Red-backed Mice and the True Meadow Mice. The colors are dark, the tips of the hairs with a somewhat metallic glint. The two pairs of

nipples are on the belly. These animals are rather smaller than the Pennsylvania Meadow Mice that we know near New York. The color is gray-brown, with the tips of the hairs distinctly rufous in some forms. They are nocturnal and partly diurnal. In Burma they may be trapped in the rank grass of mountain meadows, or along the banks of trails and under rocks and logs.

The typical species of *Eothenomys*, *E. melanogaster* (meaning "black-bellied"), occurs from Fukien in southern China to northern Burma and Assam. Other related species are *E. miletus* from Yunnan and Hupeh, *E. eleusis* also from Yunnan, *E. libonotus* from the Mishmi Hills of Assam. The length of the head and body in *E. melanogaster* is $3\frac{1}{2}$ to $3\frac{3}{4}$ inches, tail $1\frac{2}{5}$ to $1\frac{4}{5}$ inches, hind foot $\frac{1}{2}$ to $\frac{3}{5}$ inch. *E. m. colurnus* from Fukien is larger, the length of head and body between 5 and 6 inches. *E. miletus* is also large but *E. eleusis* is smaller again, with a longer tail—about 2 inches.

A subgenus of *Eothenomys*, named *Anteliomys*, is restricted to Yunnan and adjoining parts of southern China and Tonkin. Species included here are *E. chinensis* from Szechwan, and *proditor*, *olitor*, and *custos*, all from Yunnan. They vary in size according to species, just as typical *Eothenomys* do. *Eothenomys chinensis* has the head and body length from $4\frac{1}{4}$ to 5 inches, the tail longer ($2\frac{1}{2}$ inches), and the hind foot from $\frac{4}{5}$ to almost 1 inch; *E. custos*, *proditor*, and *olitor*, on the contrary, have shorter tails.

Caryomys, another subgenus of *Eothenomys*, contains only two species, *E. eva* from Shansi and Shensi, and *E. inez* from Kansu, Hopei, Shensi, Szechwan, and Jehol. In *E. inez* the tail is only $1\frac{1}{2}$ inches long, in *E. eva* 2 inches or more.

The form of "*Microtus*" recorded by Blanford from the Himalayas, *sikkimensis*, is perhaps referable to *Eothenomys*. Other "species" in his list are forms of *Alticola*, a genus of the high mountains having a northwestern distribution.

The Himalayan Meadow Mice, genus *Alticola*, are very close relatives of Red-backed Mice. Clad in long dense fur, they occur for the most part among the mountains of the Himalayas and Tibet and northward into central Siberia. The typical species is *A. stoliczkanus* from northern Ladak. Several other species are known also from Ladak, Kashmir, and adjoining territory. *Alticola macrotis* is found in the Syansk Mountains, east Siberia, near the Mongolian boundary.

A subgenus of *Alticola*, named *Platycranius* (meaning "flat-skulled"), has a still more northern distribution. *A. (P.) alliaris* is found about Lake Baikal in Siberia and perhaps in the coastal ranges of the Maritime Provinces. *Alticola stoliczkanus* is colored straw-buff, with the dark gray bases of the long silky fur often showing through. The tail, hands, and feet are whitish. Species of the extreme north are grayer dorsally. The length of the head and body is 4 inches, tail 1 inch, hind foot $\frac{7}{10}$ inch. Another species, *A. strelzovi*, is larger; the first two corresponding dimensions are $5\frac{1}{2}$ and $1\frac{3}{4}$ inches.

The Mice of the genus *Alticola* seem to correspond in Asia to the Snow Mice of Europe, *Chionomys nivalis*, which live at high levels among the mountains and which also have the tail white.

The Old World Water Rats, genus *Arvicola*, are typified by the rather large, strongly amphibious, gray-brown Water Rats of Europe, which may often be seen swimming in ponds. These are relatives of the Meadow Mice, *Microtus*, but have aquatic adaptations and ways of life. They are represented in western North America. There is also a terrestrial branch of the genus, *A. terrestris*, a subspecies of which, *A. t. jacutensis* of Yakutsk, should be sought in the Siberian coastal regions. The last mentioned, with very long, dense fur and underfur, is colored dark gray-brown. The length of the head and body varies from 6 to $6\frac{1}{2}$ inches, tail 4 to $4\frac{1}{2}$ inches, hind foot $1\frac{1}{4}$ to $1\frac{1}{2}$ inches. Certain kinds of field Mice from China formerly

placed in *Arvicola* are currently considered to be *Microtus* (Meadow Mice).

The Pine Mice, genus *Pitymys*, are an offshoot of the Meadow Mice that have become burrowers. They can be distinguished from these by the fact that their females have 4 nipples instead of 8. This genus conspicuously exemplifies discontinuous distribution. It occurs from central and southern Europe to Asia Minor, and reappears in the eastern and southern United States and in Mexico. Although no living species are known from eastern Asia, a fossil, *P. simplicidens*, is recorded from southwest of Peking, China.

The Meadow Mice, genus *Microtus*, are typically somewhat shaggy-haired, short-tailed Mice, colored brownish gray above, light gray beneath. The species are very numerous. They have been grouped together by various students into a number of subgenera, some of which can be distinguished only with considerable difficulty. Many of the species are of economic importance, for they become very numerous periodically and then injure crops. They are generally controlled by such predators as foxes and owls. As they may have a new generation every 50 days or so, and from 4 to 9 may be born in a litter, it is easy to appreciate how rapidly a population of field Mice may increase under favorable conditions. The subgenera of *Microtus* occurring in the oriental parts of Asia are four: *Phaiomys*, *Neodon*, the narrow-skulled *Stenocranius*, and *Microtus* proper.

The subgenus *Phaiomys* (including *Lasiopodomys*) is primarily Himalayan and central Asiatic. The typical species is *P. leucurus* (= *blythi*) from Tibet; that of *Lasiopodomys* is *L. brandtii* from Mongolia. All species have undergone slight reduction of the ears and tail and enlargement of the claws. The thumb has a claw instead of a nail. Two additional species are known, *mandarinus* from Shansi and Shensi and *everesti* from Mt. Everest, 17,000 feet. All are somewhat fossorial.

The subgenus *Neodon* is characteristic of south-central China and extends into the highlands of southern Yunnan. Recognized species are the typical species, *Microtus sikkimensis*, *M. irene* from Yunnan, Szechwan, and Kansu, and *M. forresti* from southern Yunnan. The Mice of this subgenus are separated from *Microtus* on technical grounds. They are not fossorial; they have the mammary formula of *Microtus* (8 nipples) but the tooth structure of the Pine Mice.

The subgenus *Stenocranius* is northern. It occurs from Mongolia to Siberia eastward and westward to Europe. *Microtus slowzowi* is typical. Eastern forms are *Microtus brandti* aga and *M. michnoi*, both from the Transbaikal region; *M. koreni* from the Kolyma River region, northwest of the Sea of Okhotsk; *M. gregalis*, with its several races, from eastern Siberia; and *M. tshuktshorum* from Plover Bay, extreme eastern Siberia. The species of this subgenus are distinguished by having narrower skulls than those of true *Microtus*.

The Meadow Mice included in the subgenus *Microtus* in the most restricted sense are probably best known to residents of the eastern United States through *M. pennsylvanicus*, common in all our waste fields and pastures. These Mice are gray-brown in color and have short tails. They may sometimes be seen running along their runways in late afternoon. The typical species is the European *M. terrestris* (= *arvalis* Pallas).

In the Far East of Asia the pattern of distribution of true *Microtus* is singularly like that of the shrew-genus *Sorex*, namely, a great concentration of forms in the north, a minor aggregation in the highland of southwest China and in Tibet, and few species in the intervening lowlands of east China. In northern Burma and Tonkin the microtines are represented chiefly by *Eothenomys*. Beginning in the northeast, there is *M. camtschaticus* from Kamchatka and *M. uchidaë* from Paramushiro, one of the northern Kurile Islands; *M. koreni* from the Kolyma River northwest to the Sea of Okhotsk; *M. oecono-*

mus generally distributed in Siberia; *M. pelliceus* from Ussuri; and *M. amurensis* from Amur. In Japan exist the several races of *M. montebelloi*. Most of the foregoing are close relatives of *M. oeconomus*. Near Nanking, China, almost at sea-level, *M. fortis calamorum* is found. Typical *M. fortis* occurs in Shensi. The mountainous country east of the highlands of Tibet is the home of *M. clarkei* (Yunnan) and *M. millicens* (Szechwan).

Rabbit-tailed Meadow Mice, genus *Lagurus*, are circum-polar forms resembling Meadow Mice but have the tail reduced to a mere stump. The ears are so small as to be almost concealed by the hair, and the soles of the feet are thickly hairy. The principal species is the north European *L. migratorius*. The species *L. lagurus* occurs in inner Siberia and *L. przewalskii* in Mongolia. Representatives should be looked for also in the Siberian Maritime Province.

Species of *Lagurus* less specialized than the Old World members are found also in western North America.

The color is usually drab yellow to ochre-yellow above, drab gray beneath; the tail bicolored, the feet ashy gray. Length of head and body is 4 inches, tail $\frac{3}{5}$ inch, hind foot $\frac{3}{5}$ inch.

The Mole-like Meadow Mice, *Ellobius*, are possibly the most specialized of all the Meadow Mice. The ears are rudiments, the tail a mere projection. The fur is soft and plush-like, as becomes animals that live mainly underground. The claws, contrary to expectations, are short, for these Mice are reputed to do their digging with their teeth instead of scratching with the claws. Their range extends from eastern Europe to central Asia. One form, *E. talpinus orientalis*, occurs as far east as eastern Mongolia. The color of the back in this species varies from bright cinnamon to sandy; the belly is whitish. There is a dark area on the face and forehead. Length of head and body, $4\frac{1}{4}$ inches, tail, $\frac{1}{3}$ inch, hind foot, $\frac{7}{8}$ inch.

The Duke of Bedford's Vole, genus *Proedromys*, containing the single species *P. bedfordi*, was discovered in Kansu. It

differs from other local Microtines by being very long-haired, and is further distinguished by having broad, grooved incisor teeth. The ears are rather small. This anatomically peculiar Vole is colored dull brown. The underparts are "slaty drab, washed with brownish white" (Thomas), the feet white, the tail brown above and white below. The length of the head and body is 4 inches, tail $1\frac{3}{5}$ inches, hind foot $\frac{3}{4}$ inch. Only one specimen is known.

THE BAMBOO RATS (FAMILY RHIZOMYIDÆ)

The Bamboo Rats, which externally resemble the American Pocket Gophers, comprise three genera, all very similar to one another. They have thick, heavy bodies, short legs equipped with stout digging claws, very short tails, but no cheek pouches. Two of the genera, *Rhizomys* and *Cannomys*, of which the first is the larger, occur in eastern Asia.

The Chinese Bamboo Rat, *Rhizomys sinensis*, and other closely related races are somewhat variable in color and size. The fur is silky brownish gray above and beneath. The skull is wide and triangular, and the back of it provides broad, sloping expanses of bone to which are attached the immensely powerful neck muscles. The length of the head and body varies in different races from 9 to 10 inches, the tail from 2 to $3\frac{1}{2}$ inches, hind foot $1\frac{3}{4}$ inches.

The animal, which spends much of its life underground, feeds upon the roots and shoots of bamboo, grass, seeds, certain fruits, and doubtless other plants. It is found in Fukien, Yunnan, and Szechwan. Ward's Bamboo Rat, the race *R. s. wardi*, occurs in northern Burma at about 9000 feet.

The Hoary Bamboo Rat, *R. pruinusus*, found in the extreme south of China from Kwangtung to southern Yunnan and Assam and south into Tonkin, is recognized by its slaty fur flecked with numerous whitish tips. The head and body in

males may measure nearly 12 inches in length, the tail 4 inches, the hind foot 2 inches; females are smaller. There are several races. A near relative, *R. pannosus*, a species comprising two races from Siam and the Malay Peninsula, is dark grayish brown. Though many of the hairs are tipped with white, it is less hoary than *R. pruinus*. The length of the head and body is 12 inches, tail 5 inches, hind foot $1\frac{3}{4}$ inches.

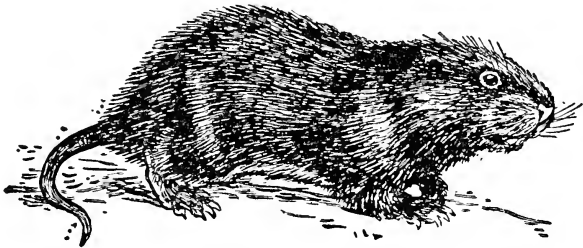


FIG. 59. Hoary Bamboo Rat, *Rhizomys pruinosus*.

The Red-cheeked and Yellow-cheeked Bamboo Rats, *R. sumatrensis*, usually placed in a distinct subgenus, *Nyctocleptes*, are represented in the Malay Peninsula by the race *R. s. cinereus*, the Yellow-cheeked form, found from Tenasserim to southern Burma. The fur is harsh and short and the animal may be large—the head and body 15 to 17 inches, hind foot 2 to $2\frac{3}{4}$ inches. Farther north, in the Salween area, the slightly differentiated Red-cheeked form, *R. erythrogyens*, occurs.

The Chestnut Bamboo Rat, *Cannomys badius*, is distinguished from *Rhizomys* chiefly by the fact that the upper teeth project far forward. The animals are smaller. *C. badius*, found in Nepal, is divided into six geographical races. The color is usually chestnut-brown above, brightest on the head and duller on the rump, the underparts ashy gray. The teeth are reddish orange. The length of head and body varies from 7 to 10 inches, tail $2\frac{1}{2}$ to 3 inches, hind foot $1\frac{1}{4}$ to $1\frac{1}{2}$ inches. There is con-

siderable geographical variation. Flower writes that the food consists of unhusked rice, yams, and pumpkins, and that the animal is aggressive when surprised.

The Small Bamboo Rat, *C. b. minor* from southern Siam, is dark brown beneath, the muzzle and around the eye whitish. The length of head and body is $6\frac{1}{2}$ inches, tail $1\frac{3}{4}$ inches. Other races include *C. b. lönnbergi* from eastern Siam, *C. b. plumbescens* from the northern Shan States, *c. b. castaneus* from Arakan in southeastern Burma, and *C. b. pater* from Mt. Popa in the dry belt of Burma.

THE RATS AND MICE (FAMILY MURIDÆ)

Rats are so generally regarded as low forms of animal life fit only to be struck down with clubs or dosed with poison, that many people will be surprised to learn of the value of the very large number of wild species of Rats for studies on evolution and distribution. The study of similarities and differences between the many members of the Rat family may be compared to the work lavished upon their hobby by the devotees of stamp-collecting. The slight variations in color, shape of feet and ears, the bones of the skull, and tiny distinctions in the teeth correspond in interest to differences of perforation, watermark, and "secret marks" in postage stamps.

The usual low regard for Rats is exemplified by the following story: A scientist studying the animals of mountainous country had been hospitably entertained by an American gold-miner. It is frequently the custom for scientists to name new discoveries after persons, as a signal of special esteem, but the gesture is sometimes misunderstood. This scientist published the description of a new kind of Field Mouse and named the animal for the miner. When the miner came back to civilization from the mountains, he was asked, "How did you get along with Dr.—?" "A great fellow, and a swell poker player," the

old-timer replied, "but I guess he didn't like me too well. He named a damned rat after me."

"What is the difference between a Rat and a Mouse?" is a question frequently asked. The trouble with this poser is that it refers only to domestic Rats and Mice. In the mind of the public, a Rat is a very large Mouse, and a Mouse is a very tiny Rat. On the other hand, those who are on more intimate terms with these rodents know that the murids (Rats and Mice) that make themselves known to man by living in his cellar or in the closet where he stores food amount to the merest handful out of literally hundreds of distinct kinds of rarely seen wild Rats or Mice, whose sizes intergrade completely and which reveal an immense variety of small but appreciable differences. So the supposed distinction of "rat" and "mouse" has no real application when the whole family of these rodents is considered, and no one can indicate the precise point where one of the many species of Mice is considered large enough to be called a Rat, or the reverse. The difference between a horse and a pony does not present, as one might think, a strictly comparable case, because horses and ponies are merely large and small varieties of the same horse species. The House Mouse, however, is an animal entirely different from any of the several kinds of House Rats.

Some scientists believe that commensal Rats, namely, those that live right in houses with man, have darker underparts than wild Rats of the same identical kind. They claim that the two can be distinguished visually, and imply that life in man's houses and feeding upon his food affects the colors.

With such large numbers of generally similar species of murids needing to be arranged and systematically studied, it can readily be understood that their classification presents a difficult problem. The system of classification employed in zoology has already been explained (pp. 7-9). The Rat family is divided into subfamilies, genera, species, and subspecies in just the same way as the cattle family or the kangaroo family, but many more

species of Rats exist and often they appear much more alike. Only the subfamily Murinæ comes within the area dealt with in this book; dentition (Fig. 57, b).

SUBFAMILY MURINÆ

For the convenience of the readers of this book, the Rats and Mice are grouped into three categories: those Murinæ which have the hind foot either completely or incipiently hand-like, with the great toe wholly or partly opposable to the other toes; and the "Mice," and "Rats." The first group includes the Old World Harvest Mice, *Micromys*, in which opposability is imperfect; the Long-tailed Climbing Mice, *Vandeleuria*; Vernay's Climbing Mice, *Vernaya*, intermediate between these two genera; the Pencil-tailed Tree Mice, *Chiropodomys*; the Marmoset Mice, *Hapalomys*; the Monkey-handed Rat, *Pithecheir*; and the Burma Tree Mouse, *Chiromyscus*.

The remaining Rats and Mice, in which the feet are not so modified for climbing, may be divided arbitrarily but unscientifically into "Mice" and "Rats." The "Mice" are relatively small; the "Rats," with few exceptions, are large or very large. The "Mice" include the House Mice, *Mus*; the Jungle Mice, *Leggada*; Flat-haired Jungle Mice, *Leggadilla*; Millard's Mice, *Millardia*; *Golunda*; and the Old World Wood Mice, *Apodemus*, and its subgenus *Sylvæmus*.

All those murines left over fall into the third group, the "Rats," which includes the True Rats, *Rattus* (containing, besides many large forms, a few rather small, mouse-like species); the Large-toothed Rats, *Dacnomys*; the Bandicoot Rats, *Bandicota* and *Gunomys*. Any other rat-like animals that may be encountered in eastern Asia belong to subfamilies other than the Murinæ.

The Old World Harvest Mice, *Micromys* (unrelated to the American Harvest Mice) are among the tiniest of rodents.

The hind foot has the three central digits relatively long, the fifth unreduced. The great toe, though moderately short, bears a claw and is at least partly opposable. The ear is equipped with a triangular valve by which the opening can be closed. There are 8 nipples. The typical species is the European Harvest Mouse, *M. minutus*. There is only one form in China, *M. minutus pygmæus*, a near relative of the common little species *M. m. soricinus* of western Europe. The European Harvest Mouse extends into European Russia. This species is known to burrow in the ground as well as to make its nest in hayricks or off the ground among standing wheat or thistles. The nest is a small, ball-shaped mass of dry grasses. From 5 to 8 young are born in it.

The Chinese Harvest Mouse, *M. m. pygmæus*, is dull rufous, with a blackish wash and with the hairs gray at the roots. The tail is usually longer than the body, the former about $2\frac{3}{4}$ inches long, the latter $2\frac{1}{2}$ inches, the hind foot $\frac{3}{4}$ inch. It is widely distributed in China in Shensi, Fukien, Yunnan, Szechwan, and Hupeh.

The form found in northern Burma is *M. minutus erythrotis* (meaning "red-eared"). Typically *erythrotis* is found in the Khasi Hills, Assam. These Burmese Mice were found on open hillsides, not in dense forest. *M. m. usuricus* and *M. m. batarovi* are races from eastern Siberia, *M. m. japonicus* from Japan. All species are good climbers.

Vernay's Climbing Mouse, genus *Vernaya*, stands somewhat intermediate between *Vandeleuria* and *Chiropodomys*. In *Vernaya* the thumb bears a small flattened nail; the incisor teeth are not grooved. There is but a single species, *Vernaya fulva*, a reddish Mouse found in Yunnan and northeastern Burma at about 7500 feet. The head and body measure $3\frac{1}{2}$ inches, the tail $4\frac{1}{2}$ inches, the hind foot $\frac{3}{4}$ inch.

The Long-tailed Climbing Mice, genus *Vandeleuria*, are pretty red-brown Mice having the tail, which is much longer than the head and body, untufted at the tip (compare with

Chiropodomys). They are found only in the tropics of south-eastern Asia, from India through Burma and Indo-China to southern Yunnan in China. In common with *Chiropodomys* they have the great toe of the hind foot opposable and thumb-like, just as monkeys do. The teeth are substantially like those of True Mice and True Rats. The upper incisors are weakly grooved. The number of nipples is 8, 2 pairs on the chest and 2 on the belly.

In Ceylon a specimen was captured alive in a nest 30 feet up a tree. The animal proved to be nocturnal and strongly arboreal, using its long tail as a balancing organ as it ran out to the tips of slender twigs. The nest was made from a broad-bladed grass that had been carried up from the ground.

The Indian Field Mouse, *V. oleracea* of central India, the type species of *Vandeleuria*, is colored "bright pale chestnut" above, yellowish white beneath. The very long tail is not prehensile. The second and fifth digits of the hands are shorter than the third and fourth; the first (much reduced in size) and fifth digits have each a nail instead of a claw. The great toe is (apparently) opposable to the other toes as in *Chiropodomys* and *Hapalomys*. The number of nipples is 2 thoracic pairs and 2 inguinal, totaling 8. The length of the head and body is $2\frac{3}{4}$ inches, tail $4\frac{1}{4}$ inches, hind foot $\frac{3}{4}$ inch. Three related forms are found eastward: *V. dumeticola* of Nepal, the race *V. d. scandens* of Tonkin and eastern Yunnan, and *V. sibylla* of southern Siam. The first of these is also a buffy rufous-colored Mouse with white underparts, but the tail is dusky. The hands and feet are white. The head and body measure 3 inches, tail $5\frac{1}{2}$ inches, hind foot $\frac{3}{4}$ inch. The race *V. d. scandens* is as small as *sibylla*; it has a wash of ochraceous buff over the white underparts. Like the Indian Field Mice, those of Yunnan build nests of grass among low shrubs.

The Pencil-tailed Tree Mice, genus *Chiropodomys*, which means "hand-footed Mouse," from the thumb-like great toe on the hind foot, is a genus of tropical Mice, the greatest concentra-

tion of which exists in Borneo. Those of the Asiatic mainland are found in the Malayan region and Assam, through Siam and Indo-China to Kwangtung in southern China. The color is light dull brown above, whitish beneath. The tail, furnished with a distinct tuft of hairs at the tip, is considerably longer than the head and body. The thumbs of both hands and feet have nails instead of claws, and the feet are broad and well adapted for climbing and grasping.

The only continental species, *C. gliroides*, has the length of the head and body $3\frac{1}{2}$ inches, tail 4 inches, hind foot $\frac{3}{4}$ to $\frac{4}{5}$ inch. Some of the Bornean species are much larger, others much smaller. Gairdner gives the dimensions of one from lower Burma as $3\frac{7}{8}$ inches, 5 inches, and $\frac{4}{5}$ inch.

The Marmoset Mice, genus *Hapalomys*, are fitted to an eminent degree for climbing. They resemble the Pencil-tailed Tree Mice in having grasping hind feet with opposable, thumb-like great toes and the very long tail furnished with a tuft of hairs at the tip. But they are somewhat larger and their noses are longer. The cheek teeth present a strikingly regular pattern, the little tubercles arrayed in successive sets of three, almost as regularly as the pattern on a rubber coin mat. These Mice seem to be extremely scarce. Only one species is known: *H. longicaudatus* from Tenasserim, which extends eastward into Indo-China where it is represented in Annam and Laos by the race *H. l. delacouri*, and on the Island of Hainan by the race *H. l. marmosa*. The dense soft fur is colored brownish gray above, pure white beneath. Young animals have more gray, less brown. The length of head and body varies from $5\frac{1}{2}$ to $6\frac{1}{4}$ inches, of the tail 6 to $8\frac{1}{4}$ inches, hind foot $\frac{4}{5}$ to $1\frac{1}{5}$ inches.

The Monkey-handed Tree Mouse, *Pithecheir*, is a Malayan genus containing the single species *P. melanurus*. It occurs in Selangor, the lower part of the Malay Peninsula, Sumatra, and Java. The somewhat smaller mainland form has been distinguished as a separate race, *P. m. parvus*.

The popular name is not precisely suitable; "monkey-footed" would have been preferable, since the foot, not the hand, has the first digit opposable. There are 4 inguinal nipples. The dorsal color of *P. m. parvus* is tawny, the bases of the hairs gray; the ventral color is clear white. The tail is black. The length of the head and body is 5 inches, tail $5\frac{3}{4}$ inches, hind foot 1 inch.

The Burma Tree Mouse, *Chiromyscus chiropus*, appears somewhat like *Rattus* but has the hind foot specialized for climbing. The claws are short and the foot, with the great toe opposable, is hand-like. There are 8 nipples in the females. The color is "warm lined buffy," with the cheeks and rump rich ochraceous; a dark area surrounds each eye. The length of the head and body is 5 inches, tail 8 inches, hind foot $1\frac{1}{4}$ inches. This Mouse occurs in the Karin Hills, in central Laos, Burma, and in Tonkin.

The House Mice, genus *Mus*, are distinguished by the relatively great size of the first of the three molar teeth and the small size of the last (third) one. There are three primary divisions of the House Mice in eastern Asia, which for practical purposes will be treated here as genera, although they are sometimes considered merely subgenera. These are *Mus* proper, containing all the temperate-zone forms and extending into the warmer parts of Asia; *Leggada*, the Jungle Mice; and *Leggadilla*, the Flat-haired Jungle Mice, the last two chiefly Indian.

The True House Mice, *Mus*, in a restricted sense, are considered by at least one scientist as all referable to a single species. That species he divides into numerous subspecies or races. The typical and most widely known one is, of course, the Common House Mouse, *Mus musculus*, now widely distributed in the coastal regions of most of the world but once known only in Europe. In four cases out of five, this is the little wretch that infests poorly constructed food closets and eats our cheese and crackers. A mouse of this kind was once almost the basis of a lawsuit. One was found dead in a bottle of Indian chutney. The

irate lady who had purchased the chutney, though she admitted that the bottle had been opened in her home and that the top might subsequently have been left off, insisted that the Mouse in question was an Indian species that had been embalmed in the chutney in India when the bottle was filled. The animal proved to be *Mus musculus*, indistinguishable from those of the United States, which fact considerably weakened the lady's position.

Robert Burns may have addressed one of the races of *Mus* as "Wee, sleekit, cow'rin tim'rous beastie." On the other hand, the nest plowed up in his poem may have been that of a Meadow Mouse, *Microtus*, or even a Wood Mouse, *Apodemus*.

The House Mouse, well known as it is, has probably been viewed by very few people motionless and at close range. The color above and below is dark slate-brown; the feet and tail are dark slate. The females usually have 10 nipples, 3 pairs thoracic and 2 pairs inguinal. The length of the head and body is $3\frac{1}{4}$ inches, tail $3\frac{1}{4}$ inches, hind foot $\frac{3}{4}$ inch. The nest is made of paper, old bits of rag or wool, and other debris. From 8 to 12 pink naked young are born. They soon become covered with fur and in a few weeks are able to shift for themselves.

The House Mouse has been used extensively in the study of genetics. Under laboratory conditions many striking color varieties have been produced: yellow, brown, white, and variously dappled and pied races. The waltzing Mice are a strain in which a defect of the nerves controlling semicircular canals, the apparatus that regulates the sense of balance, is passed on from generation to generation.

In the interior of China the House Mouse is replaced by the local native mouse, *M. m. bactrianus*, and in eastern Siberia by *M. m. vinogradovi*. A form found in Nepal is named *M. m. homourus*, while others from Japan are designated *M. m. molossinus* and from the Kurile Islands *M. m. kurilensis*. This is merely a sample of the many named forms of *Mus*. The races

are so much like each other that they can be distinguished only with great difficulty.

The Chinese House Mouse, *M. m. bactrianus*, differs from the True House Mouse by having the feet and the underside of the tail whitish. In some local forms the tail may be longer than the head and body, in others shorter. *Mus m. vinogradovi* has the underparts somewhat whitish also; the length of the head and body $3\frac{3}{5}$ inches, tail $3\frac{1}{4}$ inches, hind foot $\frac{3}{4}$ inch. The race in Yunnan, Tonkin, Laos, and Annam is *M. m. kakhyensis*. *Mus m. taiwanus* is recorded from Formosan houses (Kur-oda).

The Jungle Mice, genus *Leggada*, are tropical animals of Burma, India, and Ceylon. Some of the Indian species are spiny. *Leggada* is often distinguishable from the House Mice, *Mus*, by its longer snout, best observed when the skull has been extracted and cleaned, and from *Micromys* and *Apodemus* by having only two tubercles composing the posterior one of the three transverse ridges on the first two molar teeth. *Leggada* may be merely a subgenus of *Mus*.

The typical species of *Leggada* is *L. booduga* of Bombay, western India, "mouse-colored varied with brown; beneath grayish white. Underfur lead colored, with pale, slender, grooved, black tipped bristles." The length of the head and body amounts to 2 inches, hind foot $\frac{5}{8}$ inch. This genus, of which the following three species are well-known examples, occurs through India, Burma, and Indo-China.

Leggada nitidulus of Burma and Annam is colored gray-brown, with the underparts dull white. The bases of the hairs are gray. The total length is $6\frac{1}{2}$ inches. The place where this form was first found is Shwe Gyeng, lower Burma. A race, *L. n. annamensis*, comes from Annam and Laos. *L. cookii* of the northern Shan States and Yunnan is larger than *L. booduga*—the length of head and body $3\frac{1}{2}$ inches, tail $3\frac{3}{4}$ inches, foot $\frac{3}{4}$ inch. The hairs of the underparts are gray with white tips,

the feet white, the tail dark above and pale below. *L. pahari* of Sikkim and Siam is still larger. The grayish buff fur contains a mixture of spines and the undersurface is grayish white. The length of the head and body is $3\frac{3}{4}$ inches, tail $3\frac{3}{5}$ inches, hind foot $\frac{4}{5}$ inch. The *L. pahari* group includes *L. thai* from western Siam and Annam, a very similar form, and *L. p. gairdneri* from northern Siam, Laos, Annam, and Tonkin (Osgood).

The Flat-haired Jungle Mice, genus *Leggadilla*, are founded upon *L. platythrix*, also a species from India. This species is colored fulvous gray above, yellowish white beneath. The fur is mixed with flattened spines. The length of head and body is $3\frac{1}{4}$ inches, tail 3 inches, hind foot $\frac{3}{4}$ inch. Only one of the dozen forms of *Leggadilla* known occurs as far east as Burma. *L. shortridgei* from Mt. Popa, in the drier parts of Burma, has the fur thickly mixed with blackish spines and the dorsal color drab gray, the underparts white, the hands and feet white. The number of nipples in females is 10. The length of the head and body is from $4\frac{2}{5}$ to 5 inches, tail $3\frac{3}{5}$ to 4 inches, hind foot $\frac{4}{5}$ inch.

Millard's Rats, *Millardia*, which include *Millardia kathleeni* of Burma, represent a small Indian genus related to *Rattus*. The dentition is heavy and the palatal foramina are very long. The ears are rather large, the fur soft. The fifth toe of the hind foot is unusually short. In the Indian species there are 3 or 4 pairs of nipples, 1 or 2 thoracic, 2 inguinal; but in *M. kathleeni* the thoracic pair or pairs remain undeveloped. The color is pale gray-brown, the tip of the tail white. The length of the head and body is $5\frac{3}{4}$ inches, tail 6 inches, hind foot $1\frac{1}{10}$ inches.

The Golundi Mice, genus *Golunda*, have their headquarters in the Indian Peninsula. In *Golunda* the molar teeth are proportionately very large and the upper incisors have a single groove. The body form is thick-set and the tail well haired and short; the first and fifth digits of the hand are reduced. There

are 8 nipples. The typical form is *G. ellioti* of Madras, a race of which, *Golunda ellioti myothrix*, is found in Nepal. *G. e. myothrix* is a forest Mouse, reddish fawn colored above, fulvescent beneath. The length of head and body is 6 inches, tail $3\frac{3}{4}$ inches, hind foot $1\frac{1}{16}$ inches.

Hume's Rat, *Hadromys humei* from the Assam-Burma border, is soft-furred and stout-bodied, with the tail rather short, the fifth toe short, and the number of nipples in females 8. The color is grizzled gray, lighter on the head but becoming dark rufous on the rump. The tips of many of the hairs of the head and fore quarters are white, but numerous black hairs are also present. The hairs of the underparts are yellow with slate bases; the inner sides of the legs and around the base of the tail reddish. The tail is blackish above, white beneath, the feet yellowish white. The length of head and body is 5 inches, tail $4\frac{1}{4}$ inches, hind foot 1 inch. *Hadromys*, of which only the one species is known, is related to *Golunda* but has ungrooved incisor teeth.

The Old World Woods Mice and Field Mice, genus *Apodemus*, including numerous species and races, occur in the Old World temperate and subtropical zones. They have short, rather broad heads in comparison with *Mus*. The fur, usually soft, is bristly in *A. speciosus* of the Far East. The tail may be longer or shorter than the head and body, the number of nipples 6 or 8 (with 1 or 2 pairs of pectoral nipples, 2 pairs inguinal). The typical species is the Striped-backed Field Mouse, *A. agrarius*, of Europe. Other principal species are *A. sylvaticus* and allies, forest-dwelling forms sometimes separated as the subgenus *Sylvæmus*; *A. geisha* of Japan and the Luchu Islands; and *A. speciosus* of Japan, Saghalin, Siberia, Manchuria, Fukien, Formosa, Nepal, and Szechwan.

The *Apodemus agrarius* group is represented in eastern China by *A. a. ningpoensis* from Hunan, Fukien, and Chekiang, *A. a. chevrieri* from northern Yunnan and Szechwan, *A. a.*

pallidior from Shantung and Hopei, and *A. a. mantchuricus* from northern Hopei. The last named extends into Manchuria. In Korea is found the race *A. a. coreæ*. The general color in the *A. agrarius* group is reddish brown, underparts dull white. The dorsal stripe, characteristic of European *A. agrarius*, tends toward obsolescence in the races of southern China. The number of nipples is 8. The Mice of this group prefer semi-open habitats to forests. The size in the various races is quite variable; head and body about 4 inches, tail about 3½ inches, hind foot ¾ to ⅘ inch.

The *A. sylvaticus* group, subgenus *Sylvæmus*, occurs from western Europe to eastern Siberia and south into the Himalayas. *A. s. wardi* occurs in Ladak. Both the *geisha* group and the *speciosus* group have been regarded as parts of *Sylvæmus*. The members of the subgenus *Sylvæmus* are reputed to prefer forested conditions, in contrast to the field habitats affected by *A. agrarius* and its relatives.

Apodemus speciosus and races seem to represent *A. sylvaticus* in the Orient. All are perhaps only races of *sylvaticus*. The forms in eastern Asia include *A. s. major* from Amur, *A. s. giliacus* from Sakhalin, *A. s. peninsulæ* from Korea and Hopei, *A. s. rufulus* from Ussuri, *A. s. prætor* from Manchuria, *A. s. speciosus* from Japan; and farther south *A. s. draco* from Hopei and Fukien, *A. s. orestes* from Hupeh, Yunnan, Szechwan, and northern Burma. *Apodemus semotus* for Formosa, *A. latronum* from Szechwan, *A. ilex* from Yunnan and northern Burma, and *A. rusiges* from Kashmir are species belonging to the *sylvaticus* group.

Typical Japanese *A. speciosus* is bright reddish brown above, beneath white, including the lips and hands and feet. Length of head and body is about 4 inches, tail 3¾ inches, hind foot 1 inch. Several darker related Japanese races have been distinguished. The number of nipples is 8, 6 in the Formosan *A. semotus* (6000 to 8000 feet). The race *prætor* of the mainland adjoining Japan is larger; its corresponding dimensions are 4¾ inches,

4 $\frac{4}{5}$ inches, and 1 $\frac{1}{2}$ $\frac{5}{5}$ inches, respectively. *Apodemus s. peninsulae* is distinguished by having reddish instead of blackish ears. *Apodemus s. orestes* and *A. s. draco* are distinguished from each other by having the ankles white, and dark, respectively, while *A. latronum* is considerably larger. *Apodemus ilex*, of Yunnan and northern Burma, is a brown species with 6 nipples in the females; as in *A. sylvaticus*, its color is dorsally reddish brown lined with blackish, ventrally soiled gray. The ears are rather large. The length of the head and body is 4 inches, tail 4 $\frac{1}{5}$ inches, hind foot $\frac{5}{6}$ inch.

Apodemus geisha is a small, reddish brown species with sharply defined white underparts and 8 nipples. Length of head and body is 3 $\frac{2}{5}$ inches, tail 3 $\frac{4}{5}$ inches, hind foot $\frac{3}{4}$ inch.

The Large-toothed Rat, *Dacnomys* (the Greek root *dacno-* signifies "to bite"), very similar to certain large kinds of *Rattus*, contains the single species *D. millardi* from Sikkim, Assam, and Laos. A geographical race has been separated in each of the above-mentioned regions. The molar teeth are greatly enlarged. The audital capsules of the skull are especially large. The number of nipples is 8. The smallest race is *D. m. millardi* from Sikkim, with the length of the hind foot 2 inches; next comes *D. m. ingens* of Laos, and largest of all, the Assam race *D. m. wroughtoni*. In the last two the length of the hind foot is 2 $\frac{1}{4}$ inches or more. Typical *D. millardi* is a plain-looking brownish Rat with tail gray in color above and below. The fur is rather thin and short; the length of the head and body is 9 inches, tail 13 inches. The race *ingens*, with proportionately shorter tail, is colored fuscous brown with pale underparts; the corresponding dimensions are 10 $\frac{1}{2}$ and 12 $\frac{1}{4}$ inches. *Dacnomys m. wroughtoni*, somewhat more rufous in color, has the same measurements 11 $\frac{1}{2}$ inches and 13 $\frac{1}{2}$ inches.

The True Rats, genus *Rattus*, are the most complex and difficult group to analyze and classify of any of the Murinæ. A recent list ¹ of the species and subspecies contained in the collec-

¹J. R. Ellerman, *The Families and Genera of Living Rodents*, London, 1941.

tions of the British Museum included 38 species groups and 554 forms. The headquarters of the genus is tropical southeastern Asia, where no less than thirteen major species groups are found. These become fewer as one moves away from the center: nine in Burma, six in south China, three in India, three in north China, two in Europe. In Africa, a second center of speciation, nine groups are present. Two of the groups, the semi-domestic Norway Rats and the Alexandrine Rats, are common to all the regions named and have been accidentally carried on ships to North and South America and most of the islands of the oceans.

The Rats are strongly variable in size and in the color and quality of the fur, as one species or another is examined. The number of nipples varies in different species from 4 to 12. But all look "rat-like," with substantially similar body form, and the tails, apparently bare and scaly, longer or shorter than the head and body, according to species.

Some of the species groups comprise very few species; others include many forms of Rats. Some have restricted geographical ranges; others are represented over enormous territories. In a general way, the Rats of a given group conform to rather a narrow range of size. Six of the groups that show markedly local distribution are: *Rattus canus*, *cremoriventer*, *whiteheadi*, *eha*, *bowersi*, and *berdmorei*. Four more, having broader geographical patterns, reaching especially into the Sunda Islands or into southern China, are *R. mülleri*, *confucianus-huang*, *rajah*, *edwardsi-sabanus*. One, *R. concolor*, the smallest and most mouse-like of *Rattus* groups, has extended itself to New Guinea and most of the islands of the Pacific Ocean. Two, *R. rattus* and *norvegicus*, include the parasitic Rats that, as previously mentioned, have been distributed by man all over the world.

A synopsis of the present arrangement of the oriental Rats of the genus *Rattus*:

1. Very large forms, with the length of foot $1\frac{3}{4}$ to $2\frac{1}{4}$ inches and white underparts :
 - a. *edwardsi-sabanus* group fur brown or gray
 - b. *mülleri* group fur gray
 - c. *bowersi* group fur gray
2. Medium-sized form, with the length of foot $1\frac{1}{4}$ to $1\frac{1}{2}$ inches, black or gray-black above and below :
 - d. *rattus rattus*, the Common Black Rat. fur black, above and beneath.
3. Medium- to small-sized gray or brownish gray forms having the ventral hairs white to the roots :
 - e. *rattus alexandrinus*, the Roof Rat or Alexandrine Rat
 - f. *andersoni* group fur soft
 - g. *canus* group fur soft
 - h. *berdmorei* group size medium, hair coarse; incisor teeth whitish
 - i. *confucianus* group
 - j. *rattus jalorensis*, the Malaysian Field Rat
4. Medium-sized forms with reddish upperparts and white underparts :
 - k. *rajah* group fur spinous in most species, at least seasonally
5. Small-sized Rats, the length of the foot about 1 inch, with reddish pelage and white underparts :
 - l. *cremoriventer* group fur spinous in most species, tip of tail tufted.
 - m. *fulvescens-huang* group tip of tail not tufted

6. Medium- to small-sized Rats, in which the bases of the ventral hairs are gray, no matter what the color of their tips:

- | | |
|--|--|
| n. <i>cha</i> group | size small; fur very long and soft |
| o. <i>concolor</i> group | size small; dull colored |
| p. <i>whiteheadi</i> group | size small; fur strongly spinous |
| q. <i>rattus</i> group (other than <i>jalorensis</i> , <i>alexandrinus</i> , and <i>rattus</i>) | size medium; highly variable with many races |
| r. <i>norvegicus</i> group | size larger (hind foot $1\frac{3}{5}$ inches), tail shorter than body. |

1. The largest of the Asiatic Rats, those with the length of the hind foot from $1\frac{3}{4}$ to $2\frac{1}{4}$ inches, include three of the species groups: *edwardsi-sabanus*, *mülleri*, and *bowersi*.

a. **Edwards' Rats**, *Rattus edwardsi* and relatives, include two easily recognized types: true *R. edwardsi*, gray or brownish gray above, white beneath, found only north of the Malay Peninsula, chiefly in the mountains, and *R. sabanus* and allies, colored strongly reddish brown on the back and occurring in the Malay area and out onto the Sunda Islands. A relative, *R. palmarum*, lives on the Nicobar Islands. All have strong feet and claws and are good climbers. The nipple count is 8.

The gray section of this group occurs in Assam, the Himalayas, northern Burma, Yunnan, Laos, Annam, Tonkin, Szechwan, and eastward along the hills of south China to Fukien. The length of the head and body is from 10 to 11 inches, tail 12 inches, hind foot 2 to $2\frac{1}{4}$ inches. The typical race of *edwardsi* is from Fukien. The reddish section is composed of a large number of slightly differentiated forms, some of which are

peculiar to tiny islands lying close to the coastlines of the Malay Peninsula and southern Siam. Important races on the mainland are *R. sabanus revertens* from extreme northern Laos to Annam, *R. vociferans*, *R. v. herberti*, and *R. kennethi*, respectively from western, eastern, and lower Siam. *R. e. milleti* is from southern Annam, *R. e. garonum* from Assam, *R. e. gigas* from Szechwan, *R. e. ciliatus* from Selangor. Many races of the *sabanus* section are smaller than *edwardsi*: *revertens* has the length of the hind foot only $1\frac{3}{4}$ inches, *kennethi* a trifle less.

b. **Müller's Rats**, *Rattus mülleri*, are colored iron-gray or sometimes reddish gray above, below white, the hairs without gray bases. The tail is usually nearly equal in length to head and body. The number of nipples in females is 8. They are tropical Rats, unknown from north of lower Siam. Most of the races are from the islands of the Sunda region. Mainland forms are *R. villosus* from Singapore, *R. m. foederis* from Perak, Malay Peninsula, and *R. validus* from lower Siam. The dimensions of *villosus* are: head and body 9 inches, tail 10 inches, hind foot $1\frac{3}{5}$ inches; of *validus*, 10, $10\frac{1}{2}$ and 2 inches.

c. **Bowers' Rats**, *Rattus bowersi* and relatives, are large species with rather soft, dense, brownish gray fur above, white beneath. They can be confused readily with *R. edwardsi* but are distinguished by the pear-shaped outline of the skull, compared with the narrowly elliptical skull of *edwardsi*. The original Bowers' Rats came from Yunnan. Relatives are *latouchei* from Fukiens, Tonkin, and Laos, *wellsi* from Khasi Hills, Assam, *mackenziei* from the Chin Hills, Burma, *feæ* from Tenasserim, *lactiventer* from Siam, and *ferreocanus* from lower Siam. The length of head and body in *bowersi* is 9 inches, tail $10\frac{1}{4}$ inches, hind foot $2\frac{1}{10}$ inches; in *wellsi* the same dimensions are 8, 9, $1\frac{7}{8}$ inches; in *mackenziei* $9\frac{1}{2}$, 10, $1\frac{7}{8}$ inches; in *feæ* $8\frac{1}{2}$, $10\frac{1}{2}$, 2 inches; in *lactiventer* $9\frac{1}{2}$, $10\frac{1}{4}$, 2 inches.

2. Medium sized; blackish above and below :

d. **The Common Black Rat**, *Rattus rattus rattus*, of medium size, can at once be separated by its slate-gray or blackish gray fur, above and below. It is medium-sized, the body and head 6 to 7 inches long, tail 7 to 8 inches. It is supposed to have lived originally in western Europe and is a black variety of the Roof or Alexandrine Rat of the eastern Mediterranean. From Europe it has been carried on ships all over the world. Black varieties of other kinds of Rats, which are of extremely rare occurrence, will not be confused with it, because they are likely to be smaller and to have fur of finer quality. Not one of the remaining species has the fur of the underparts black.

3. Among the medium-sized gray or brownish gray Rats with the ventral hairs white to the roots are included the *R. andersoni* group, the *R. canus* group, the *R. confucianus* group, two members of the *R. rattus* group (*R. r. alexandrinus* and *R. r. jalorensis*), and the *R. berdmorei* group.

e. **The Alexandrine or Roof Rat**, *Rattus rattus alexandrinus*, probably the most widely distributed of all Rats throughout the world, is brownish gray above, dull white beneath, and has the tail longer than the body. The length of the head and body varies from 7 to 8 inches, tail 9 to 10 inches, hind foot $1\frac{1}{2}$ to $1\frac{3}{5}$ inches. This is the commonest Rat around ships and docks. It is of great importance from the standpoint of health because it can carry plague and other diseases.

f. **Anderson's Rats**, *Rattus andersoni* with its allies *zappeyi*, *excelsior*, and *culturatus*, are white-bellied forms with softer, usually denser pelage than *alexandrinus*. In Anderson's Rat the head and body measure $6\frac{3}{5}$ inches, the long tail 10 inches, the hind foot $1\frac{1}{2}$ inches. *Rattus andersoni* is found in Szechwan, *zappeyi* in Szechwan, *excelsior* in western China, and *culturatus* in Formosa.

g. **The Woolly-haired Rats**, *Rattus canus* group, were originally set off as a distinct genus, *Lenothrix*. There are but

four forms, with rather scattered distribution: *R. canus* from Tuangku Island, off Sumatra, *R. c. malaisia* from Selangor, Malay Peninsula, *R. c. sodyi* from west Java, and *R. legatus* from the Luchu Islands.

R. canus malaisia, with the somewhat enlarged molars characteristic of the group, has the color of the upperparts mouse-gray to brownish gray, the underparts creamy white, the tail black at the base, the terminal half or two-thirds white. The number of nipples is 4. Externally these Rats resemble those of the *bowersi* and *berdmorei* groups. The length of the head and body in *malaisia* is from $6\frac{1}{2}$ to $7\frac{1}{2}$ inches, tail $8\frac{1}{2}$ to 9 inches, hind foot $1\frac{1}{3}$ to $1\frac{1}{2}$ inches.

h. Berdmore's Rats, *Rattus berdmorei* group, were originally recorded from Mergui (near Tenasserim), upper Malay Peninsula. The fur, coarse or almost bristly, is grizzled gray without mixture of rufous; below and on the feet it is pure white. The tail, slightly shorter than head and body, is rather more densely haired than is usual in *Rattus*. The upper incisors are whitish yellow, not orange. The length of the hind foot is $1\frac{3}{8}$ inches. Another race, *R. b. magnus*, is recorded from southeastern Siam, and a third form, *R. manipulus*, from upper Burma. The first of these has the length of the head and body $6\frac{1}{4}$ inches, tail 6 inches, hind foot $1\frac{2}{5}$ inches; the same dimensions in *manipulus* are $7\frac{1}{3}$, $7\frac{1}{3}$, $1\frac{3}{5}$ inches, the terminal two-fifths of the tail being white.

i. The Confucian Rats, *Rattus confucianus*, are represented by at least four races in various parts of China. The fur, which may be slightly spinous in summer, is dark slate-gray above, whitish or yellowish white beneath. The tail is dark above, white beneath, usually white-tipped, and considerably longer than the head and body. The length of the head and body varies from 5 to 6 inches, tail $6\frac{1}{2}$ to $7\frac{1}{2}$ inches, hind foot $1\frac{1}{8}$ to $1\frac{1}{4}$ inches. In the race *R. c. chihliensis* from Jehol the tail is less elongate proportionately. North of the Yangtse River the race *R. c. sacer*

predominates. The typical race occurs from Chekiang and Fukien westward to Szechwan, thence south to the mountains of Tonkin. In Hainan *R. c. lotipes* represents the species.

j. **The Malaysian Field Rat**, *Rattus rattus jalorensis*, is the common Field Rat of the lower Malay Peninsula. Brownish gray above, it has pure white underparts. The length of head and body is 6 inches, tail 6 inches.

4. Large to medium-sized Rats with reddish spiny pelage and white underparts:

k. **The Rajah Rats**, *Rattus rajah* (with *surifer*) and allies, are large to medium-sized forms, with coarse reddish brown fur mixed with black, often densely spiny (other smaller species also have spines); the underparts white or buffy white. The tail, dark above, white beneath, is usually shorter than the head and body. In forms from the northern parts of the total range, Indo-China and Formosa, seasonal shedding of the spines seems to take place, leaving these Rats at certain months virtually spineless. A very large number of forms belong to the group. Although Rajah Rats occur through the Malay area and Indo-China to Formosa, most of them are island races. The continental forms are *R. surifer leonis* from Singapore, *R. pellax*, *siarma*, and *koratis*, respectively from lower, western, and eastern Siam. The form from Formosa is *R. coxinga*. The race *finis* occurs from extreme northern Laos to central Annam. The length of the head and body in *leonis* is $6\frac{3}{4}$ inches, tail 7 inches, hind foot $1\frac{3}{5}$ inches; in *siarma* 7, $7\frac{1}{2}$, and $1\frac{3}{5}$ inches; in *pellax* 6, $6\frac{3}{5}$, and $1\frac{1}{2}$ inches; in *koratis* $7\frac{1}{4}$, $7\frac{1}{4}$, and $1\frac{1}{2}$ inches; in *coxinga* 7 to $7\frac{3}{4}$, $8\frac{1}{2}$ to 10, and $1\frac{1}{2}$ inches (Kuroda). There appears to be a very strong resemblance between the many forms of the *rajah* group. One suspects that some will at length be shown as merely seasonal or age phases of single races.

5. Small-sized Rats with reddish pelage and white underparts. Under this heading come two entire groups of Rats: the *cre-*

moriventer group, and the *huang* section of the *confucianus-huang* group. Most of them are tropical in range.

1. **The Tufted-tailed Lesser Spiny Rats**, *Rattus cremoriventer* and relatives, range from Annam and Siam through the Malay Peninsula to Sumatra, Java, and Borneo. In the typical form from Siam, the dorsal color is reddish brown with the bristles tipped with blackish, the underparts creamy white. The slender tail is dark brown, the pencil of hairs at its tip reddish brown. The length of the head and body is nearly 6 inches, tail nearly 7 inches, hind foot $1\frac{1}{5}$ inches.

Rattus indosinicus from the Tonkin highlands, with the number of nipples 4 pairs and the tail wholly blackish, is thought by Ellerman to belong to the *cremoriventer* group. Its head and body measure $5\frac{3}{5}$ inches, tail $7\frac{3}{5}$ inches, hind foot $1\frac{1}{4}$ inches.

m. **The Spiny-haired Lesser Rats**, *Rattus fulvescens* (= *jerdoni*), appear to be the tropical counterparts of the Chinese *R. confucianus* group. The dorsal color is reddish instead of slaty, the underparts white. There is a strong development of flat spines mixed with the normal hairs in most species, and the tail is generally considerably longer than the body. The length of the head and body in *R. fulvescens* is about 6 inches, tail 7 inches, hind foot 1 to $1\frac{1}{4}$ inches. There is considerable variability in size. The number of nipples in females is 8.

These Rats are found from southern China and Formosa through the provinces of Burma, Indo-China, and the Malay Peninsula, to Sumatra, Java, and Borneo. A large number of races have received names. The original *R. fulvescens* came from Nepal; a race, *R. f. huang*, occurs in Fukien, *R. f. champa* in Annam, *R. indosinicus* in Tonkin, *R. f. condorensis* in Cochin-China, *R. mentosus* in upper Burma, *R. brahma* in Assam, *R. lepidus* in Tenasserim, *R. f. bukit* in Jalor, Malay Peninsula.

6. Medium-sized or small Rats in which the bases of the hairs of the underparts are gray, no matter what the color of their

tips. Here come the remaining species groups of *Rattus*: *R. eha*, *R. concolor*, *R. whiteheadi*, *R. norvegicus*, and *R. rattus*. These can be separated from one another by differences of size, color, degree of spininess.

n. **The Spectacled Mountain Rats**, *Rattus eha* group, are clad in very soft, dense fur, colored reddish brown above, grayish white beneath, with the bases slate-gray. The line of demarcation along the flanks is distinct. Dark rings around the eyes are extended forward to meet at an acute angle near the tip of the nose. The tail is dark above, white beneath, the fine hairs covering it becoming somewhat longer toward the tip. The length of the head and body is $4\frac{3}{5}$ inches, tail $7\frac{1}{2}$ inches, hind foot 1 inch. This form occurs at 8000 feet in Sikkim. A relative from Yunnan, *R. e. ninus*, is colored less brightly reddish and the marks on the face are indistinct.

o. **The Little Burmese Rats**, *Rattus concolor* group, are quite small brownish Rats with dirty whitish gray underparts (the bases darker) and 8 nipples in females. The length of the tail slightly exceeds the head and body. This group is enormously developed among the islands of the western Pacific and even reaches Hawaii, the Tuamoto Archipelago, and New Zealand. On the Asiatic mainland typical *concolor* is widely distributed from Singapore through the Malay Peninsula into lower Burma, Laos, and Annam. The length of the head and body is about 3 inches, tail 4 inches, hind foot $\frac{4}{5}$ to 1 inch. This is the most mouse-like of all *Rattus*, though its feet are much larger and its hair coarser than in *Mus*. In Asia it is suspected to be a disease-carrier, since it often lives in the thatches of native houses. The form found in New Guinea and nearby islands is known to be one of the hosts of the mite *Trombicula*, which is the vector of the rickettsial disease known today as scrub typhus.

p. **The Short-tailed Lesser Spiny Rats or Whitehead's Rats**, *Rattus whiteheadi* group, are a distinct group of small Rats about the size of those in the *R. concolor* group. All are

heavily spinous and have the tail shorter than the head and body. Although the original *R. whiteheadi* is from Borneo, the group is present also on most of the other Sunda Islands and from the Malay Peninsula to Siam. In Perak the form *R. inas* is found, in Johore *R. klossi*, in lower Siam *R. asper*, and in eastern Siam *R. sakeratensis*. The colors are a mixture of blackish and rufescent on the back, "pinkish buff" beneath. The length of the head and body is about $4\frac{3}{4}$ inches, tail 4 inches, hind foot 1 inch.

q. **The Alexandrine Roof or rattus Rats group**, *Rattus rattus* and relatives (with white-tipped gray ventral hairs), includes a large number of often poorly distinguishable races. The headquarters of this group, as is the case with the entire genus, is southeastern Asia. Although no attempt can be made in this place to describe more than a few representative forms, it should be understood that many additional local races are known. The *R. rattus* group in the Orient comprises coarse-haired, sometimes weakly spinous Rats of the general size of the Roof Rat (already described) or a little smaller. The tail is usually longer than head and body, as in *R. r. alexandrinus*, but it may be shorter, as in *R. flavipectus*. The color too is variable—brownish gray in some, reddish brown in others.

The following are members of the gray-bellied *R. rattus* group: *R. r. diardi* from the Malay Peninsula, *R. r. thai* from central Siam, *R. r. robustulus* and *tikos* from Tenasserim, *R. r. tatkorensis* from the west bank of the Chindwin River, *R. r. rattoides*, *brunneus*, and *brunneusculus* from Nepal, *R. r. sladeni* from Yunnan, *R. flavipectus* from Yunnan, Tibet and Assam, Tonkin and Laos, *R. r. molliculus* from central Annam, *R. r. exiguus* from Fukien, *R. r. hainanicus* from Hainan, *R. losea* from Formosa, *R. tanezumi* from Japan.

In the majority of the races the tail exceeds the head and body in length. A few examples of size follow: Roof rat, head and body 7 to 8 inches, tail 8 to 10 inches, hind foot $1\frac{2}{5}$ to $1\frac{3}{5}$ inches; *diardi*, $7\frac{1}{2}$, 7, $1\frac{2}{5}$; *tikos*, $6\frac{3}{4}$, $7\frac{1}{2}$, $1\frac{2}{5}$; *sladeni*, $6\frac{1}{2}$ to

7, 7 to $8\frac{1}{4}$, $1\frac{2}{5}$; *exiguus*, 6, $6\frac{1}{3}$, $1\frac{1}{4}$; *losea*, 6, $6\frac{3}{4}$, —; *tanezum*, $4\frac{1}{2}$ (?), $4\frac{1}{2}$, —; *flavipectus* (with the tail shorter than head and body), 8, $6\frac{2}{5}$, $1\frac{1}{4}$. The dimensions of *tanezum* were perhaps those of a young specimen.

The rat *nitidus*, originally from Simla, is recorded also from Sikkim, Szechwan, and Yunnan, and the related form *obsoletus* from the Chin Hills, Burma.

1, **The Norway Rats**, *Rattus norvegicus*, like the Alexandrine Rats, have been accidentally conveyed by men here and there about the world. They probably originated in northern Eurasia. Two eastern races, *R. n. caraco* of Manchuria and Siberia and *R. n. socer* of Kansu and Yunnan, China, occur. These are moderately large, coarse-haired brownish gray animals with white-tipped gray underhairs and the tail shorter than the head and body. Length of the head and body is 9 inches, tail $5\frac{1}{2}$ to 6 inches, hind foot $1\frac{3}{5}$ inches. There are 12 nipples. True Norway Rats are now common in most of the ports of the world. In the northern United States, New York and Boston, they are common; their place is taken in the southern United States by *R. rattus alexandrinus*, the other world-renowned parasitic species.

Howell's Rats, *R. humiliatus*, a smaller species with tail equal in length to or slightly shorter than the head and body, and also with 12 nipples in females, is tentatively placed here. It occurs in east China from Hopei to Fukien. Osgood records a race, *exiguus*, from Fukien and Annam and a second race, *celsus*, from Yunnan and Szechwan. In Manchuria a darker race, *R. h. sowerbyi*, is found. The tail is brown above, white below. The length of head and body is about $6\frac{1}{2}$ inches, tail $6\frac{1}{2}$ inches, hind foot $1\frac{2}{5}$ inches.

The Bandicoot Rats, genus *Bandicota*, must not be confused with the True Bandicoots, which are pouch-bearing mammals of Australia (discussed in *Mammals of the Pacific World*). They are rather large Rats with the tail about equal in length to the head and body; the thin, coarse hair is colored brownish

gray above, dirty white beneath. These animals can be distinguished from *Rattus* by their broad molar teeth, the transverse ridges on which are continuous from side to side instead of being divided into three tubercles on each ridge. An accompanying character (which is not completely diagnostic) is the presence in females of 6 pairs of nipples, 3 pairs on the chest and 3 on the belly. In a special subdivision of the genus, sometimes separated under the name *Gunomys*, the number of nipples may vary from 16 to 18. The animals are ground-dwellers and good diggers.

The distribution of the Bandicoot Rats is tropical; they are found in India, Burma, Malaysia, and as far north as Yunnan and Formosa. The typical species of *Bandicota* is *B. indica* from Pondicherry, the east coast of the Indian Peninsula. These are large Rats, the hind foot about 2 inches long. The color, like most, is iron-gray above, grayish white beneath. Close relatives of *B. indica* are *B. nemorivaga* from Nepal, northern Siam, Yunnan, and Formosa; *savilei* from Mt. Popa, Burma, and western Siam, and *siamensis* from central Siam. In animals of this group the head and body measure about 9 inches, the tail 9 inches. *B. savilei* is smaller, the hind foot $1\frac{3}{4}$ inches; *B. siamensis* is larger.

In Formosa a Bandicoot Rat, *kragii*, is recorded by Kuroda with the length of head and body $6\frac{1}{2}$ to 7 inches, tail $5\frac{3}{4}$ to 7 inches, hind foot $1\frac{3}{5}$ to $1\frac{4}{5}$ inches. This may belong to the section *Gunomys*.

The Giant Bandicoot Rats, *B. gigantea*, of the Malabar coast, are represented in Annam by the race *B. g. jabouillei*, which seems to be the largest form known. The foot measures $2\frac{1}{4}$ inches, the length of the skull $2\frac{1}{2}$ inches.

The Bengal Bandicoot Rats, *B. bengalensis*, or *Gunomys bengalensis*, are smaller and their females have more numerous mammæ. The eastern races are *B. b. varius* and *varillus* of Penang, Malay Peninsula, which are described as larger and smaller races occurring on the same island. In Kashmir, a mountain

race, *B. b. wardi*, is found at 5500 feet. These are smaller animals than those of the *B. indica* section; the length of the head and body is about 8 inches, the tail 7 to 8 inches, the hind foot from $1\frac{1}{4}$ to $1\frac{1}{2}$ inches.

SUPERFAMILY GLIROIDEA

Here belong two distantly related families, the True Dormice and the Spiny Dormice. The latter, because of structural relationships, includes also the peculiar "Blind Mouse," *Typhlomys*. The name Gliroidea is based upon the Latin word for Dormouse (*glis, gliris*); in fact, the original term for all rodents and rabbits used by Linnæus, who started binomial terminology, was "glires." Although the Dormouse was for Linnæus the prototype of all Rodents, it plays but a small role in the modern scheme of classification.

THE DORMICE (FAMILY GLIRIDÆ)

My first, and somewhat erroneous, impression of a Dormouse was obtained when I read about the mad hatter's tea-party in *Alice in Wonderland* and examined the old wood-cut showing the mad hatter and the hare trying to cram the Dormouse into the tea-pot. I hardly realized from that picture how much more a European Dormouse resembles a tiny Squirrel than a Mouse.

The Dormouse Family has its headquarters in southeastern Europe, Africa, and Asia. It contains a number of genera, only one of which occurs in eastern Asia.

One of the species of Dormice in France is said to live in pairs, building a commodious nest in dense shrubbery, and there producing 4 or 5 young. The call is a whistle-like sound. The animals feed upon fruits and nuts, often damaging orchard crops by testing many fruits with their teeth before deciding to make a meal of one. A heavy layer of fat is accumulated beneath the skin before hibernation begins.

The Japanese Dormouse, *Glirulus japonicus*, is a strongly colored animal with the aspect of a small Chipmunk. A dark stripe runs down the back from head to rump, on either side of which is a broad area of light brown; the sides are brownish gray. A tuft of silky hairs springs from the base of the short ear. The tail is straw-colored. The length of the head and body

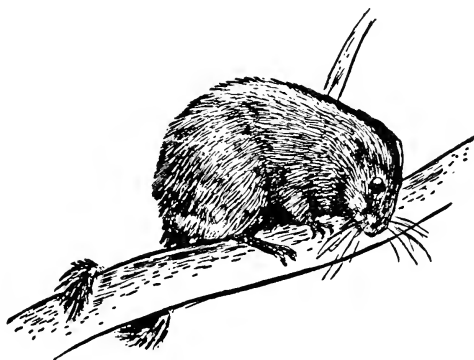


FIG. 60. Japanese Dormouse,
Glirulus japonicus.

is $3\frac{1}{4}$ inches, tail 2 inches (including the hairs). This is reputed to be a rare animal. It was first discovered in the Island of Sikok, Province of Awa, Japan. Later it was taken near Yokohama.

THE SPINY DORMICE (FAMILY PLATACANTHOMYIDÆ)

This tiny family, considered related to the True Dormice, is differentiated by peculiar anatomical features. There are but 3 cheek teeth in the toothrow, compared with 4 in True Dormice. The family contains only two genera, *Typhlomys* of China and *Platacanthomys* of India.

The Blind Mouse, *Typhlomys cinereus*, is a mouse-like creature about the size of a House Mouse. Above it is colored uniform mouse-gray; the underparts and inner sides of the limbs are light gray with the tips of the hairs white. The tail, longer

than the head and body, is clad near its root with short dark hairs which become longer and whiter toward the end, where they form a brush or pencil, usually whitish. The length of the head and body varies from $2\frac{3}{4}$ inches to $3\frac{1}{2}$ inches, tail $3\frac{3}{4}$ to $4\frac{2}{5}$ inches, hind foot $\frac{4}{5}$ inch. It is likely that the term "Blind Mouse," a translation of *Typhlomys*, is a misnomer, since no positive evidence has yet been brought to indicate either weakness of vision or even burrowing habits, or what often accompanies them—reduction in the size of the eyes. *Typhlomys cinereus* is known from Fukien Province, about 4000 feet. A larger related form, *T. c. chapensis*, with hind foot $\frac{7}{8}$ inch in length, comes from Tonkin.

The Spiny Dormouse, *Platacanthomys lasiurus*, is, like *Typhlomys*, an isolated genus. It is found in southern India and is recorded from Cochin-China (Trouessart: this record doubtful). The animal, though slightly like a Dormouse or a tiny Squirrel, is but distantly related to either. It has a long bushy tail, the distal hairs of which are arranged distichously, or like the webs of a feather. The ears are rather long and pointed. The pelage comprises a mixture of hairs and broad flat spines, which have thickened edges. The color above is reddish brown, beneath white, the line of demarcation sharply drawn. The length of the head and body is $4\frac{1}{2}$ inches, tail without hair $3\frac{4}{5}$ inches (with hair, 5 inches), hind foot 1 inch. In southern India this rodent is found in old trees in rocky ravines at about 3000 feet above sea-level.

THE JERBOA-LIKE RODENTS (SUPERFAMILY DIPODOIDEA)

These animals are represented in North America only by our Jumping Mice, seen occasionally in moist meadows where plenty of lush grass grows. In Asia there exists a wealth of Jumping Mouse relatives, usually divided into two families: the Jumping Mice, family Zapodidæ, and the True Jerboas, family Dipodidæ. Most of them are extraordinarily like small or even

tiny kangaroos; they accomplish prodigious leaps with their powerful hind legs.

THE STRIPED MICE AND JUMPING MICE
(FAMILY ZAPODIDÆ)

The Zapodidæ include but two genera, *Zapus* and *Sicista*. These genera are so different from one another that they are often placed in separate subfamilies. Members of the genus *Zapus* have grooved upper incisor teeth, with the grooves, easily seen, running up the face of each front tooth; *Sicista* has the incisor teeth ungrooved. Both look more mouse-like than do the Jerboas. *Sicista*, which does not jump far, has shorter hind legs.

The Birch Mice or Striped Mice, genus *Sicista*, have slender but not especially long hind limbs and the tail considerably longer than the head and body. All the species that occur in Asia seem to be rare. They extend from Kashmir through central China to Mongolia. The typical species, *S. subtilis*, ranges from Russia eastward. Other species are found east and south-east of Russia but only three, two northern forms and a Himalayan species, reach the eastern Asiatic areas under present consideration.

The Concolorous Birch Mouse, *Sicista concolor*, originally from Kansu, was found also near Kirin by Sowerby. It is colored rather uniformly brown, the sides paler and more reddish, the underparts pale brown. The ears are brown, the feet white. The length of the head and body is $2\frac{3}{4}$ inches, tail $4\frac{1}{4}$ inches, hind foot $\frac{3}{4}$ inch.

The Long-tailed Birch Mouse, *S. concolor caudata*, is a relative from Sakhalin. It is smaller and lacks the dorsal stripe of *S. subtilis*. The length of the head and body is $2\frac{1}{2}$ inches, tail $4\frac{1}{2}$ inches, hind foot $\frac{3}{4}$ inch.

The Yellow Birch Mouse, *S. flavus*, is from Kashmir. It is mentioned here because its range may possibly extend east of the

eastern Himalayas. This form is colored reddish gray above, with a sprinkle of blackish guard hairs, reddish yellow on the sides, and creamy white beneath, with the bases of the hairs gray. The ears and the sides and top of the muzzle are chocolate. The tail is brown above, white beneath; the hind feet and the fingers of the hands are white. The length of the head and body is $2\frac{3}{4}$ inches, tail $4\frac{1}{4}$ inches.

The Jumping Mice, genus *Zapus*, are known in the Old World only from the Chinese uplands of Szechwan and Kansu.

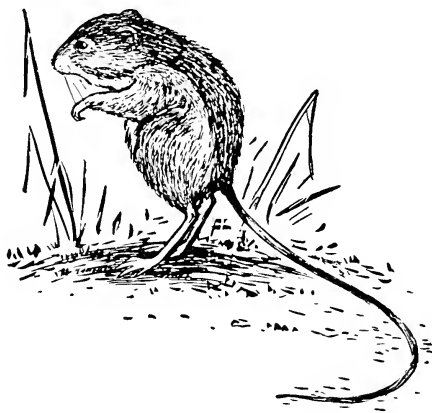


FIG. 61. Szechwan Jumping Mouse,
Zapus szechwanus.

The Szechwan Jumping Mouse, *Z. szechwanus*, is tawny brown with a scattering of black hairs. Along the back runs a very broad band of darker olive-brown color. The underparts are white with a median stripe of tawny. The tail is dark gray above and white beneath. There are 4 teeth in each molar toothrow. The nearest relatives are the American Jumping Mice.

THE TRUE JERBOAS (FAMILY DIPODIDÆ)

The kangaroo-like aspect of these rodents has already been indicated. The Jerboas live in deserts. They have developed a

set of characteristics which seem to fit them more completely for leaping about in great, open, arid spaces. Some of them, much like the kangaroos and wallabies of the Australian deserts, have undergone reduction in the number of toes on the hind feet. Others have enlarged all parts of the skull which have to do with hearing to almost balloon-like proportions, or have large ears and capacious cheek pouches. They are inveterate diggers or burrowers, using the large, powerful claws on their front feet. It is regrettable that more of these amazing rodents do not occur in the areas dealt with in this book. Of the several genera found in western China, only *Allactaga*, a Five-toed Jerboa, enters the western edge of the coastal strip being discussed. It extends eastward to about 126°, near the Gulf of Pechili of the Yellow Sea.

The Siberian Five-toed Jerboa, *Allactaga sibirica*, is about the size of a Roof Rat; the head and body is 5 to 6 inches long,

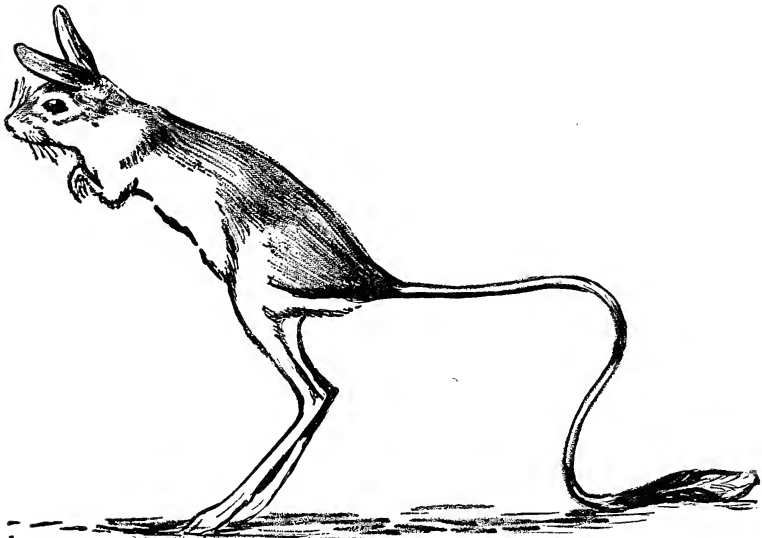


FIG. 62. Five-toed Jerboa, *Allactaga sibirica*.

the tail 7 to 8 inches. The general dorsal color is a mixture of russet and black, that of the underparts and inner sides of the limbs pure white. The white brush at the tip of the tail has a black band encircling it. This animal hibernates, becoming active again about the middle of April. It inhabits plains country and lives in small colonies, in burrows closed with a plug of earth while the animal is inside. It is active at dusk and is reputed to make jumps from 2 to 6 feet in length. Its food consists of bulbs of *Gagea* and other vegetation. The eyes reflect light readily.

THE OLD WORLD PORCUPINES

(SUBORDER HYSTRICOMORPHA) (FAMILY HYSTRICIDÆ)

The Porcupines of the Old World, though related to those of America, belong to a different family. Unlike our Porcupines, they do not climb trees but spend their lives on the ground. Both long-tailed and short-tailed genera occur. The bodies are clothed with quills that can no more be "shot" at enemies than can the quills of North American "porkies."

The Brush-tailed Porcupines, *Atherurus*, have the tail about twice as long as the hind foot. The tail ends with a tuft of very peculiar bristles, which at intervals along their length are expanded into flattened, capsule-like or globule-like portions about the size of a wheat grain. Each bristle, therefore, somewhat resembles a string of beads. Most of the quills on the back are strongly flattened; only a few slender ones are round in section. The ears are small and rounded, the claws rather straight and blunt. The only species in southeastern Asia, *Atherurus macrourus*, is gray-brown, sometimes with a few white bristles; the flanks and hips are paler, the underparts white. The tassel of beaded hairs at the tip of the tail is white. The average length of head and body is 20 inches, of the tail 9 inches, and of the hind foot 3 to 3½ inches. These Porcupines are found in the



FIG. 63. Brush-tailed Porcupine, *Atherurus macrourus*.

forests of Malaysia, Assam, and India to southern China, including Hainan. They are reputed to eat roots, tubers, and green plants.

The Long-tailed Porcupine, *Trichys lipura*, with headquarters in Sumatra and Borneo, is also recorded from Malacca and Perak in the lower part of the Malay Peninsula. Like *Atherurus*, the size is relatively small, and the spines are less specialized. Thick quills are not developed on the back as in *Hystrix*. The tail is long and scaly, its tip provided with a cluster of simple bristles. The animal is reputed to be destructive to pineapples.

The Crested or Short-tailed Old World Porcupines, *Hystrix*, are the only Porcupines to extend to Europe. In consequence, the genus is perhaps the most studied of all. It is called "crested" on account of the long quills of the nape of the neck, shoulders, and back, which can be raised and vibrated to make a rustling noise. Those of the oriental regions that have this characteristic somewhat less developed have been separated under the name *Acanthion*. There is some question regarding the number of species contained in *Acanthion*, but several geographical races have received recognition. Possibly the oldest known specific name, *brachyurus*, should be employed for all. In

Burma the local form is named *subcristatus*, in Nepal *hodgsoni*, and in Tenasserim and Assam *klossi*.

Most of the quills are dark brown, some blackish; others have bands of white. The stumpy tail is concealed by the overhang of the large quills of the back. The head and body have a length of about 28 inches, the tail only 2½ inches, the hind foot 3



FIG. 64. Old World Porcupine, *Hystrix brachyurus*.

inches. The weight may amount to 40 pounds. The *Acanthion* Porcupines are found from India and Malaysia north to middle China. A distinct variety, *Hystrix yunnanensis*, is known from the Province of Yunnan.

The Porcupines of this general type are nocturnal burrowing animals. They produce from 2 to 4 young at a birth. The young are reported born with their eyes open and the body clothed with short soft spines. When alarmed, these Porcupines make a grunting sound and if attacked by dogs may charge backward, inflicting wounds with their sharp quills. They feed normally on vegetation but will gnaw bones for the sake of the lime or salt contained in them. The flesh is good to eat.

THE ELEPHANTS (ORDER PROBOSCIDEA)
(FAMILY ELEPHANTIDÆ)

The "proboscis animals," the largest of land mammals, are represented by two living genera, the Indian Elephants with comparatively small ears, and the African Elephants with huge ears almost as broad as the animals' heads.

These two kinds of Elephants are the survivors of a vast array of species, genera, and families of trunk-bearing mammals. Some of those ancestral Elephants had lower as well as upper tusks; others had those lower tusks converted into flat scoops for rooting up water plants; and still others had upper tusks two or three times as big as the largest in modern Elephants and variously curled and twisted.

The cheek teeth of some sorts of Elephants had rather simple, rough, knobbed surfaces, as in the extinct Mastodons; on the contrary, the Woolly Mammoth, also extinct, had the cheek teeth made up of many flat plates set face to face, with their hard edges appearing on the surface of the tooth. This plan appears in the Indian Elephant, although the plates are less numerous.

The tusks of Elephants are distinguished from the tusks of pigs or the canine teeth of wolves through the fact that they are enlarged incisor teeth, not canine teeth. Also the molar series come into place one at a time at the back of the jaw and move forward to the front, where they are shed. This may be compared to the movement of the treads of a tractor. Not more than two are in place at the same time.

The oldest known member of the Elephant order, when alive, was a little tapir-like creature, *Mæriotherium*. Its remains were discovered in Egypt. The incisors of that animal had not yet become tusks, and it is likely that its trunk was either undeveloped or less developed than the trunks of modern tapirs.

The Elephant order has very distant relatives in the hyraxes

of Africa and southwest Asia, Order Hyracoidea. These mammals, the "coney" of the Bible, are small marmot-like creatures. The manatees and dugongs, Order Sirenia, are perhaps the descendants of Elephant allies that became aquatic.

The Asiatic Elephant, *Elephas maximus*, with its trunk, its enormously thick-set body and sloping hind quarters, and its pillar-like legs terminating in rounded, cushioned feet with the toes so buried in them that only the five toenails show, is a familiar sight to every circus-goer. Large tusks are developed in males; those of females scarcely extend beyond the lips. For centuries these thick-skinned giants of the animal world have been domesticated in the Far East and used as laborers to roll, drag, or carry teak logs here and there, or as beasts of burden. Their great strength permits them to carry miniature hunting lodges or howdahs on their backs.

The association of the Elephant with man goes far back into mythology. In India the elephant-faced God, Ganesa, plays a part in religion. The mythical origin of Elephants, according to Hindu lore, was the two half shells of a "cosmic egg." The Creator chanted seven "samans" at once, whereupon eight bull Elephants were born from one half shell and eight cows from the other. In course of time the offspring of these Elephants ranged over the whole world. Formerly Elephants had the power of flight and of going anywhere they liked. But once, when landing in a banyan tree, they accidentally broke off a branch which fell upon the dwelling place of a hermit. The angry hermit cursed them so effectively that he deprived them of the power of moving at will, and they became subjugated to mortal men.

Wild Elephants today customarily live together in herds of fifteen to thirty individuals. The herd is headed by a large old bull but may contain a number of younger bulls, as well as many females and calves. The food consists of leaves and small branches, fruits, tubers, melons. In captivity a good-sized Ele-

phant eats a quarter of a ton of hay daily. If Elephants break into the garden patch of a native, they can destroy acres of produce in a single night. These animals love to bathe, entering and crossing quite deep rivers. They may stop in midstream, fill their trunks with water and spray it all over themselves. They are not, as a rule, preyed upon by any large animals other than man, but doubtless are checked in the wild state by parasitic diseases and epidemics. They have a life expectancy somewhat less than has the average American man today, fifty years being regarded as old. The oldest known Elephant was about eighty. Usually one Elephant calf is born at a time; the mother carries it for 18 to 21 months before birth. The newly born calf, standing some 3 feet high and weighing about 200 pounds, at first wears a coat of fairly dense woolly hairs. It is said to nurse for two years. Its trunk is short and imperfectly flexible; it is not used in suckling. An Elephant may be considered adult, though not fully grown, when it is 12 to 15 years old. The greatest height of the male seldom exceeds 9 feet, its weight from 3½ to 6 tons. Very old wild Elephants sometimes become outcasts from the herds. Some become dangerous and develop what amounts to mental derangement. The phenomenon known in India as "must" is considered related to sexual excitement and to increased exudation from the frontal glands of the head.

The expression "white elephant" is associated in America with some encumbrance you cannot use and find difficulty to get rid of, but in *Anna and the King of Siam* we learn that white Elephants are welcomed and revered as creatures related to the Siamese gods. They are ordinary Elephants that lack their full complement of dark pigment.

The Asiatic Elephant is found on the mainland of Asia in India, Burma, Siam, Indo-China, and down the Malay Peninsula. Unsuccessful attempts have been made to split off geographical races.

DUGONGS AND MANATEES (ORDER SIRENIA)

These are large, aquatic mammals that are easily confused with some of the smaller whales but may be distinguished by the following combination of characters: There is no dorsal fin (also true in a few whales and porpoises); the nostrils are invariably separate; the two nipples are situated on either side behind the arms, never close to the vent as in the whales; the snout, broad, obtuse, and provided with a vertical median anterior groove and paired vertical lateral grooves, is quite unlike that of any whale; the bones of the upper and lower jaws are abruptly down-turned before their tips.

The Order Sirenia contains two distinct types of living representatives: the Old World Dugongs, genus *Dugong*, and the New World (and African) Manatees, genus *Manatus*. Each of these is placed in a separate family, respectively the Dugongidæ and the Manatidæ. A third family, containing the giant Steller's Sea-cow, formerly inhabited the area of the Bering Straits but became extinct in about 1768 (Stejneger).

Dugongs and Manatees are distinguished from each other by a number of characters, of which the most obvious is the shape of the tail. In *Dugong* the tail is notched into a pair of flukes, but in *Manatus* it is rounded like a gigantic paddle. Other differences include the presence of rudimentary nails on the flippers of *Dugong* and their absence in *Manatus*; the presence of enlarged tusks in the male *Dugong*, and their absence in *Manatus*.

The Dugong, *Dugong dugong*, distributed widely through the tropical portions of the Pacific and Indian Oceans, although it never penetrates more than a short distance into river estuaries, may be included with the present list of continental mammals of eastern Asia. The dorsal color is gray-brown, the underparts whitish gray. The smooth skin is sparsely dotted with coarse short bristles that are so scanty and inconspicuous as to

escape notice unless looked for. The front of the mouth and the lower lip of the Dugong is set with thick, short bristles. The over-all length of full-grown individuals varies from 9 to 10 feet, the males usually being larger than females.

The food, obtained mostly at night, consists of "dugong grasses," or green seaweeds. Dugongs, rarely seen in herds, have a strong, distinct, aromatic Dugong odor. They have been observed to breathe at the surface with a distinctly audible "puff," at intervals varying from two minutes to as often as fourteen seconds if excited. They are said to remain below water normally from five to ten minutes. A captured specimen was asphyxiated by plugging the nostrils; it died without attempting to open and breathe through its mouth. Ordinarily, breathing is accomplished quickly. After surfacing, the nostrils are opened, out- and in-breathing is completed, the nostrils are closed, and the animal sinks to the bottom. The unusually heavy skeleton probably helps submersion.

Dugongs are thought to have the sense of taste developed to the extent of selecting green seaweeds and rejecting brown ones, though an acute sense of touch in the sensitive, prehensile lips may accomplish nearly the same results. The sense of smell has yet to be demonstrated clearly. Vision is rather poor, each deeply sunken eye looking somewhat forward and downward. The iris reacts promptly to light. A copious secretion of slimy matter, the so-called Dugong's tears, is exuded around each eye. The sense of hearing is acute. Animals beached in the open air are found to wince at squeaking sounds. In the water they are easily frightened by noises.

THE EVEN-TOED UNGULATES (ORDER ARTIODACTYLA)

This order, comprising the Pigs and all browsing, grazing, and ruminating animals, makes such an unwieldy mass that it may be well to see how its various parts are made up. First, the

Pigs, Peccaries, and the Hippopotamus, which have well-developed upper incisors and are not ruminants, are separated as the Suborder Suina. Next, the Camels and Llamas, neither of which are known in eastern Asia, which retain upper incisors and have the molars composed of sharp, moon-shaped sections, form a second suborder, the Tylopoda. Third, the little Mouse Deer of the Family Tragulidæ have so many unusual or peculiar characters that they are placed in a suborder by themselves, the Tragulina. Fourth, the three remaining families of artiodactyls, comprising the Cattle, Antelopes and Sheep, the Giraffes and the Deer, all of them ruminants, go into a single huge suborder, the Pecora (from *Pecus*, Latin for "cattle"). In this last belongs also the American Pronghorn, last survivor of a long line of fossil ancestors that with it form the Family Antilocapridæ.

The Suborder Pecora have the stomach more complex than have other ruminants. The swallowed food is received in the first and largest of four divisions of the stomach, where it undergoes a kind of predigestion. It is regurgitated into the mouth where it is rechewed, a process known as "chewing the cud." In the less specialized Tylopods and Chevrotains the stomach has only three divisions.

The Pecora of eastern Asia are restricted to the Bovidæ or Cattle family, and the Cervidæ or Deer family. An excellent way to distinguish between these is to remember that the first have horns which are never shed but grow as the coverings of bony horn cores projecting from the frontal bone, and that the second have antlers that are shed every year, developed at the end of bony pedicels.

THE PIGS (FAMILY SUIDÆ)

The familiar characters of the Pigs include the long snout ending in the flat, expanded mobile disk in the middle of which the nostrils are placed; the small eyes and long ears; the strong,

heavily built body, more or less clad in coarse hair ; and the narrow, four-toed feet in which the two central toes are used for walking, while the two lateral ones, reaching the ground only in mud-holes where the feet sink deep, are nearly useless. The tail is rather short.

The teeth are numerous and large. The crowns of the molars bear a series of conical tubercles, which do not wear down into crescents. The upper canines tend to turn outward and upward. Both upper and lower canines, by wearing against each other, maintain razor-sharp lateral edges. Horns or antlers are never developed. The animals normally feed on leaves, fruits, roots, tubers, and bulbs, grubbing up the last three with their strong, flexible snouts. They are not ruminants. They have a characteristic smell. Large litters of young are born. The young, like those of tapirs, are in most cases patterned with a distinctive brown and black striping running more or less lengthwise, a color scheme that is lost as they mature.

The African Hippopotami and the American Peccaries, though related to the True Pigs, belong in separate subfamilies. The genus *Sus* alone occurs in our area. That quaint-looking relative of *Sus*, the *Babirussa*, is found only on Celebes and the Moluccas.

The True Pigs, genus *Sus*, include all the pig-like animals of eastern Asia. It is usual to regard Oriental *Sus* as divided into not more than four species: the Northern Wild Pig, *Sus scrofa* and its races; the Japanese Wild Pig, *S. leucomystax*, believed by some to be related to the Indian Wild Pig, but possibly only an island race of *S. scrofa*; the Crested or Indian Wild Pig, *S. cristatus*; and the Bearded Pig, *S. barbatus*.

The "Pigmy Pigs" of the Terai and Sikkim, which Hodgson named *Porcula salvania*, may be only juvenal specimens of the Indian Boar. The skull figured by him was so young that the last molar was not erupted. On the other hand, this alleged species was reported to be colored dark brown, unstriped, and

to have the tail extremely short. Lydekker states that it has 3 pairs of nipples instead of the customary 6 of *Sus*. More information about it is needed.

Recently Schwarz has stated that the Bearded Pigs are merely races of the Warty Pigs of Java, *Sus verrucosus*. He believes that the Oriental Pigs fall into two major groups: the *S. scrofa* group, including *cristatus* and *vittatus*; and the *barbatus* group.

The distinction between the Crested or Indian Pigs and the Northern Pigs and Boars is difficult to define, but is supposed to be indicated by the mane or crest on the neck of *cristatus* and the larger size and greater complexity of its last molars (the seventh of the cheek teeth). Perhaps a good distinction lies in the greater breadth of the posterior part of the last molar in contrast to its more tapered form in the European Wild Boar.

The Northern Wild Pig, *Sus scrofa*, is European typically. In the far East it is represented by a number of weakly defined forms or races: the Mongolian Pig, *S. s. raddeana*, extending from Jehol northward into Mongolia, Manchuria, and Siberia; the North China Pig, *S. s. moupinensis*, found in Hopei, Shantung, and westward; and the South China Pig, *S. s. chirodonta*, occurring through Chekiang and Fukien to Kwangsi and Hainan and possibly northern Indo-China and northern Burma. It is reasonably sure that the European Wild Pigs are ancestral to our domestic Pigs.

The Mongolian Pigs roam through the great temperate forest belt, where they feed on acorns, the tubers of peonies, and the bulbs of lilies. They form an important part of the diet of the Siberian tigers. The color of the pelage, which has thick, woolly underfur, is mixed olive and brown, with a proportion of black hairs. Some individuals have whitish areas. The edges of the ears are white. There is a white area behind the angle of the mouth, and the throat is white.

The North China Pigs, like those of Mongolia, carry heavy coats of coarse hair. The color, though as variable, is usually darker than the Mongolian race. It may be reddish or in old boars nearly black. These pigs live in the scattered scrubby woods of north China from near sea-level up to 9000 feet above sea-level. They often do much damage to crops of corn and sweet potatoes.

The South China Pigs are even darker than the foregoing and lack the dense woolly underhair of the northerly races. They are nearly black or reddish black, with a suggestion of white at the corner of the mouth. In some areas of Fukien they are so abundant that they do great damage to rice and other crops. The boars, which are of uncertain temper, may be very dangerous.

In any one of the foregoing three races of Pigs there may be developed a strong white facial mark on the cheek and just behind the mouth. Since such a mark is the basis of the name *leucomystax*, applied to the **Japanese Pig**, it seems possible that that animal will eventually prove to be a form of *S. scrofa*. On the Island of Formosa, Wild Pigs, described under the name *taivanus*, seem to be little different from those of the adjoining mainland. They have been regarded as a race of the Japanese Pig. The Pigs of Korea, *S. l. coreanus*, are stated to have narrower heads than the form found in Manchuria, *S. l. continentis*. Mori says they are brown, not blackish brown, and that the streak from the angle of the mouth is inconspicuous.

Pigs are reputed to heap up branches and pieces of bamboo to make a nest or house in which they conceal themselves by day. The young are born in such nests. Very old boars and females with families keep apart from the others. Otherwise, Pigs go about in large bands. Two litters of young per year may be produced, but the increase is apparently checked by recurrent epidemic diseases. Sowerby says that such epidemics have occurred three times in fourteen years in Shansi Province.

The Indian or Crested Pig, *Sus cristatus*, as has been indicated, is fairly distinct from the Northern Pigs. Originally described from southern India, the range extends eastward into the Malay Peninsula and onto many East Indian islands where numerous local races have been named. The color of the adult is blackish brown. There is a distinct crest of stiff black bristles extending from the back of the head along the neck and shoulders. The young are quite hairy and are striped with dark brown and yellow-brown. These Pigs are fond of moist places in the forest where they can drink and wallow frequently. They are night feeders and often lay waste extensive areas of such native crops as sugar cane. Like the Northern Pigs, the Crested Pigs are said to make little shelters of sticks and litter in which the young may hide.

A scarcely distinguishable race, *S. c. bengalensis*, represents this species in Burma and Assam; another better defined, *S. c. jubatus*, lives in the north Malay Peninsula, peninsular Siam, Laos, Annam, and Cochin-China; a third, *S. c. peninsularis*, occurs in the south Malay Peninsula.

The Banded Pig, *Sus vittatus*, of Sumatra, is of uncertain status. This Pig, a blackish animal with pale underparts and a broad, brownish red band around the middle of the snout, has been variously distinguished as a full species, as a race of *Sus scrofa* (Kloss, 1931), and as a race of *S. cristatus* (Chasen, 1940). In any case, it is probably the island representative of *jubatus* and *peninsularis*. In general, the last molar in all the Malayan races is shorter than in typical *cristatus* of India.

The Bearded Pig, *Sus barbatus*, first discovered in southern Borneo, is represented by the race *S. b. oi* on the Malay Peninsula. This is a remarkable-looking Pig, its cheeks covered with an extensive growth of whitish curly whiskers. The ears are short and rounded. In addition, there stands between the nostril and eye a large wart-like outgrowth covered with bristles. The color is slightly paler than the usually blackish *S. cristatus*, and along the back may appear distinctly paler. The animals stand

very high at the shoulders. Excellent photographs of Bearded Pigs have been published (Jentink, 1906).

THE CHEVROTAINS OR MOUSE DEER
(FAMILY TRAGULIDÆ)

These small animals, though deer-like, are not Deer at all. In some features of the structure of the teeth and skulls they resemble Camels. There are no upper incisors. The males have long curved upper canine teeth that protrude well below the lips. Antlers are developed in neither sex. There are 4 nipples. Neither facial glands nor foot glands are present. The family is represented today by the genus *Tragulus* of Asia and the spotted Water Chevrotains, *Hyemoschus*, of west Africa. Related fossil forms are known in America.

The Mouse Deer, *Tragulus*, excluding the Indian Spotted Chevrotain, *Moschiola*, is a Malayan tropical forest-frequenting genus, which fails to reach as far north as lower Burma or Tonkin. It differs sharply from the African Water Chevrotains by having the pairs of metacarpals and metatarsals, equivalent to the bones that span the palms of our hands and the soles of our feet, united into single bones called cannon bones; in the African group the same bones become united only in old age.

The oriental species of *Tragulus* include the Indian Spotted Chevrotain, *T. meminna*, sometimes separated as a genus or subgenus, *Moschiola*, and two unspotted forms occurring east of the Bay of Bengal, the Larger Mouse Deer, *T. javanicus*, and the Smaller Mouse Deer, *T. kanchil*, each of which is split up into many races. Both species have a cushion-like glandular pad behind the chin in males. Both, depending upon the race, are colored some shade of brown, with whitish underparts, and with the white expanse of chin and throat variously though symmetrically cut up by patches of brown. A narrow strip of paler brown extends from the ear, above each eye, to the nostril. The animals, which stand less than a foot high at the shoulder,

have a strong superficial resemblance to the South American agoutis.

Most of the races into which the two species are divided are restricted to one or another of the many islands adjoining the Malay Peninsula. The range of the larger species, *javanicus*, extends northward into Tenasserim and Annam. That of the

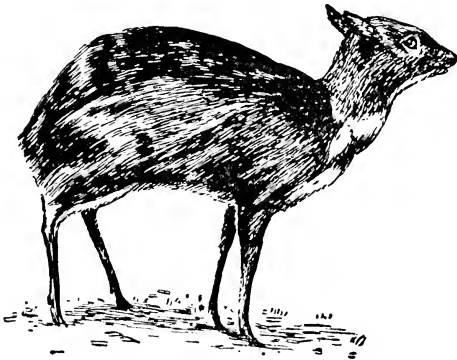


FIG. 65. Chevrotain or Mouse Deer, *Tragulus*.

small species, *kanchil*, reaches farther north to northern Siam, where it is represented by the race *williamsoni*.

The length of the head and body in *javanicus* is a little more than 2 feet, of the tail 5 inches, of the hind foot $5\frac{1}{2}$ inches. The same dimensions in the small species are given as 18 inches, 3 inches, and $4\frac{1}{2}$ to 5 inches. Both species vary in size, depending upon locality and race.

The small species, the commoner of the two in the Malay Peninsula, inhabits dense thickets and is said to be abundant in the coastal mangrove forests. The animals are solitary. They produce 1 or 2 young.

THE ANTELOPES, CATTLE, GOAT-ANTELOPES, SHEEP AND GOATS (FAMILY BOVIDÆ)

The many animals of this family are distinguished from those of the Deer family by possessing horns growing on bony horn

cores, which are not periodically shed as are the antlers of Deer. The Bovidæ are strongly developed in Asia and Africa. The family has comparatively few representatives in North America and none in South America. Four subfamilies occur in eastern Asia.

THE TRUE ANTELOPES AND GAZELLES
(SUBFAMILY ANTILOPINÆ)

This is but one subfamily of about ten, the members of which, chiefly African, are commonly called Antelopes. Of the four or five genera composing this subfamily, three only can be found in the extreme west of our region. All of those Gazelles are of the desert or semi-desert. Brief mention is made of one which extends eastward as far as western Jehol, Manchuria, and western Hopei.

The Mongolian Gazelle, *Prodocas gutturosa*, is distinguished by the combination of characters: length of tail less than 4½ inches; inguinal and tarsal glands absent; preorbital glands present. The summer pelage is reddish buff, paler on the cheeks and flanks, underparts white. A small area of white surrounds the root of the tail. In winter the hair is longer and paler. The length of the head and body is from 3½ to 4 feet. The animal stands about 30 inches at the shoulder.

When making seasonal migrations, these Gazelles gather in very large herds in Mongolia at altitudes between 6000 and 8000 feet above sea-level. During midsummer the old bucks separate from the does, and the young, usually 2, are born in plains country that affords unrestricted visibility in all directions. In the autumn the bucks rejoin the herds.

WILD CATTLE AND ALLIES (SUBFAMILY BOVINÆ)

These more or less cow-like or buffalo-like animals are, with the exception of the little Anoa of Celebes, much larger than

the Antelopes, Goat-antelopes, or Goats and Sheep. The horns, present in both sexes, if spirally twisted, are so arranged that the right horn forms a right-handed spiral, and are relatively smooth. The tail is long, with a tuft of hair at the tip. There are neither face glands, foot glands, suborbital glands, nor inguinal glands. The number of nipples is 4. One or 2 calves are born.

Three oriental genera belong in this subfamily: *Bibos*, containing the Gaur, the Banting, and the Kouprey; *Poephagus*, the Yak; and *Bubalus*, the Indian or Water Buffalo. In the first two genera the horns are nearly circular in section; in the third, more or less triangular. The Yaks differ from *Bibos* not only by their long shaggy hair but in having fourteen instead of thirteen dorsal vertebræ (the vertebræ of the backbone). The Wild Yak of Tibet, *Poephagus grunniens*, does not properly come within the range of this work. The Water Buffalo, *Bubalus bubalis*, though occasionally found in the feral state, can be regarded as a domestic animal. It can be recognized at once by the wide sweep of its flat-faced, triangular horns. It likes swampy areas.

The Gaur, *Bibos gaurus*, the largest of the three oriental species of this subfamily, may reach a height at the shoulders of from 6 feet to 6 feet 4 inches. The cows are smaller. Old bulls are distinguished from those of the Banting and the Kouprey by lack of a horny mass connecting the bases of the two horns. The body is deep and massively built. The limbs appear proportionately short. The ears are large and, compared with those of the Banting, are broad. There is a high ridge along the back, ending in a sudden step down between the withers and the tail. The dewlap is little developed in the typical race. The color of old bulls is deep brown tending to blackish above, with the upperpart of the forehead and the nape buffy gray or whitish. The legs are white from the knees and hocks downward. The eyes are generally blue. Cow Gaur tend to be reddish rather than

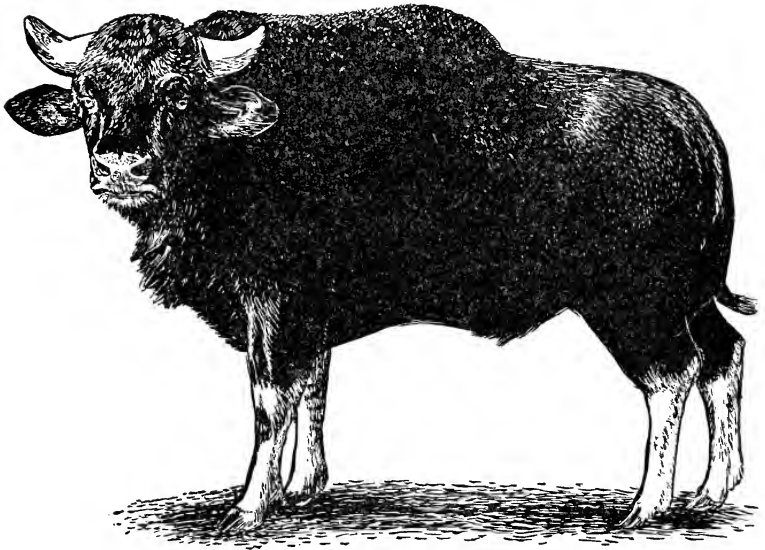


FIG. 68. Gaur, *Bibos gaurus*.

blackish. Calves are said to have a dark stripe along the back. The typical Gaur is a native of India.

Read's Gaur, *B. g. readi*, found from southern Burma and Tenasserim to southern Annam and Cochin-China, possesses a dewlap and a fringe of hair at the throat. It is darker than the Indian Gaur; the color is nearly black. **Hubback's Gaur**, *B. g. hubbacki*, is the Gaur of the Malay area. There is no dewlap. The lower parts of the limbs are yellowish white and a whitish band may appear over the muzzle. Semi-domesticated Gaur are known as **Gayal**.

The Banting or Tsine, *Bibos sondaicus*, are probably the most cow-like of the Asiatic wild cattle. A pair of Banting associated with a cock and a hen of the jungle-fowl in a museum show-case present a strong likeness to farm cattle and chickens in spite of their jungle setting.

Banting are smaller and lighter in build than Gaur. The dor-

sal ridge is less prominent, the limbs relatively long. The bases of the horns in old bulls are connected by a rough, horny, shield-like mass. In both sexes, except in the Malay race, a white rump patch is seen (absent in the Gaur). Old bulls become very black,

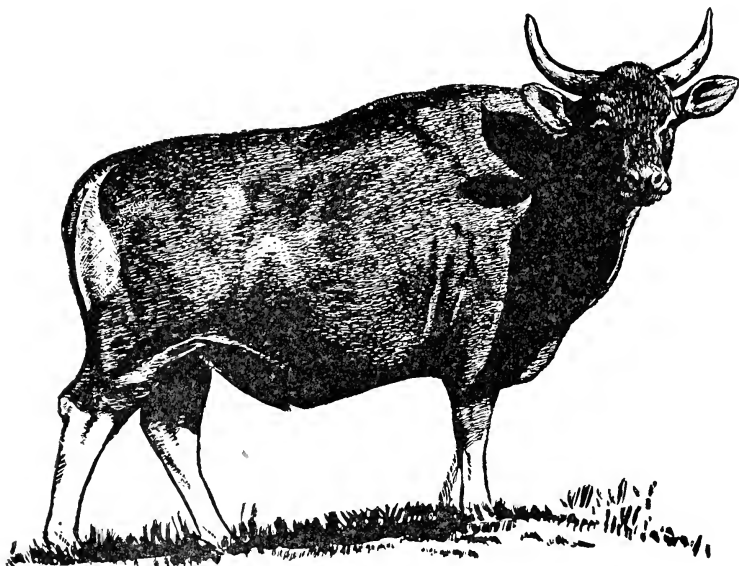


FIG. 67. Banting, *Bibos sondaicus*.

while cows and young bulls remain reddish or tawny, and lighter beneath. The lower parts of the limbs, as in the Gaur, are white. The young calves have a dark dorsal stripe. The typical Banting occurs on Java and a form exists on Borneo. There are several races on the mainland. Banting are sometimes domesticated.

The Malay Banting, *B. s. butleri*, is at once distinguished from others by the obsolescence of the white rump patch, at least in cows. The horns of the cows are unusually short. The Siamese Banting, *B. s. porteri*, is reputed to have the skin flecked with white and the horns very heavily ridged at the base.

The Burmese Banting, *B. s. birmannicus*, exhibits less tendency for the bulls to be black. The usual color is dark brown, shading to light brown beneath. The face is gray-brown, with a chestnut band across it in front of the eyes. The cows are bright reddish at all stages. The height at the shoulder in bulls may be 5 feet 4 inches. The maximum known spread of the horns is 34½ inches.

Under the specific name *B. banting*, Osgood has recorded specimens from Cochin-China, Laos, southern Annam, and Tonkin.

The Kouprey, Gray Ox, or Indo-Chinese Forest Ox, *Bibos sauveli*, of Cambodia and Laos, has been known to science only for some fifteen years. It is astonishing that such a large animal should have escaped attention for so long. Its existence was first mentioned by a professional guide and hunter, Defosse. Later a living specimen was sent to the zoological gardens in Paris. This animal has been separated generically from *Bibos* under the name *Novibos*.

The Kouprey is a large ox-like animal, distinguished by the manner in which the horns of the male become frayed at the tips, leaving 5 inches or so of the polished inner horn exposed. The horns are large, "curving backward, outward, and upward, with a slight backward inclination as in wild Yak." The height at the shoulder is about 5 feet 7 inches, cows being smaller. The spread across the horns may reach 33 inches.

Though in some respects intermediate between the Gaur and the Banting, the Kouprey is not considered to be a hybrid. The short and glossy hair is generally colored blackish brown. There may be a white stripe along the middle of the hinder part of the back; the ears are blackish like the body, with a few white hairs. The underparts are lighter brown than the back. There are white stockings on the lower legs, with a dark stripe down the front of each foreleg. The tail is long, its bushy tip composed of mixed black and white hairs. There is a large dewlap. Dark

chestnut-brown areas, connecting above, appear on each side of the muzzle. The forehead is chestnut, and the same color surrounds each eye. There are white hairs on the upper and lower lips. The area at and behind the shoulders and behind the ridge of the back may be gray, perhaps due to wearing of the blackish tips of the hairs. This fact may account for the name, Gray Ox. In females and young the skin is reputed to be entirely gray. The hoofs are black, the hind ones unusually slender for cattle. The length of head and body in bulls is approximately 8 feet, of the tail 3 feet 5 inches.

It has been suggested that the Kouprey may be partly ancestral to the Zebu or humped Indian Cattle.

THE GOAT-ANTELOPES (SUBFAMILY RUPICAPRINÆ)

The three genera belonging in this subfamily agree broadly with their inclusive name. They really appear to be about half-way between a Goat and an Antelope. More heavily built than the local Antelopes and Gazelles, they have heavier, broader hoofs, and their horns, which carry fine narrow horny rings narrowly spaced, originate close to each other on the top of the skull (afterward diverging in *Budorcas*). Other well-known members of this subfamily are the Chamois of Europe and the American Rocky Mountain Goat. The three genera here included are the Serows, *Capricornis*, the Gorals, *Nemorhedus*, and the Takins, *Budorcas*.

The Serows, genus *Capricornis*, have the horns thick at the base, somewhat divergent, slightly curved backward, and only about half as long as the head. Anteorbital and foot glands are developed. Four nipples are present.

There are two main types of Serows: large animals weighing nearly 200 pounds and standing 36 to 38 inches high at the shoulder, with heavy neck mane, large ears, thin coat, and moderately bushy tail; and small animals, about 22 inches at the

shoulder, without the neck mane, and having the coat thicker and more woolly and the tail more bushy. The first group contains the Southern Serows of the Malay region, Burma, and southern China, and the White-maned Serow; the second includes the Japanese and Formosan Serows.

The Southern Serow, *Capricornis sumatraensis*, is distributed over an enormous range, within which are a number of local races. As its name implies, it was described originally from Sumatra. The color varies from black to reddish, with the mane partly gray and with varying amounts of white or grayish white on the legs. The form in the Malay Peninsula, *C. sumatraensis swettenhami*, found between 2000 and 4000 feet, is only weakly separable from the Sumatran animal. The general color is grizzled blackish gray, the legs black (they are reddish in the Sumatran race). The underparts are black except the insides of the thighs, which are rusty red. The tail is black.

In the uplands of Szechwan, Yunnan, and Burma a local race, *C. s. milne-edwardsi*, occurs, which has the upperparts blackish brown, the underparts dull dark brown, the shanks reddish, and the mane of mixed black and gray hairs. There is a spot of tan on either side of the muzzle.

In the Arakan Hills of southwest Burma the form *C. s. rubidus* has the pelt prevailing red all over. North of there, in Darjiling, *C. s. jamrachi* is black, with brownish yellow behind the upper lip and at the base and on the backs of the ears. The throat and chest are black. The fetlocks are white; just above them the legs are brown.

In eastern China the White-maned or Eastern Serow, *C. s. argyrochætes*, is the local representative. Its coat is dull, deep brown, with a well-developed white throat patch and the sides of the muzzle dark brown. The mane may sometimes be whiter than in other races.

C. s. maritimus, of Tonkin, Laos, and Annam, was described by Heude as "brownish, smaller than *C. s. argyrochætes*," and

with the horns slightly convergent. Osgood records specimens from Tonkin, Annam, and Laos. The head and body are blackish, the lower parts of the legs and the rump tawny. Stripes along the jaws are colored mixed tawny and white.

The Japanese and Formosan Serows, two races of *Capri-cornis crispus*, are small Serows with thin manes and harsh, crisp coats containing much woolly underfur. The color in the Japanese race varies from blackish gray to reddish brown, with the underparts whitish, the cheeks white, and the legs blackish brown. The Formosan race, *C. c. swinhoei*, is blackish brown with a narrow nape stripe, the forelegs black in front, the hind legs light brown, the chin and throat patch yellowish brown. Temminck gives the total length of the Japanese Serow as 2 feet 8 inches, the tail as 1½ inches.

The Gorals, genus *Nemorhedus*, are generally smaller than the Serows. The suborbital gland is obsolescent, though its position is marked by a patch of nearly naked skin. Gorals are distinguished from Serows by their lack of face glands. There are foot glands but no inguinal glands. The short horns are turned backward and then slightly downward. There are 4 nipples. Allen recognizes but a single species, *Nemorhedus goral*. The Gorals are mountain dwellers ranging from the Himalayas to Amur in southern Siberia. The typical form *N. g. goral*, a native of Himalayas, has the length of the tail only 3 inches, a black stripe on the forelegs from the knees to the fetlocks, and a white patch on the throat.

Gorals in small groups of from four to eight individuals are most often found on rugged, grassy hills or rocky ground in forest. They utter a hissing sound when frightened. A single kid is born.

The West China Goral, *N. goral griscus*, has the white throat patch bordered with pale orange and extending nearly to the lips, and the general body color pale gray with the base of the tail brown. The length of the tail is greater than in the

typical race, 5 inches instead of 3, and the stripe on the foreleg turns inward at the knee and passes down the inside of the leg. The flanks and belly are buffy gray. The length of the head and body is from 3 feet 4 inches to 3 feet 6 inches, of the hind foot 10 to 11 inches. The height at the shoulder is 27 inches. The range includes Yunnan, Szechwan, and northern Burma from 3000 to 8000 feet.

The Northern Goral, *Nemorhedus goral caudatus*, differs by only small features from the West China Goral. Its pelage is heavier and more woolly in winter. The color is generally paler gray, and the base of the tail is gray instead of brown. The legs and tail are cream-colored. The Northern Goral is found from Shansi and Hopei to Amurland, its type region, where it was captured in hills near the Lagar River. The range may not be continuous. The Manchurian Gorals occur on rocky highlands in the midst of heavy forest of pine, oak, and walnut.

Sowerby says of the Northern Gorals that they sit on their haunches, dog fashion, on commanding spurs of rock or lie out and sun themselves like large cats. At dusk they descend to the grassy slopes just above the tree-line to feed.

The South China Goral, *Nemorhedus goral arnouxiannus*, is distinguished from all the foregoing races by the color of the throat patch, which is pale orange. The body in winter is brownish gray mixed with black-tipped hairs. This form is found in Chekiang, Fukien, Kwangtung, and west into Hupeh, in mountains down to 7000 feet.

The Takin, *Budorcas taxicolor*, is the most unusual-appearing of the Goat-antelopes from the fact that its horns, after rising from near the midline of the head, abruptly turn outward and sweep backward and upward, giving the head a slightly cow-like appearance. In the young the horns form simple upright spikes. The animals are heavily built. The front limbs are especially stout and the muzzle is enlarged. The color of the shaggy fur varies from dull straw-brown to blackish brown.

There is a black dorsal stripe, absent in the race *B. t. bedfordi* of Shensi. The head and ears are black typically; only the ears, the back of the head, and a ring around each eye is black in *B. t. tibetanus*. In the Shensi form the whole face is orange-yellow. The length of the head and body is about 4 feet, of the tail 4 inches. The height at the shoulders is 27 inches.

The Takins, of which there are three races, are found in the Mishmi Hills (typically) and the Himalayas, in Szechwan, and in Shensi. In each of the three areas a distinct race is recognized.

THE SHEEP AND GOATS (SUBFAMILY CAPRINÆ)

The horns of these goat-like or sheep-like mammals, usually present in both sexes, are sometimes very large in males, rarely absent in females. The tail is usually short; it never has a contrasting tuft of hairs at the end, as in cattle. There are 2 inguinal nipples (4 in the Tahr of the Himalayas). The group, though widespread in Eurasia, is restricted to the northern part of Africa and the western part of North America.

Of the five genera recognized in this subfamily, one (*Ammotragus*) is African. The other four comprise *Ovis*, the Sheep; *Pseudois*, the Bharal or Blue Sheep of Nepal, Shensi, Kansu, Szechwan, and Tibet; *Capra*, the Goats; and *Hemitragus*, the Tahrs. The Bharal and the Tahr, natives of Nepal and the Himalayan uplands, and the Goats, will not be treated. The Sheep are technically separated from Goats by possessing face and foot glands. Male goats have pronounced beards and a distinctive goatly smell.

The Sheep, genus *Ovis* (Latin: "a sheep"), are agile, light-footed, stockily built animals. The horns grow in a very wide short spiral. Sheep have extraordinarily keen senses of smell, sight, and hearing. Their preferred habitat is open, rocky, mountainous country where sufficient alpine grasses grow.

The species of Sheep include the Mouflon or European Wild Sheep; the "Red Sheep" of western Asia and the Island of Cyprus; the Urial of Transcaspia, Afghanistan, and the Indian Punjab; the Bighorns and other American Sheep; and the Argali, *Ovis ammon*, with its several races. The Argali Wild Sheep and one of the American Sheep are the only two species coming within the scope of this book. Domestic Sheep are thought to be derived from the Mouflon.

The Argali and East Asiatic Wild Sheep, *Ovis ammon*, are usually very large; some races stand as high as 4 feet at the shoulders. The horns are wrinkled and normal—that is to say, the right horn describes a right-handed spiral. The tips turn sharply outward. The facial glands and the lacrymal pits near the inner corner of the eye are large. The tail is very short, about 3 inches. There is considerable seasonal change of the fleece, both in density and in color.

A number of races of *Ovis ammon*, including the famous Marco Polo Sheep, have been recorded from the mountains of central Asia. The most southerly race is *O. a. hodgsoni* of Nepal. In western Kamchatka occurs a race, *O. a. storcki*, "small and very imperfectly known." *O. a. darvini* (= *jubata*) is found from the Altai Mountains to Mongolia.

The American Sheep, *Ovis canadensis*, of which the Bighorn and Dall's Sheep are well-known representatives, are distinguished by Lydekker from the Argali group by having the horns, apart from the growth rings, smoothish instead of wrinkled, and the face glands small. This character of the horns is difficult to appreciate and in practice may not hold. These Sheep are possibly represented in the extreme north of eastern Asia by two races, *Ovis canadensis nivicola* in eastern Kamchatka, and *O. c. borealis*, found in the Verhoyansk and Byrrhanga Mountains of Siberia. Sowerby states that *nivicola* occurs in the Amur region.

O. c. borealis has the winter pelage light gray-brown, slightly

darker on the shoulders, the top of neck, and the hind part of the back. The densely furred ears are brown, with the terminal fourth white. The forehead and face are white but a band of brown crosses the nose. The chin, throat, and underparts are brown. The rump disk is white; it is divided on the back by a dark band which is continuous with the brown tail.

THE DEER (FAMILY CERVIDÆ)

These are browsing, mostly deer-like animals, the size varying from that of a large Hare to a Moose. Most Deer are provided with antlers which are shed every year. Antlers are usually developed in male animals only; in Reindeer they appear in both sexes; in the subfamilies which contain the Musk Deer and Chinese River Deer, no antlers develop in either sex. Canine teeth, though small, are usually present; the upper canines are large and dagger-like in forms which lack antlers. The gall bladder is absent in most genera. Various types of foot glands and facial glands may be present. The metacarpal bones which support the small lateral hoofs are disappearing in Deer; in some genera only the lower end of the bone is retained, in others only the upper end. There are usually 2 pairs of nipples beneath the hinder part of the belly. One or 2 fawns are produced at a birth, except in *Hydropotes*, which bears from 4 to 7 young.

THE MUSK DEER (SUBFAMILY MOSCHINÆ)

This subfamily, containing only the genus *Moschus*, is generally treated as the most primitive of the subfamilies of Deer. The Musk Deer, the Chinese River Deer, the Muntjaks, and the Tufted Deer are the only living kinds of Deer which still develop large, powerful upper canine teeth. Some of the American Brocket Deer also have canines, which, however, are very small and relatively useless. The Musk Deer may be thought of

as more primitive than the Chinese River Deer and the Cervinæ, because it retains the gall bladder, which the latter have lost. At the same time, the Musk Deer has developed special characters, including the peculiar preputial musk gland on the abdomen in the males. The lack of a facial gland beneath the eyes and of its recess in the bones of the face, both usually present in other subfamilies, is characteristic. No antlers are developed in either sex, nor are foot glands developed. There are 2 pairs of nipples on the lower abdomen. Two young are born in the spring.

The Musk Deer, *Moschus moschiferus*, has the general appearance of a very large hare. It is a stoutly built animal with long, thick hind limbs, large ears, very short tail, half-bristly and half-woolly hair, and the canine teeth of the males extremely long and dagger-like, while those of the females are quite small. The lateral hoofs on the sides of the legs are relatively large, unusually expansible as in the Pigs, and often touch the ground.

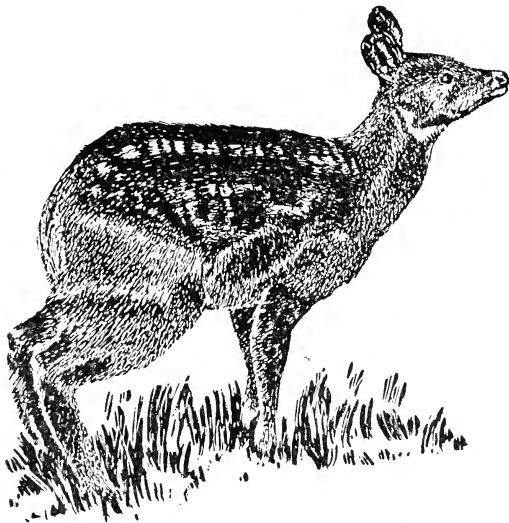


FIG. 68. Musk Deer, *Moschus moschiferus*.

There are several races distributed through the quite extensive range. The typical form (which Flerov subdivides into several) is found in Mongolia, Siberia, and Sakhalin, extending in a narrow belt behind the Gulf of Chihli, south through Jehol into Hopei and Shansi. In Siberia this race is shown by Flerov to extend almost to the Arctic Ocean, though it is missing from regions north and east of the Sea of Okhotsk. A second race, *M. m. sifanus*, extends from western Hupeh through Szechwan into upper Burma and Assam. Either the same or a slightly differing form, *M. m. chrysogaster*, occurs in Nepal. A local form, *M. m. parvipes*, with unusually small feet, is native to Korea.

The color generally is dark brown, often mottled or spotted with grayish or brownish. Though it rather resembles the Chinese River Deer, the Musk Deer may be distinguished in the field by the dark color on its feet and the more slender form of its tusks. The Northern Musk Deer, *moschiferus*, is dark chocolate-brown, with or without indistinct spots; the Southern Musk Deer, *sifanus*, is more nearly buffy brown and somewhat smaller; the small-footed Korea Musk Deer is dark-colored like the Northern, with a white streak running from the ear to the white throat and back to the shoulder. The Northern race stands about 20 inches high at the shoulder.

Like many other northern mammals, the winter and summer pelages of Northern Musk Deer are likely to be well differentiated. The animals are solitary, preferring rocky hills well covered with dense forest. The food in the north consists of tender shoots, mosses, scrub oak, and young grass.

The musk pouch or pod which develops in three-year-old males, provides the reason for the continued intense persecution of the Deer and for their approach to extinction in parts of their range. The musk is used in making perfumes. In China, in 1925, the value of pods running from $\frac{1}{2}$ to 2 ounces in weight of musk varied from 10 to 20 dollars Mexican (Sowerby).

THE CHINESE RIVER DEER
(SUBFAMILY HYDROPOTINÆ)

The Chinese River Deer, like the Musk Deer, exemplifies a subfamily that contains but a single species. Although this subfamily also lacks antlers in both sexes, it more nearly resembles the True Deer, or Cervinæ, by possessing small preorbital and inguinal glands and by the absence of the gall bladder. It has no musk gland. The long canine teeth present in the males are broader and less compressed than those of the Musk Deer and are much larger than the canines of the cervine genera *Muntiacus* and *Elaphodus*; those of the females are very small, only about $\frac{1}{4}$ inch long. The face is short. The ears are narrow and pointed, and look more deer-like and less hare-like than those of the Musk Deer. The audital bullæ of the skull are much enlarged.

The Chinese River Deer, *Hydropotes inermis* (meaning "unspotted water-drinker"), has harsh yellowish brown hair, the color effect coming from the gray bases, the dark brown subterminal rings, and the buff tips of each hair. The underparts are buffy or whitish. Most of the head is reddish brown, with a whitish spot at the front upper corner of each eye. The chin and throat are whitish buff. The feet are clear reddish to the hoof, not blackish as in the Musk Deer. The young are marked with white spots and stripes. The length of head and body in adults is about 3 feet, of the tail $2\frac{1}{2}$ to 3 inches, of the hind foot 10 to 11 inches. The height at the shoulder is about 20 inches, and the weight from 20 to 24 pounds.

This Deer occurs among rushes and low brush on islands and along the shores of the Yangtse River but likes dry land quite as well. It rarely occurs in herds. In May large litters of 5 to 7 young are produced at birth. There are 4 nipples.

A Korean race, *H. i. argyropus*, is darker and the head is more reddish. Otherwise it is very similar.

THE MUNTJAKS, DEER, MOOSE, AND REINDEER
(SUBFAMILY CERVINÆ)

Represented by many genera in all parts of the world except Australia and Africa,¹ this subfamily contains the remaining oriental Deer. Characters common to all include the lack of the gall bladder, the presence of antlers in males, the usual presence of facial glands and foot glands. Antlers are absent in the females of all genera except the Reindeer or Caribou. In two of the genera, *Muntiacus* and *Elaphodus*, the antlers are developed on the tips of tall bony pedicels that rise from the frontal bones. The upper canine teeth are often developed, although not so large as in *Hydropotes*, while the depression in the face which receives the anteorbital gland may be almost as large as the eye socket.

Besides the two genera just mentioned, there occur in eastern Asia a number of subgenera of True Deer, *Cervus*; the Moose, *Alces* (this is the "elk" of Europe); and the Caribou or Reindeer, *Rangifer*.

The Tufted Deer, *Elaphodus cephalophus*, looks like an incipient Muntjak. As in the Muntjaks, the antler pedicels develop, but they are shorter and their bases terminate behind the eyes instead of extending over the eyes to the rostrum as pronounced ridges. The anteorbital glands are well developed. The canine teeth are approximately the same size as in the Muntjaks. The antlers, on the contrary, are so small that they must be searched for on the tips of the pedicels among the long hairs of the brow tuft. The backs of the ears at the tips are conspicuously marked with white. The general color is chocolate-brown, the underparts whitish, the head and neck grayish; a pale streak extends from the pedicel forward above the eye; the tuft is blackish brown. The height at the shoulder is 22 to 23 inches, the weight about 40 pounds.

¹ A kind of *Cervus* occurs in extreme northwest Africa; the Fallow Deer is introduced in Egypt.

This is a Chinese Deer. The typical race occurs in northern Yunnan and in Szechwan; the coastal and east Chinese race, *E. c. michianus*, found in Chekiang and Fukien, is colored a somewhat grayer shade of chocolate than the former, and there is often a line of white just above the hoof. The number of young born is one. The young has a pattern of indistinct spots along the back.

The Muntjaks or Barking Deer, genus *Muntiacus*, are very distinctive small Deer from the fact that the antlers are carried on long, bony, hair-covered pedicels. They can be confused only with the Tufted Deer, *Elaphodus*, which also has pedicels. In the Muntjaks the antlers are well developed, while in *Elaphodus* they remain little more than rudiments. In the Muntjaks the pedicels are extended forward and downward on the face above the eyes as prominent ridges, reaching halfway to the front of the muzzle; in *Elaphodus* the pedicels stop behind the eyes. The antlers are simple, the tips curving slightly inward;

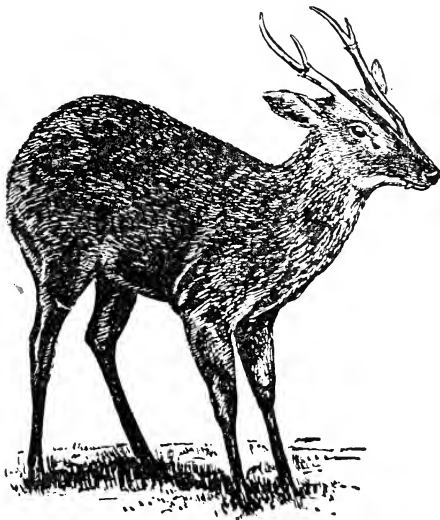


FIG. 69. Muntjak or Barking Deer,
Muntiacus muntjak.

on the inner side of the base of each antler is a short tine. The pedicels in females are represented by short bony processes, each covered with a tuft of bristly hair. The lateral hoofs are rudimentary or wanting. The young have white spots (except possibly in *M. feæ* and *M. crinifrons*).

Four species of Muntjaks need be considered here: the typical Indian Muntjak, *Muntiacus muntjak*; the Reeves' or Chinese Muntjak, *M. reevesi* of central China; the Black Muntjak, *M. crinifrons*, confined to a small area in Chekiang, south of the mouth of the Yangtse River; and Fea's Muntjak, *M. feæ*, from Tenasserim. In *M. muntjak* and in *M. reevesi* frontal glands are present and the top of the tail is red; in *M. crinifrons* and *M. feæ* the frontal glands are reputed sometimes to be absent and the top of the tail is black.

The Indian Muntjak, *Muntiacus muntjak*, originally described from Kangean Island, Java, is represented by a number of races distributed all over the Indian, Burmese, and Malayan areas and on many of the East Indies islands. The color of the Indian Muntjak varies from chestnut to tawny. There is a dark streak along each antler pedicel, a pale crown patch, and a gray area on the nape; the underparts are white. The height at the shoulder is from 20 to 22 inches; the tail is about 7 inches long.

The most widespread of the mainland races of the Indian Muntjak is *M. m. vaginalis*, found from Bengal through Burma to Indo-China and Tonkin; it reaches Yunnan in southwest China. An island race, *M. m. nigripes*, with blackish instead of reddish legs, occurs on Hainan. This Muntjak occurs also in northern Annam, presenting a type of distribution similar to that of the crested gibbon. In southern Annam and Cochin-China the local race is *M. m. annamensis*; the name *M. m. peninsula* is applied to the Barking Deer of the Malay Peninsula. There are two or three additional local races of doubtful validity.

Osgood has described a Muntjak from extreme northern Laos, *M. rooseveltorum*, somewhat intermediate in characters between the Indian and Chinese Muntjaks. The paired skin glands beneath the chin, covered with stiff short hairs, are greatly exaggerated in this species. The color is generally as in *M. reevesi* but more reddish, and the hairs are ringed to produce a fine speckled effect. The length of the head and body is almost 3 feet, the tail $5\frac{1}{2}$ inches, the hind foot 14 inches.

The Chinese Muntjaks, *Muntiacus reevesi*, are rather smaller than the Indian, 16 to 19 inches at the shoulder, and the color is duller, reddish chestnut more or less speckled with yellowish gray, the limbs being blackish brown. The backs of the ears and the forehead in most typical females are black. True *M. reevesi* is from Canton. Animals from Szechwan, tending to be slightly more yellowish and having the backs of the ears yellowish, have been named *M. r. lacrymans*. On the contrary, those from the highlands of the northern part of the range of *reevesi*, dark-colored, with blackish mixed with the chestnut, have been named *M. r. sinensis*. From Formosa comes also *M. reevesi micrurus*.

The Black Muntjak, *Muntiacus crinifrons* (in reference to the tuft of hairs on the brow), is a rare and exceptionally large species, reaching a height of 24 to 25 inches at the shoulder. It is found in Chekiang Province a little south of Shanghai. Its general color above is so dark as to appear almost black. It has the top of the tail black, but the sides of the face, the brow tuft, and the backs of the ears reddish. The underparts are white. The length of the head and body (in a dry specimen) is about 3 feet 10 inches, of the tail $6\frac{1}{2}$ inches, of the hind foot 11 inches.

Fea's Muntjak, *Muntiacus feæ*, is colored rather dark brown. The crown, pedicels, and bases of the ears are yellow and a black line marks the inner side of each pedicel. The legs darken to black above the hoofs, while the hind legs have a whit-

ish line down the front of each. The underparts are mixed brown and white. This animal is known from the part of Tenasserim that adjoins Siam, by only two specimens. It has been considered a relative of *M. crinifrons* of eastern China.

The **Roe Deer**, *Capreolus*, medium to small-sized, almost tail-less Eurasian Deer standing from 26 to 34 inches at the

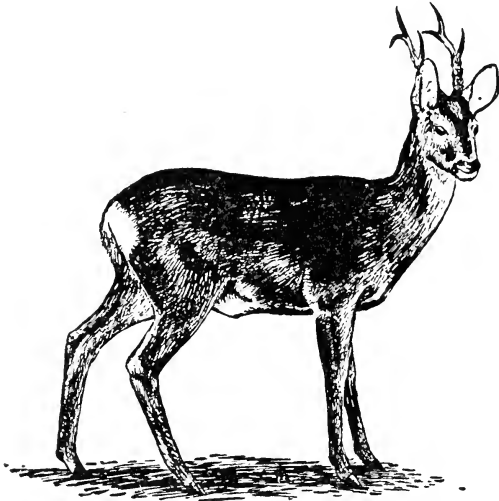


FIG. 70. Roe Deer, *Capreolus capreolus*.

shoulder, are neutrally colored, red-brown (summer) or gray-brown with the rump white (winter). The antlers are three-pointed, the beam dividing into a short branch pointed forward and a longer rear branch, which subdivides forward and backward to form the second and third points. The base of the beam is often rough and tuberculate. Roe are extremely fleet and excellent jumpers. They are often found in pairs, rarely in herds. The fawns, usually twins, have three rows of white spots on the tawny ground color.

The **Siberian Roe Deer**, *C. capreolus pygargus*, may have rugosities developed on the antlers as far up as the second fork.

The winter pelage is rough and shaggy and the white rump patch extends a short way onto the flanks.

The Manchurian Roe Deer, *C. c. bedfordi* (= *mantschuricus* Noack, Humboldt) has more the appearance of the European race. In summer it is strongly reddish dorsally, buffy on the chest, and white on the underparts. The ears are blackish buff with black edges, the insides white. The winter color is a mixture of buff and dark brown, the face, chest, and legs tawny, the large rump patch white. The throat is whitish, the underparts of the body and tail are buffy to whitish. The length of the hind foot of a Korean specimen is given by Kuroda as $13\frac{3}{5}$ inches.

In eastern Asia the southern range of Roe Deer is reached in northern Szechwan, whence it extends northeast, skirting the edge of Mongolia, to the coast of Hopei and Jehol. Thence it expands into Manchuria and east to Korea. In Siberia the northern race continues the range, probably to the northern edge of the temperate forest zone.

Sowerby states that in Manchuria this Deer is often found in open country, on the bare hills and along the lower reaches of the Yalu River or the willow-grown swamps of the lower Sungari River. It is still plentiful in the forests. The mating season is in July.

The True Deer of the large genus *Cervus*, are often represented as six subgenera (in eastern Asia by only five). These are the Hog Deer, subgenus *Hyelaphus*; the Sambars, subgenus *Rusa*; the Sika or Japanese Deer, subgenus *Sika*; the Thamin, Eld's, and Schomburgk's Deer, subgenus *Rucervus*; and the Red Deer and its allies, subgenus *Cervus* (to which belong our American "elk").

The genus, taken as a whole, can be defined only with difficulty; its characters are sometimes unstable. The antlers, large and not palmate, comprise a basal or subbasal brow tine and at least two other tines; the upper canines are quite small (absent

in *Hyelaphus*); the hoofs of the hind feet are almost completely united underneath by a web of skin. The length of the tail is short to medium. Except in *Cervus* and *Sika* there is no contrasting white patch on the buttocks, as in the Roe Deer and Reindeer.

The Hog Deer, subgenus *Hyelaphus*, are small Deer 25 to 29 inches in height at the shoulder, built rather low and stout, with short legs. The bases of the antlers rise well above the frontal bones. The antlers are very long, with rather tall brow tines and a pair of long, forked tines branching from the long,

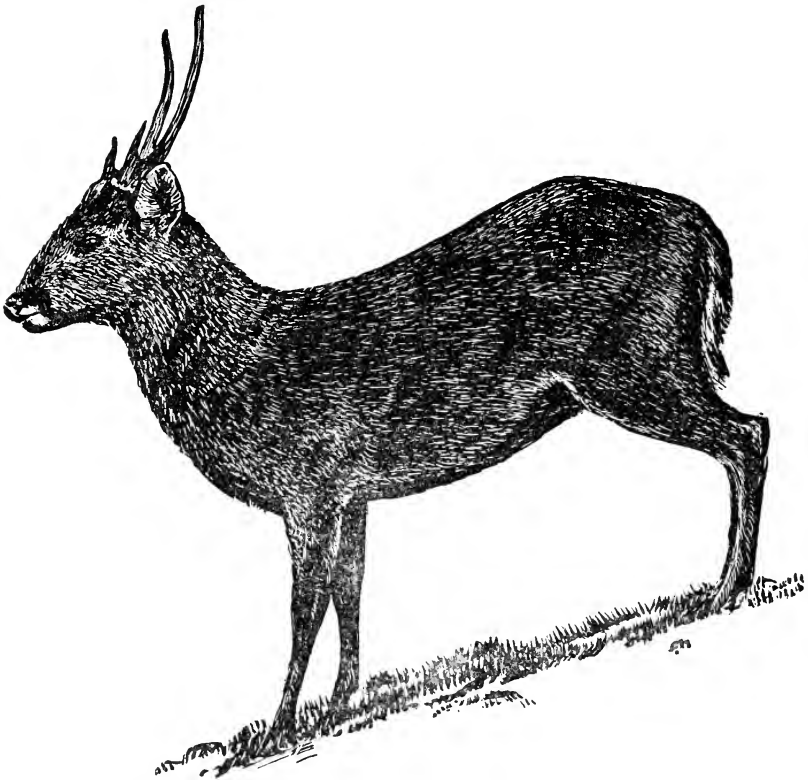


FIG. 71. Hog Deer, *Cervus (Hyelaphus) porcinus*.

slender main beam. The audital capsules of the skull are unusually large.

The Hog Deer of the mainland of Asia, *H. porcinus*, is found from India through Burma to Tenasserim, Siam, Annam, and Cochin-China. There are two races: *H. p. porcinus*, found from India to Burma, which usually has the coat of adults spotted during the summer, and *H. p. annamiticus* of Siam, Cambodia, Annam, and Cochin-China, the pelage of which remains uniformly colored at all seasons. The normal winter color is reddish brown or yellowish brown, appearing slightly speckled or grizzled on account of the pale hair tips. The spots in the Indian race may be restricted to one or two rows on each side. The young are fully spotted for six months. A relative occurs in the Philippines. Hog Deer are unsocial; more than two or three are rarely seen together.

The Sambar Deer, subgenus *Rusa*, of the Asiatic mainland, may all be treated as races of the species *Cervus unicolor*. There are relatives elsewhere which are sometimes considered species, such as the Spotted Deer of the Philippines, *alfredi*, the little *kuhlii* of Bawean Island, and the *timoriensis* group; but in relation to the present work these Deer are extralimital. In general, the island forms are small.

The typical and the largest of the races of Sambars is the Indian Sambar, *C. u. unicolor*. Next largest to that comes the Eastern Sambar, *C. u. equinus*, first recorded from Sumatra but distributed also through the Malay Peninsula, Burma, Assam, Kachar (in which last two regions the fawns are spotted), and northeast into Cambodia, Laos, Cochin-China, southern China, Hainan, and Formosa. A race from Szechwan known as *S. u. dejeani* occurs also in Yunnan, and probably in Burma. It is found at altitudes between 4000 and 14,000 feet.

In the Sambars the antlers are three-pointed, like the Hog Deer, but the brow tine comes off from the rough, corrugated beam at a wider angle. The coloring of the coat is uniformly



FIG. 72. Sambar Deer, *Cervus (Rusa) unicolor*.

dark smoky brown, without ticking. The tail is relatively long. The hairs along the throat form a kind of inverted mane. In Siam the horns are shed annually in August. Usually the fawns show little or no spotting.

The Sika or East Asia Spotted Deer, subgenus *Sika*, are medium to small-sized, lightly spotted Deer, marked with a white rump patch of partly erectile hairs. The antlers bear four (rarely five) tines. The second tine of the antler branches off unusually far above the brow tine. Sika Deer have metatarsal and suborbital glands but no glands on the hind pasterns. The upper canines are small. These Deer occur along the eastern

coast and off-shore islands of Asia, from Formosa to Manchuria and Japan. The distribution in China is spotty. The Sika may be considered as composed of several races belonging to a single species, *Cervus nippon*.

The South China Sika, *Cervus n. kopschi*, is the race most likely to be seen on the south Asiatic mainland. The color is rich yellow-brown, with fairly distinct small white spots at all seasons; a dark stripe extends along the back to the tail. The belly and the insides of the forelegs are brownish white, and a brown line passes along the middle of the chest. The tail is white with a narrow black stripe on top. The head, the neck, and the backs of the ears are brown. The length from the muzzle to the root of the tail is about 4 feet, of the tail 8 inches. The height at the shoulder is about 3 feet.

The Formosan Sika, *C. n. taiouanus*, is substantially like the mainland form.

The North China Sika, *C. n. mandarinus*, occurs in a restricted area northwest of the Gulf of Chihli, near Peking. It is colored dark brown, and is spotted especially on the neck at all seasons, though less in the winter. The dorsal stripe is strongly developed. The tail is reddish, with little white. This Deer is very rare, or may even be extinct.

The Ussuri Sika, *C. n. hortulorum*, is the largest of the Sika Deer. It reaches 43 inches at the shoulder. In summer the general color is reddish brown with a dark back stripe, the underparts grayish white, the tail white with a black streak along the top. The white rump area, bordered in front with blackish, is distinct. The large spots, though they become grayish in winter, are retained throughout the year. In winter the coat becomes very shaggy and the color is yellowish brown, darker on the back. The range extends through Manchuria to Korea and Ussuri. This is probably the same form as *mantschuricus*. Along the coast the local form is sometimes distinguished as *C. n. dybowskii*.

The Japanese Sika, *C. nippon nippon*, the first Deer of this kind ever described, is not one of the larger races. The height at the shoulder varies from 32 to 34 inches. The spots in this form disappear in the winter. The white rump area is large and conspicuous. There is a white metatarsal tuft.

Father David's Deer, subgenus *Elaphurus*, with the single species *Cervus davidianus*, is reported to be now little more than a memory in its native land of China. It was obtained originally from the gardens of the Summer Palace at Peking, by the French missionary naturalist, Armand David. It has not been known wild within the recorded memory of man. Its original range is reputed to have been northern China or perhaps Manchuria. Small colonies have been established from time to time in England. Its fossil remains are recorded from Japan.

This is a large Deer, with suborbital glands present but no foot glands. The lateral hoofs are large. The long slender antlers have the brow tine unusually high and forked once or twice. The summer coat is grayish red; in winter it is nearly uniform grayish buff, becoming whitish posteriorly. There are both neck and throat manes. The young are spotted. The height at the shoulder in adults is about 45 inches.

Schomburgk's Deer and the Thamin or Eld's Deer, both members of the subgenus *Rucervus*, are restricted as a group to southern Asia. Only the Thamin reaches extreme southern China and Hainan.

Rucervus are large Deer with flattened or rounded antlers, widely forked into a forward projecting brow tine and a backwardly projecting main beam. Both brow tine and main beam are forked again, and the latter is often provided with a number of supplementary tines. The brow tine may form a continuous curve with the beam (Thamin). A third species, the Swamp Deer of India, *C. duvanceli*, belongs to *Rucervus*. The color of these Deer is relatively uniform; no well-defined rump patch is seen. Suborbital glands are present but no glands are found on the pasterns. The subgenus is related to *Rusa*.

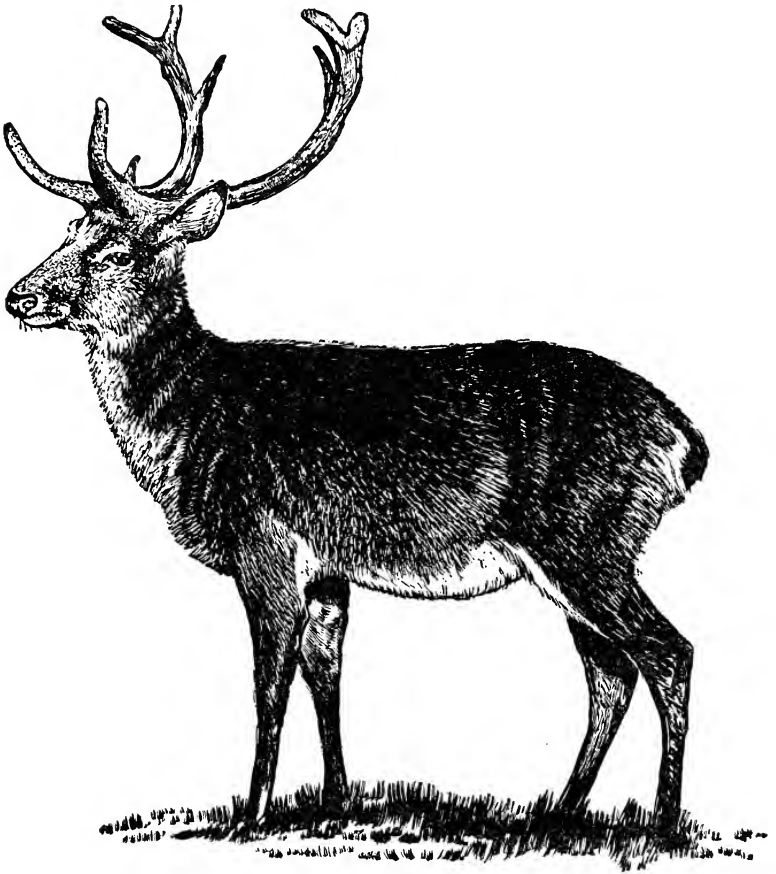


FIG. 73. Eld's Deer, *Cervus (Rucervus) eldi*.

Schomburgk's Deer, *Cervus schomburgki*, grows complexly divided antlers, which by forking may develop as many as nine tines each. The brow tine is placed at a right angle with the main beam, which soon subdivides. The color is uniform brown, the underparts whitish. The hair on the front of the lower forelegs becomes fringe-like. The height at the shoulder is about 40 inches. This rare Deer is a native of Siam. It reputedly reaches Yunnan.

The Thamin or Eld's Deer, *Cervus eldi* (= *platyceros*) sometimes also called Panolia Deer, can be distinguished from young specimens of Schomburgk's Deer by the curving continuity of the brow tine with the beam. One or more prominent small tines often develop at the junction of the brow tine with the beam, which latter otherwise is unbranched for some distance. The number of points in adult bucks varies from two to eight or ten. The antlers are often somewhat asymmetrical.

The Thamin is typically brown above, whitish below; the females are somewhat rufous. New-born fawns may have white spots on the rump. This Deer is somewhat larger than Schomburgk's Deer, reaching 45 inches at the shoulder. In winter the coat becomes shaggy and dark brown. Three races are recognized: typical *eldi* occurring in lower Burma and southward into the Malay Peninsula; *C. e. frontalis*, with the undersurface of the hind pasterns horny instead of haired, found in Manipur; and *C. e. siamensis*, with the brow tine exceptionally short, occurring in southern Siam, Cochin-China, Cambodia, Hainan, and Formosa. The Hainan race has been distinguished as *C. e. hainanus*.

The Red Deer and Wapiti, subgenus *Cervus*, include the Red Deer of Europe, *C. elaphus* and its races; the Kashmir Stag, *C. macneilli*; the Himalayan Shou, *C. wallichii*; and the American "Elk," *C. canadensis*. Only the first, which has representatives in northeastern Asia, need be treated in the present work. These Deer, larger than the East Asia Spotted Deer, *Sika*, may be further distinguished by the position of the second or "bez" tine, which diverges from the main beam only a short way beyond the brow tine. The beam becomes further divided into four or more additional points. Red Deer are red only in the summer—actually a reddish brown, becoming dull brown in old animals. The underparts are light slaty gray and the legs grayish brown, becoming dark gray distally in front. The rump patch in summer is virtually absent. The winter pelage, which

has developed by September, is dark gray or brownish gray, with a strongly differentiated yellowish buff rump patch. The tail is brown. The young in their first coat are spotted. The height at the shoulder is about 4 feet.

The Red Deer is a night feeder. It hides during the day in wooded valley bottoms, emerging toward evening into swampy clearings to browse upon the rich grasses. In winter it moves

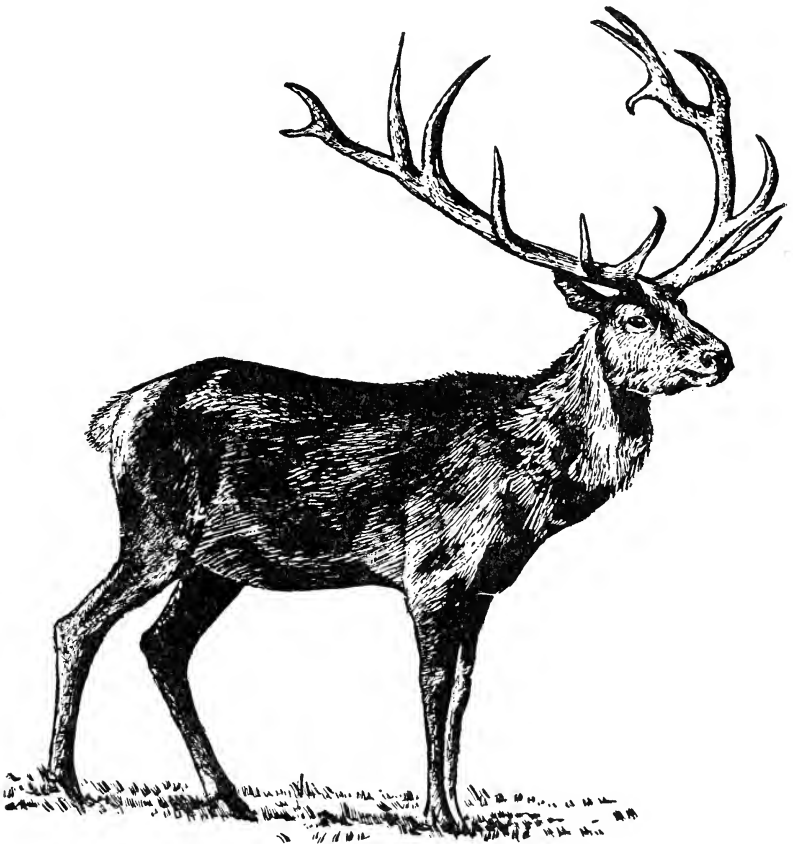


FIG. 74. East Asiatic Red Deer or Wapiti, *Cervus* (*Cervus*) *elaphus xanthopygus*.

about by day as well and, in association with others of its kind, tramples down the snow to form open spaces or yards, from which paths radiate in all directions.

The rutting season is September. Antlers, which begin to grow in the spring, lose their velvet in July. The young, usually one, are born in May or June.

The East Asiatic Wapiti, *C. e. xanthopygus*, ranges through the whole of the temperate forest zone of Mongolia, Manchuria, and Siberia from Transbaikal to Ussuri and north into the Amur area. In Kansu and Shensi there is a local isolated race, *C. e. kansuensis*. This is a darker, browner Deer than *xanthopygus* and lacks the predominance of chestnut on the head, neck, and legs. It has paler ears and is white under the chin.

The Moose, *Alces alces*, is such a different-looking Deer from the familiar concept that, as Allen has suggested, it may with propriety be put into a subfamily by itself. These huge animals are distinguished by the almost trunk-like upper lip, the flat, spreading, often palmate antlers, the much reduced tail, and the hair-clad bell hanging from the neck. The color of the adults is dark grayish brown or blackish brown, the winter coat darker than that of the summer. As animals become older, the coat gets lighter; in old males it is grizzled. The young, which are born singly or as twins, have neither white spots nor streaks but are colored much like the parents. Old males may reach between 5 and 6 feet at the shoulder.

The degree of flattening of the antlers may depend on the quality of nourishment during their growth period. In some animals there is very little flattening of the beam.

The Moose has a circumpolar distribution. The typical race is *A. a. alces* of Europe (there called Elk); the American Moose is *A. americana*; the Manchurian Moose, *A. alces cameloides*, is the only moderately well defined form found in northeastern Asia.

Like the Red Deer, the Moose seems to have its headquarters

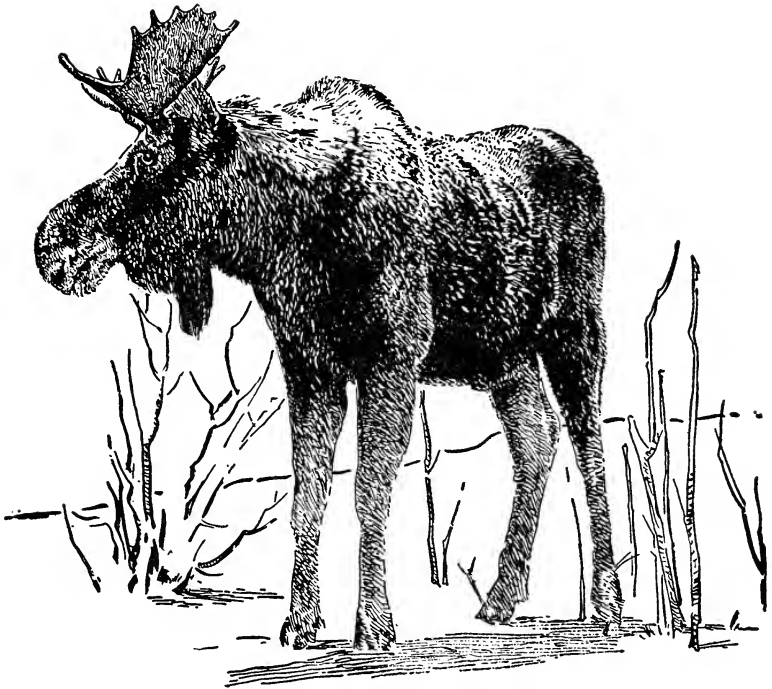


FIG. 75. Asiatic Moose, *Alces alces*.

in the great forest belt of the temperate zone. The southward limit may be that of larch and birch; northward it reaches the limit of evergreen forest margining the tundra. The Moose is reputed to be absent from the lower Amur region east of the Bureja Mountains.

Reindeer or Caribou, genus *Rangifer*, include the single species *R. tarandus*. This genus, especially its American representatives, has been divided into a considerable number of geographical races. In northeastern Asia only two need be considered: the Siberian Caribou, *R. t. sibiricus*, of the Obi Basin, and the larger Kamchatka Caribou, *R. t. phylarchus*. Caribou are the only deer in which the females as well as the males grow

and shed antlers annually. The brow tine, the "bez" tine, and the main beam become palmate and develop numerous points. They vary greatly in different races. The beam is often angled at the middle. The muzzle, unlike the muzzle of other Deer, is completely hairy. The ears and tail are short. There are anteorbital

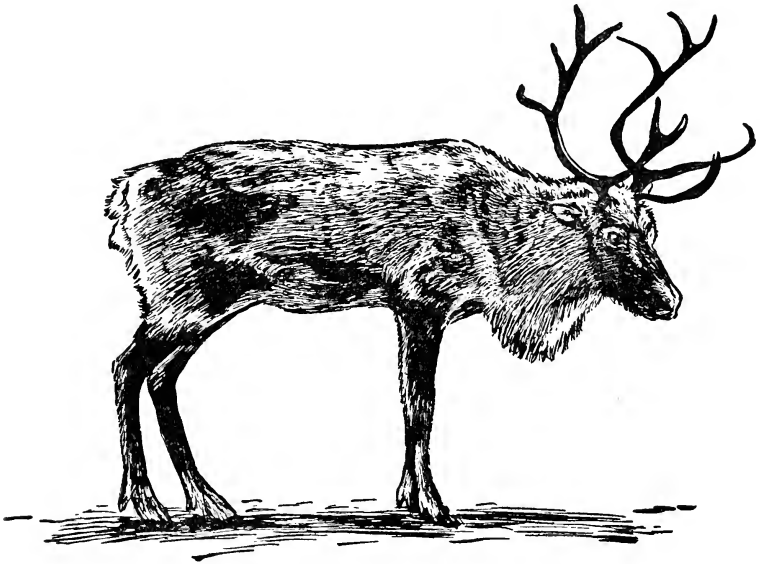


FIG. 76. Reindeer, *Rangifer tarandus*.

and tarsal glands but no metatarsal glands. Upper canines are present in females as well as in males. The fawns are not spotted.

The color of the coat is some shade of gray-brown, with the underparts whitish, the hair remarkably dense, springy, and crinkly. A pale rump patch is developed. The antlers are colored brownish white, the hoofs black. The height at the shoulder is about $4\frac{1}{2}$ feet.

Caribou occur on Sakhalin Island, at Marcova on the Sea of Okhotsk, at the mouth of the Amur (Sowerby), and south along

the Primorsk coast. Both wild and domestic Caribou have been reported fifty miles east of Gichiga.

THE ODD-TOED UNGULATES (ORDER PERISSODACTYLA)

This order, containing large-sized plant-eating mammals with the number of toes usually one, three, or five, never paired in two's or four's, comprises three families: the Horses, the Tapirs, and the Rhinoceroses. Formerly the five-toed elephant family was included in the odd-toed ungulates but many fundamental differences suffice to show the distinctness of the elephants. In prehistoric times other perissodactyl families existed, notably the Titanotheres, some species of which attained gigantic size and developed weirdly shaped excrescences on the head. Like most of the great orders of the mammals, the perissodactyls once ranged over virtually the whole of the world except the Australian region. Today the number of species is reduced to a remnant and the distribution of most of these is enormously curtailed. Tapirs and Rhinoceroses but no wild Horses occur in the area dealt with in this book.

THE TAPIRS (FAMILY TAPIRIDÆ)

The Tapirs are heavy-bodied, short-legged, almost tailless mammals with the upper lip and nostrils projecting from the bony part of the face to form a short trunk. The limbs, though short and heavy, have the elastic spring-like form of the limbs of running animals, not the massive, pillar-like shape to be seen in elephants and to some degree in Rhinoceroses. The forefeet have four toes, digits 2, 3, 4 and 5, of which digit 3, the axial toe of the artiodactyl forefoot, is the largest; the hind feet have three toes, digits 2, 3, and 4. The nails on all the toes are short, heavy, almost hoof-like structures.

The Tapirs are browsers; they get their food by nipping off

the twigs and foliage of herbs and shrubs and grinding them with their heavily cross-ridged cheek teeth. A characteristic of the Tapir skull, compared with that of the Horse, is seen in the nasal bones, so short as to appear like small triangles.

The living Tapirs are found in only two parts of the world—southeastern Asia, where *Tapirus indicus* becomes continually more scarce, and Central and South America. In most American species the skin appears comparatively hairless. But one species, *Tapirus pinchaque*, of the high Andes, has the coat as densely hairy as that of a cow. The word Tapir is derived from one of the Indian dialects of Brazil.

The Malay Tapir, *Tapirus indicus*, is the only species showing a color pattern; the American species are uniformly slate-colored. The Malay Tapir, on the contrary, is colored dirty white over the whole of the back behind the shoulders and on the sides, while the head, shoulders, forelimbs, and hind limbs from the thighs to the toes are blackish, as are the chest and belly. The height at the shoulder is about 3½ feet; the weight may

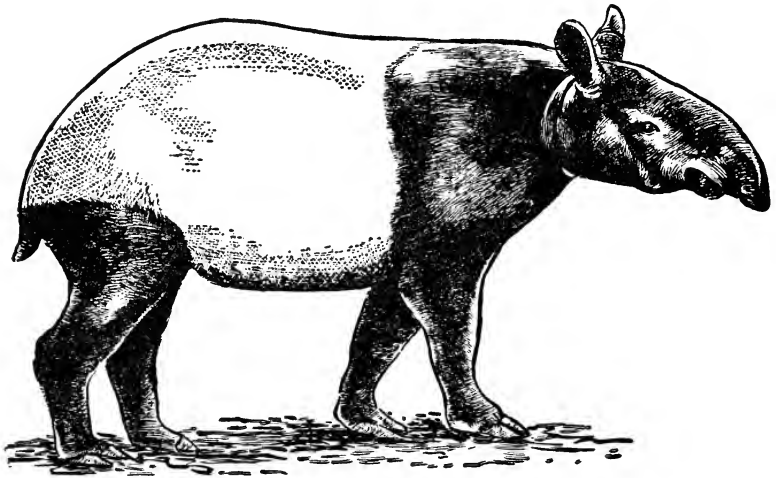


FIG. 77. Malay Tapir, *Tapirus indicus*.

reach 520 pounds, which was the weight of a ten-year-old male that died in the Bronx Zoo. The young at birth have a spotted and striped pattern of yellow-brown mixed with blackish brown, but they change to a mature coloring in the first year. One or two are born at a time. Tapirs are rather solitary animals living in swampy, often very wet forest. The range includes the Malay Peninsula as far north as Tenasserim.

THE RHINOCEROSSES (FAMILY RHINOCEROTIDÆ)

These huge, ungainly creatures with their armor-plated hides, their massive legs, their odd-looking heads, their ears placed far back and their eyes far forward, and the bosses or horns on their noses, are sufficiently well known to need little further description.

The skin plates, very thick and relatively inflexible, work against one another along suture-like contact lines where there is much thinner, pliable connecting skin. The horns on the nose are not made of bone. They are special structures derived from the fusing or cementing together of hairs. Three broad, hoof-like toes, of which the middle one is the largest, are present on both front and hind feet. There are two nipples under the belly. Only one calf is born. The senses of smell and hearing are very acute in Rhinoceroses; sight is reputed to be weak. When attacking an enemy, Rhinos are said to bite severely with their incisor teeth, as well as to strike with the horn.

Fables have it that the Rhinoceros is the deadly enemy of the Elephant. In *The Arabian Nights*, the Rhinoceros, after stabbing its horn into the underparts of the elephant, carried that animal about on its head until blinded by the juices running down from the elephant's body.

There are still several living species of Rhinoceroses. The African two-horned Rhinos are placed in the genus *Diceros*. The three species of Asia, the Great One-horned Rhinoceros,

the Two-horned or Sumatran Rhinoceros, and the One-horned Rhinoceros are contained in *Rhinoceros*.

Relatively enormous prices have been paid by Chinese for all parts of Rhinoceroses, but especially for the horn and the dried blood for use as charms and medicines. This demand has led to such destructive and continuous hunting of these animals that they are verging upon extinction.

The Asiatic or Sumatran Two-horned Rhinoceros, *Rhinoceros sumatrensis*, is at once recognized by the two horns.

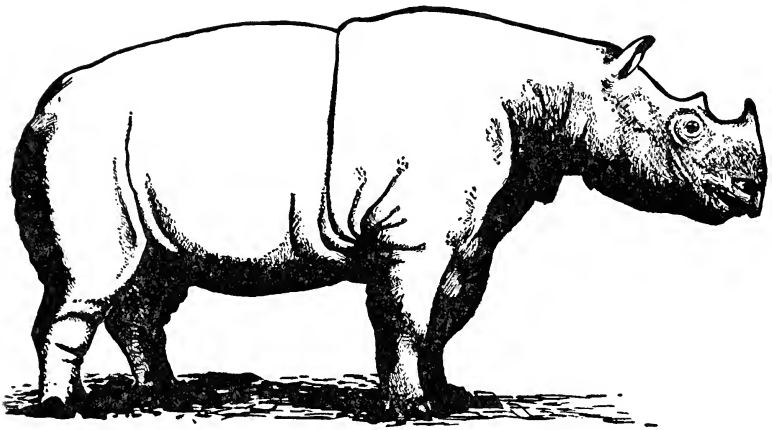


FIG. 78. Sumatran Rhinoceros, *Rhinoceros sumatrensis*.

The smallest and most hairy of the living Rhinos, it has the skin granular, somewhat thinner, and the skin folds less distinct than either *unicornis* or *sondaicus*. The front horn in the female is about 5 inches high, and broad at the base; the rear horn is little more than a large boss or tubercle, 2 inches high, placed between the eyes. Males, however, may have very long horns. The front one normally is 15 to 20 inches, and very rarely reaches 2½ feet along the curve; the hind one is about 7 inches. The black hair fringing the ears, though usually short, may reach a length of 5 inches. The height at the shoulder scarcely ever

exceeds 41½ feet and is often less; the weight is about 1 ton. The maximum width of the forefoot in big specimens is about 9 inches; the central toe-nail occupies 3½ inches of this.

This Rhinoceros is reputed to be much stronger and more agile than *sondaicus*. The period of gestation is reputed to last only about 7 months, a statement which requires checking, considering that that of *unicornis* is known to be nearly three times as long.

The species is found through the Malay Peninsula, to Siam and Assam up to 6000 feet. It is present on Sumatra and Borneo but not on Java. The form found in southwest Burma has been distinguished by the name *lasiotis* (broad-eared). It likes moist shaded hilly country, the steeper the better, and is generally solitary, or a bull and cow may be together. It frequently makes wallows in the stream beds. When enjoying its wallows, it makes a low humming or buzzing sound. The food consists of twigs and branches and a species of bamboo. In the dry season it may eat figs and mangos or other fruits also; thus, it is a good distributor of mango seeds. Formerly it was found in the lowlands as well as among the hills, but is now almost as scarce as *R. sondaicus*.

The Greater One-horned Rhinoceros, *Rhinoceros unicornis*, rapidly becoming extinct, enters our area only at the eastern end of its range near the southern foot of the Himalayas and eastward into Assam. Formerly it occurred over much of peninsular India. The skin of the sides is covered with rivet-like flattish tubercles, particularly on the fore and hind quarters. The heavy skin fold in front of the shoulder does not extend over the neck to meet the one on the other side, as in *R. sondaicus*. The horn is sharply conical and often about 6 inches high. Unusually large horns measuring 24 inches around the curve have been recorded.

This Rhinoceros is a denizen of the vast areas of grass, growing from 8 to 20 feet high, that cover much of the uncultivated parts of the alluvial plains of northern India, including

the Brahmaputra Valley. It is mainly nocturnal and prefers damp or swampy ground where it makes mud wallows. The animal lives solitary or in very small groups. The height at the shoulder is about $5\frac{1}{2}$ feet, the weight 2 tons. The animal is reputed to attain an age of 50 years. The gestation period is about 19 months. The new-born calf weighs from 75 to 120 pounds and stands about 2 feet at the shoulders.

The Javan or Lesser One-horned Rhinoceros, *Rhinoceros sondaicus*, has the head smaller and the horn shorter than in

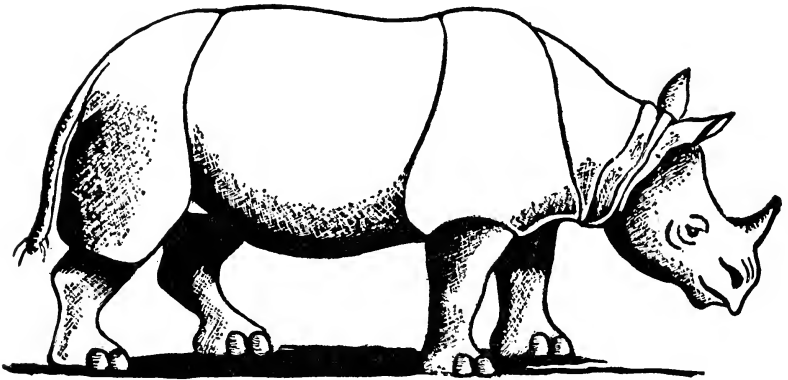


FIG. 79. Javan Rhinoceros, *Rhinoceros sondaicus*.

R. unicornis. Although almost as tall, it is more lightly built. Its skin armor is lighter, and the rivet-like tubercles of *unicornis* are represented by many-sided scale-like disks. The folds of skin between the neck and shoulders on either side unite over the back. The horn is usually absent in females. In males it may reach a length along the curve of more than 10 inches.

The original range of this Rhino includes Assam, Burma, and Indo-China, south through the Malay Peninsula to Sumatra and Java. By 1939, it had been reduced to scattered remnants in northern Indo-China, Siam, Tenasserim, the Malay Peninsula, south Sumatra, and west Java. The remains of a specimen found in the Thaton district of Burma was reported in 1943.

GLOSSARY

amphibious	Able to live on land and in the water.
anomalous	Irregular, unconformable.
anteorbital	Before the orbit (eye).
anthropoid	The group of monkeys most resembling man ; man-like.
arboreal	Tree-living, tree-climbing.
archaic	Of an earlier or primitive age ; antiquated.
asymmetric, -al	With parts not arranged correspondingly.
bandicoot	A long-snouted marsupial of the family Peramelidæ.
canine teeth	Eye teeth or dog teeth, usually longer than other teeth and sharp-pointed.
carnassial teeth	The shearing cheek teeth of carnivores.
conch	External ear.
coniferous	Pertaining to cone-bearing trees.
cusps	Points on the crowns of teeth.
dasyures	Carnivorous marsupials.
dentine	The hard, bone-like tissue of teeth.
deciduous	Relating to seasonal loss of leaves (botany) ; teeth that are replaced by others (zoology).
diastema	A gap between teeth.
dimorphism	Occurrence of two distinct forms of structure, size, coloring, etc., in a single species.
distal	Farthest away from the body. The hand is attached to the distal part of the forearm.
distichous	In two rows, as the webs of a feather.
diurnal	Active during daylight hours.
embryonic	Relating to an embryo or unborn young.
enamel	A hard substance which forms a thin layer capping or partly covering the teeth of most mammals.
endemic	Having their habitat in a specific district (biology).
environment	The sum total of the surroundings affecting the life of an organism.

extinct, -ion	No longer living. Applied to species, etc., not to individuals.
extrusile	Able to be thrust out.
fauna	Total number of animals, etc., of a certain group or class in a given region.
feral	Having escaped from domestication and become wild.
forearm	The part of the arm between the elbow and wrist.
genus, genera	A classification ranking between family and species.
gestation	Process of carrying young before birth (zoology).
gregarious	Habitually living with numbers of its kind.
habitat	The natural abode of an animal or plant, or the particular location where they normally live.
hibernate	To pass the winter in a more or less torpid state.
incisor teeth	The front teeth.
indigenous	Native to a country.
insulate, -ing	Cut off passage of heat into or out of body (zoology).
interfemoral membrane	Membrane situated between the hind legs. Present in bats.
lemur	Primitive relatives of monkeys; found in Madagascar, Africa and the Orient.
locomotion	Act or power of moving from place to place.
longitudinal	Extending lengthwise.
melanistic	Having a high degree of blackish pigmentation which produces a very dark or black color.
metacarpal	Long bones of the hand or forefoot between wrist and fingers.
metatarsal	Long bones of hind foot between ankle and toes.
molar teeth	One, two, three, or four teeth in the rear of the jaw used for chewing and not preceded by deciduous teeth.
mutant, mutation	An individual differing from the usual members of the same species, for instance a white animal of a species that is usually gray or brown.
myotine	Relating to the genus of Bats named <i>Myotis</i> .
obsolete, obsolescence	No longer used; no longer present.

- Oligocene** Age in the Tertiary between the Eocene and Miocene.
- opposable** Of the thumb, first toe, or other fingers and toes. The ability to act like a man's thumb in grasping.
- Palaearctic** Pertaining to a region of the world including Europe, Asia north of the Himalayas, northern Arabia and Africa north of the Sahara.
- palmate** (Of antlers.) Broad, resembling the spread-out hand of a man, the points extending like fingers.
- pedicel** A supporting part, as a stem or stalk.
- phalanger** Australian marsupial of the family Phalangeridæ.
- physiography** The form and physical features of the surface of the earth.
- physiology** The life process of an animal.
- pigment, -ed** Material that produces black, red, and other colors in the tissues of animals.
- plantigrade** Walking on the sole with the heel touching the ground, in opposition to digitigrade, walking on the toes like dogs and cats.
- Pleistocene** The most recent past geological period during which large ice caps were developed in Europe and North America; between the Pliocene and present, roughly from 10,000 years ago to 1,000,000.
- predator** An animal that preys upon other animals.
- prehensile** Adapted for grasping. Applied to hands, feet and tails of mammals.
- premolar teeth** Chewing teeth between canines and molars, usually less broad than the latter; preceded by deciduous teeth.
- primitive** Pertaining to the beginning or origin, like mammals whose structure approximates that of ancestral mammals.
- proboscis** A long, flexible nose, or trunk.
- relicts** Survivors. In zoology often used for species which have persisted for long periods after their allies have become extinct.
- rudiment, -ary** An initial or imperfect stage or form.

sacculated	Having a series of sac-like expansions.
sanguivorous	Feeding on blood.
scansorial	An organism that climbs or is given to climbing.
specialized	Designed, fitted or adapted for use in one special manner.
supersonic	Pertaining to sounds of such high frequency as to be inaudible to humans.
tactile	Touching. In some mammals, special tactile surfaces of toes, fingers and the tips of tails; also tactile hairs as cat's whiskers.
termites	White ants, pale-colored, soft-bodied insects of the family Termitidæ. They are not true ants.
Tertiary	The last great period of geologic time following the Mesozoic or Age of Dinosaurs. Most modern orders of mammals developed during the Tertiary period.
trefoil	Shaped like a three-leafed clover.
truncate	Cut off, chopped off.
type locality	The locality from which a species or subspecies was first described.
type specimen	The actual specimen from which a species or subspecies was originally described.
unicuspid teeth	Teeth having a single cusp or point—especially of the Insectivora.
W-pattern	In describing teeth, crowns with cusp pattern, when seen from above, arranged like the letter W .

INDEX OF COMMON NAMES

- Apes, 118
 Argali, 327
- Badgers, 153; Ferret, 151; Hog, 153, 154; Sand, 154
- Banting, 319; Malay, 320
- Barbastelles, 88
- Bats, 66; Bent-winged, 92; Big Brown, 90; Bulldog, 96; Bulldog, Naked, 97; Copper-winged, 83; Disk-footed, 89; False Vampire, 100; Flat-headed, 89; Frosted, 90; Fruit, 70; Fruit, Dawn, 76, Dog-faced, 74, Long-tongued, 76, Short-nosed, 74; Harlequin, 91; Harpy-headed, 95; Hollow-faced, 102; Horseshoe, 102; Horseshoe, Hairy-faced, 112, Round-leaf, 108, Trident, 111; Ia, 88; Insect-eating, 77; Large-footed Mouse-eared, 84; Linnaean, 90; Long-eared, 85; Mastiff, 96; Mouse-eared, 81; Mouse-tailed, 98; Natterer's, 83; Rickett's Mouse-eared, 84; Serotine, 90; Sheath-tailed, 99; Slit-faced, 102; Tickell's, 89; Tomb, 100; Trumpet-eared, 95; Tube-nosed Insectivorous, 94; Whiskered, 82; Wrinkled-lipped, 97; Yellow, 91
- Bears, 166; Asiatic Black, 169; Blue, 168; East Siberian Brown, 168; Eurasian Brown, 167; Himalayan Black, 170; Japanese Brown, 168; Malay, 170; Manchurian Black, 168; Polar, 166; Sloth, 168; Tibetan Black, 170
- Beavers, 252; Mongolian, 253
- Binturong, 179
- Caribou, 347
- Cats, 187; Fishing, 189; Flat-headed, 190; Jungle, 188; Leopard, 189; Marbled, 190; Temminck's, 190; Tiger, 189
- Cattle, 317
- Chevrotains, 315; Spotted, 315
- Chipmunks, 234
- Civets, 173; Banded Palm, 181; Indian, 174; Large-spotted, 174; Little, 175; Malay, 175; Masked Palm, 178; Otter, 182; Palm, 176; Small-toothed Palm, 180; Tangalung, 175; Three-striped, 180; True, 174
- Cricetine Mole Rats, 257
- Deer, 328, 337; Barking, 333; Chinese River, 331; East Asia Spotted, 340; Eld's, 342; Father David's, 342; Hog, 338; Musk, 328; Red, 344; Roe, 336; Sambar, 339; Schomburgk's, 342; Sika, 340; True, 337, 344; Tufted, 332
- Dogs, 158; Asiatic Wild, 161; Raccoon, 162; Red, 161
- Dolphins, 195; Chinese White, 200; Ganges River, 199; River, 197; True, 199; White-flag, 198
- Dormice, 296; Japanese, 297; Spiny, 297
- Doucs, 127; Black-footed, 128
- Dugongs, 308
- Elephants, 305; Asiatic, 306
- Ermines, 148
- Ferret Badgers, 151
- Flesh-eaters, 142
- Flying Foxes, 70, 71
- Flying Lemurs, 115
- Flying Squirrels, 239; Arrow-tailed, 248; Eurasian, 247; Giant, Anderson's, 244, Annamese, 244, Black,

- 246, Clark's, 244, Formosan, 241, Grooved-toothed, 246, Hoary, 243, Orange-footed, 246, Red, 241, Spotted, 242, Taylor's, 244, White-backed, 243, White-cheeked, 245, White-headed, 241; Horsfield's, 251; Lesser, 250; Pigmy, 251; Smaller, 247; Smoky, 247; Tufted, 247
- Foxes, 158; Arctic, 158; Red, 158; True, 158
- Gaur, 318
- Gayal, 319
- Gazelle, Mongolian, 317
- Gibbon, 137; Agile, 141; Black, 138; Crested, 138; Gabriella's, 139; Hoolock, 141; Indo-Chinese, 138; Siamang, 138; White-cheeked, 139; White-handed, 139
- Glossary, 355
- Goat-Antelopes, 322
- Goats, 326
- Goral, 324; Northern, 325; South China, 325; West China, 324
- Gymnures, 35
- Hamsters, 254, 255; Korean, 257; Least, 256; Little, 255; Miller's 257
- Hares, 201; Assam, 207; Burmese, 207; Gray-tailed, 206; Hainan, 206; Harsh-furred, 203; Indian, 206; Japanese, 205; North Eurasian, 204; Red-tailed, 207; Snow, 204; South China, 205; South Eurasian, 205; True, 203; Whistling, 207; Woolly Himalayan, 206
- Hedgehogs, 34
- Hoolock Gibbon, 141
- Insect Eating Mammals, 30
- Jackals, 159, 160; Himalayan, 161
- Jerboas, 300; Five-toed, 301
- Kolinski, 149
- Kouprey, 321
- Lemmings, 259; Collared, 259; Gray, 260; Red-backed, 260; True, 260
- Lemurs, 120; Flying, 115
- Leopards, 194; Snow, 194
- Linsangs, 172; Banded, 172; Spotted, 173
- Lorises, 120
- Lynxes, 187, 191
- Macaques, 131; Crab-eating, 132; Japanese, 136; Long-tailed, 132; Pig-tailed, 134; Rhesus, 132; Stump-tailed, 135
- Marmots, 237; Himalayan, 238; Hoary, 238; Tarbagan, 238
- Martens, 145; Beech, 145; Stone, 145; Yellow-throated, 146
- Mice, 271; Birch, 299; Blind, 297; Climbing, Long-tailed, 274, VERNAY'S, 274; Golundi, 280; Harvest, 273, Chinese, 274; House, Chinese, 279, True, 277; Indian Field, 275; Jumping, 300; Jungle, 279; Jungle, Flat-haired, 280; Marmoset, 276; Meadow, Dawn, 263, Himalayan, 265, Mole-like, 268, Rabbit-tailed, 268, True, 266 Old World Harvest, 273; Pine, 266; Red-backed, 262; Tree, Burma, 277, Monkey-handed, 276; Pencil-tailed, 275; Wood, 281
- Moles, 39; Shrew, 40; True, 42
- Mongoose, 183; Asiatic, 184; Crab-eating, 184; Indian, 185; Javan, 185; Short-tailed, 186; Water, 186
- Monkeys, 118; Langur, 123; Langur, Dusky, 126; Leaf, 122; Leaf, Banded, 127, Bonneted, 124, Capped, 123, Mitred, 127, Sureli, 127; Old World, 122; Rhesus, 132; Snub-nosed, 128
- Moonrats, 35
- Moose, 346
- Mountain Beaver, 211
- Mouse Deer, 315
- Muntjaks, 333; Black, 335; Chinese, 335; Fea's 335; Indian, 334

- Noctules, 87
- Otters, 155; Clawless, 157; Hairy-nosed, 156; Small-clawed, 157; Smooth, 157
- Ox, Forest, 321; Gray, 321
- Pandas, 163; Chinese Lesser, 164; Giant, 164; Lesser, 164
- Pangolins, 112
- Pigs, 310; Banded, 314; Bearded, 314; Crested, 314; Indian, 314; Japanese, 313; Mongolian, 312; North China, 313; Northern Wild, 312; Pygmy, 311; South China, 313; True, 311
- Pikas, 201, 207; Hokkaido, 210; Kolyma River, 210; Manchurian, 209; Red-eared, 209; Sakhalin, 210; Yezo, 210
- Pipistrelles, 86
- Polecats, 147; Masked, 148
- Porcupines, 302; Brush-tailed, 302; Crested, 303; Long-tailed, 303; Old World, 303
- Porpoises, 195; Black Finless, 200; Irrawaddy, 200
- Primates, 118
- Rabbits, True, 201, 202
- Rats, 271, 283; Alexandrine, 288, 293; Anderson's, 288; Bamboo, 269; Bamboo, Chestnut, 270, Chinese, 269, Hoary, 269, Red-cheeked, 270, Small, 271, Yellow-cheeked, 270; Bandicoot, 294; Bandicoot, Bengal, 295, Giant, 295; Berdmore's, 289; Black, Common, 288; Bower's, 287; Confucian, 289; Cricetine Mole, 257; Edwards' 286; Howell's, 294; Hume's, 281; Large-toothed, 283; Lesser, Spiny-haired, 291; Little Burmese, 292; Malaysian Field, 290; Millard's, 280; Mole, 257; Müller's, 287; Norway, 294; Old World Water, 265; Rajah, 290; Roof, 288, 293; Speckled Mountain, 292; Spiny, Lesser, 291, Short-tailed, 292, Tufted-tailed, 291; Spiny Haired, 290; True, 283; Whitehead's, 292; Woolly-haired, 288
- Reindeer, 347
- Rhesus Monkeys, 132
- Rhinoceroses, 351; Asiatic, 352; Greater one-horned, 353; Javan, 354; Lesser one-horned, 354; Sumatran two-horned, 352
- Rousettes, 71
- Sable, 146
- Sambar Deer, 339
- Scaly Anteater, 112
- Serow, 322; Eastern, 323; Formosan, 324; Japanese, 324; Southern, 323; White-maned, 323
- Sewellel, 211
- Sheep, 326; American, 327; East Asiatic, 327
- Shrew Moles, 40
- Shrews, 45; Asiatic Short-tailed, 63; Himalayan Water, 64; Japanese Water, 64; Kastschenko's, 54; Old World Water, 56; Oriental Short-tailed, 56; Red-toothed, 46; Southern Long-tailed, 52; Tibetan Water, 64; Web-footed, 64; White-toothed, 57
- Siamang, 138
- Slow Lorises, 120
- Squirrels, 211, 212; Eurasian, 212; Flying, 239; Giant, 215; Giant, Hip-marked, 218, Long-tailed, 216, Pallid, 217; Ground, 235; Ground, Dahurian, 236, Eversmann's, 236; Hoary-bellied, 228; Multi-striped Palm, 214; Plantain, 226; Rock, David's, 233, Forrest's, 234; Three-striped Palm, 214; Tree, 219; Tree, Black-banded, 226, Bushy-tailed, 227, Chinese Striped, 229, Cockerell's, 224, Gray-handed, 225, Gray-headed, 225, Lesser, 227, Long-nosed, Continental, 230, Long-nosed, Lokriah, 231, Long-nosed, Perny's, 230, Long-nosed, Red-cheeked, 231, Long-nosed, Sunda Islands, 233, Loew's, 227, Macclelland's, 299, Oriental, 219, Plantain, 226, Prevost's, 219, Red-

- billed, 220, Russet, 223, Siamese Black, 224, Siamese Black-backed, 224, Siamese White, 224, Sladen's, 222, Striped, 229, Striped-bellied, 228, Yellow-handed, 221; True, 212
 Stoats, 148
 Susliks, 235

 Takin, 325
 Tapirs, 349; Malay, 350
 Thamin, 342
 Tigers, 187, 193; Manchurian, 194
 Toddy Cats, 176
 Tree Shrews, 31, 32; Bridled, 32; Pen-tailed, 31; Pigmy, 32
 Tsine, 319

 Ungulates, 309; Even-toed, 309; Odd-toed, 349

 Voles, 259; Duke of Bedford's, 268
 Wapiti, 344, 346
 Water Buffalo, 318
 Weasels, 148; Asiatic Alpine, 149; Bare-footed, 150; Duke of Bedford's, 151; Least, 150; Long-tailed, 148; Malay, 150; Short-tailed, 150; Siberian, 149; Snow, 151; Striped-backed, 150; Tonkin, 150; Yellow, 149
 Whales, 195
 Wolverine, 144
 Wolves, 159, 160; Chinese, 160; Siberian, 160; South Asiatic, 160
 Woodchucks, 237

 Yak, 318
 Zebu, 322

INDEX OF SCIENTIFIC NAMES

- Acanthion*, 303
Aeluroidea, 171
Aeretes, 246
Aeromys, 246
Ailuropoda, 164
Ailuropodidae, 164
Ailurus, 164
Alces, 346
Allactaga, 301
Alopex, 158
Alticola, 265
Amblyonyx, 157
Amblyotus, 90
Anourosorex, 63
Aplodontia, 211
Apodemus, 281
Arctogalidia, 180
Arctoidea, 144
Arctonyx, 154
Artiodactyla, 309
Arvicola, 265
Aschizomys, 263
Aselliscus, 111
Asiocricetus, 257
Atherurus, 302

Bandicota, 294
Barbastella, 88
Belomys, 247
Bibos, 318
Blarinella, 56
Bovidae, 316
Bubalus, 318
Budorcas, 325

Callosciurus, 219
Calomyscus, 255
Canidae, 158
Canis, 159
Cannomys, 270
Canoidea, 144

Capreolus, 336
Capricornis, 322
Caprolagus, 203
Carnivora, 142
Castor, 252
Castoridae, 252
Castoroidea, 252
Cercopithecidae, 131
Cercopithecoidea, 122
Cervidae, 328
Cervus, 337, 344
Cetacea, 195
Chacrephon, 97
Charronia, 146
Cheiromeles, 97
Chimarrogale, 64
Chiomyscus, 277
Chiropodomys, 275
Chiroptera, 66
Chodsigoa, 54
Chrotogale, 181
Chrysopteron, 83
Citellus, 235
Clethrionomys, 262
Coelops, 112
Colobidae, 122
Cricetidae, 254
Cricetiscus, 256
Cricetulus, 255
Crocidura, 60
Cuon, 161
Cynocephalidae, 115
Cynocephalus, 117
Cynogale, 182
Cynopterus, 74

Dacnomys, 283
Daimonelix, 253
Delphinidae, 199
Dendrogale, 32
Dermoptera, 115

- Dicrostonyx*, 259
 Dipodidae, 300
 Dipodoidea, 298
Discopus, 89
Dremomys, 230
Dugong, 308
Dymecodon, 41

Echino-sorex, 35
Elaphodus, 332
Elaphurus, 342
 Elephantidae, 305
Elephas, 306
Ellobius, 268
 Emballonura, 99
 Emballonuridae, 99
Eothenomys, 263
Eptesicus, 90
 Erinaceidae, 34
Erinaceus, 38
Euroscaptor, 43
Eutamias, 234

 Felidae, 187
Felis, 188
 Feloidea, 171

 Gliridae, 296
 Gliroidea, 296
Glirulus, 297
Golunda, 280
Gulo, 144
Gunomys, 295

Hadromys, 281
Habalomys, 276
Harpiocephalus, 95
Helarctos, 170
Helictis, 151
Hemicchinus, 38
Hemigalus, 181
Herpestes, 184
 Herpestidae, 183
Hesperoptenus, 89
Hipposideros, 108
Hydropotes, 331
Hylaphus, 338
Hylobates, 138
 Hylobatidae, 137
Hylomys, 36

Hylopetes, 248
 Hystricidae, 302
 Hystricomorpha, 302
Hystrix, 303

Ia, 88
 Insectivora, 30
Iomys, 251
Isotus, 83

Kerivoula, 95

 Lagomorpha, 201
Lagurus, 268
Lariscus, 214
Leggada, 279
Leggadilla, 280
Lemmus, 260
 Leporidae, 201
Lepus, 203
Leuconoë, 84
Lipotes, 198
Lutra, 155
Lutrogale, 157
Lynx, 191
Lyroderma, 101
Lyssodes, 135

Macaca, 131
Manis, 114
Marmota, 237
Martes, 145
Megaderma, 101
 Megadermidae, 100
Meles, 153
Melursus, 168
Menctes, 214
Micromys, 273
Microtus, 266, 267
Millardia, 280
Miniopterus, 92
Mogera, 44
 Molossidae, 96
Moschus, 328
Muntiacus, 333
 Muridae, 271
Murina, 94
 Muroidea, 254
Mus, 277
Mustela, 148

- Mustelidae, 144
 Myomorpha, 253
Myopus, 260
Myospalax, 257
Myotis, 81, 83

Naemorhedus, 324
Nasillus, 41
Nectogale, 64
Neoschizomys, 263
Neodon, 267
Neofelis, 191
Neomeris, 200
Neomys, 56
Neotetrachus, 37
Nomarthra, 112
Nyctalus, 87
Nyctereutes, 162
 Nycteridae, 102
Nycteris, 102
Nycticebus, 120
Nyctinomus, 98
Nyctocleptes, 270

Ochotona, 208
 Ochotonidae, 207
Ogotoma, 208
Olisthomys, 250
Orcella, 200
Oryctolagus, 202
Ovis, 326

Pachyotus, 91
Paguma, 178
Panthera, 193
Paradoxurus, 176
Paramanis, 115
Parascaptor, 44
Pardofelis, 190
Perissodactyla, 349
Petaurillus, 251
Petaurista, 240
Petinomys, 250
Phaiomys, 266
Phodopus, 257
Pika, 209
Pipistrellus, 86
Pithecheir, 276
Pitymys, 266
 Platacanthomyidae, 297
Platacanthomys, 298
Platanista, 199
 Platanistidae, 197
Platycranius, 265
Plecotus, 85
Poephagus, 318
Presbytis, 127
Presbytiscus, 130
Prionailurus, 189
Prionodon, 172
 Proboscidea, 305
 Procyonidae, 163
Prodocas, 317
Procdromys, 268
Profelis, 190
 Pteromyidae, 239
Pteromys, 247
Pteromyscus, 247
Pteropus, 71
Ptilocercus, 31
Putorius, 147
Pygathrix, 127

Rangifer, 347
Rattus, 283
Ratufa, 215
Rhinoceros, 352
 Rhinolophidae, 102
Rhinolophus, 104
Rhinopithecus, 128
Rhinopoma, 99
 Rhinopomidae, 98
Rhinosciurus, 233
 Rhizomyidae, 269
Rhizomys, 269
Rhynchonax, 41
Rickettia, 84
 Rodentia, 210
Rousettus, 71
Rucervus, 342
Rupestes, 234
Rusa, 339

Scapanulus, 45
Scaptochirus, 45
Scaptonyx, 42
 Sciuridae, 212
 Sciuroidea, 211
 Sciuromorpha, 211
Sciurotamias, 233

- Sciurus*, 212
Scotomanes, 91
Scotophilus, 91
Selanarctos, 169
Selysius, 82
Sicista, 299
Sika, 340
Sirenia, 308
Sorex, 47
Soricidae, 45
Soriculus, 52
Sotalia, 200
Stenocranius, 267
Suidae, 310
Suncus, 58
Sus, 311
- Talpa*, 42
Talpidae, 39
Tamioops, 229
Taphozous, 100
Tapiridae, 349
Tapirus, 350
Thalassarctos, 166
Tomeutes, 228
Trachypithecus, 123
- Tragulidae, 315
Tragulus, 315
Trichys, 303
Trogopterus, 246
Tupaia, 32
Tupaiaidae, 31
Tylonycteris, 89
Typhlomys, 297
- Uncia*, 194
Uropsilus, 41
Urotrichus, 41
Ursidae, 166
Ursus, 167
- Vandeleuria*, 274
Vernaya, 274
Vespertilio, 90
Vespertilionidae, 79
Viverra, 174
Viverricula, 175
Viverridae, 171
Vulpes, 158
- Zapodidae, 299
Zapus, 300

