The Conservation of Protected Large mammals in Thailand

Pong Leng-EE

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THE CONSERVATION OF PROTECTED LARGE MAMMALS IN THAILAND

by

Pong Leng-EE

BS.F. Kasetsart University, Bangkok, Thailand, 1960

Presented in partial fulfillment of the requirements for
the degree of

Master of Science in Wildlife Management

UNIVERSITY OF MONTANA

1966

For Prof. Behan, with
best wishes and good bye,

Pong Leng-EE

July 6 '66

Approved by:

Chairman, Board of Examiners

Dean, Graduate School

Date
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INTRODUCTION

Of the approximate one million species of creatures presently known in the animal kingdom, thirty-five hundred are mammals. They are the most highly specialized, efficient, diversified, and fascinating living things (Cahalane, 1947). The name "mammal" is given to backboned animals whose young are nourished by milk secreted from the mammary gland of the mother. They are essentially warm-blooded, and more or less hairy.

In this paper, the term "protected large mammals" means those large mammals of Thailand which are currently protected by law. Based on their present abundance and strictness of such laws, these mammals can be classified as endangered or rare species, and common species. The former include Javan rhinoceros, Sumatran rhinoceros, kouprey, wild buffalo, hog-deer, Eld's deer, Schomburgk's deer (believed to be extinct), serow, and goral. The latter group is represented by gaur, banteng, sambar deer, barking deer, chevrotain, tapir, and wild elephant.

The Kingdom of Thailand is changing rapidly. Its increasing human population has resulted in over-hunting, and an increase in the intensity of land use. Some species of wild animals have become extinct, a few are on the verge of extinction, and many have been greatly reduced.

Attempts have been made in this paper to review the literature, to bring together what is known about the life history, ecology, biology, and management of these mammals, with a view to providing this information to game managers, game biologists, and other related field workers who are interested in conserving the wild animals of Thailand. Plans and suggestions based on general facts that seem applicable to future management are also proposed.
I. THAILAND IN RELATION TO WILDLIFE CONSERVATION

It is basic to the conservation of any wildlife species to have an understanding of its ecology. A general knowledge of habitat conditions is essential for the development of wildlife conservation plans. Part of this paper, consequently, is devoted to a consideration of the environment in which the wild mammals of Thailand exist.

Geography of the Kingdom of Thailand

The Kingdom of Thailand is situated between the fifth and twenty-first parallels, north latitude, and between the ninety-seventh and one-hundred-sixth meridians, east longitude. It is bounded to the west and northwest by Burma, and to the east and northeast by Cambodia and Laos respectively. The peninsular part is bounded to the west by the Indian Ocean, to the east by the Gulf of Thailand, and to the south by Malaysia. The total area of the country is approximately 200,148 square miles, of which 51.50 percent is forested land, 20.03 percent farmland; 0.40 percent swamp land; and 28.07 percent other unclassified land (highways, railroads, airports, vacant unused land, rivers, etc. (Ministry of Agriculture; 1961). All forested land, with the exception of some mangrove forest plantations and farm woodlots, is nationally owned. Farmlands, particularly rice fields, the habitat of waterfowl during the rainy season, are mostly owned by private individuals. A land utilization of Thailand is illustrated in Figure 1.

Geographically, Thailand is divided into four major regions which are basically delineated by the pattern of rivers and mountain ranges.

1. The Central Plain. This is the largest region, encompassing about 36 percent of the whole country. Of its total area, 26-38 percent is classified as farm land; 50 percent forested and grazing land; 0.22
Fig. 1 Land utilization of Thailand as of 1961 (after the Ministry of Agriculture, 1961)
percent swamp land; and 23 percent unclassified land (Ministry of Agriculture, 1963). This region is characterized by the Chao Phya Basin and alluvial soils of paddy fields.

2. The Northeastern Region. This region is the second largest in area, occupying about 33 percent of the country total. Much of it is a parched and relatively unproductive plateau unsuitable for agriculture. It is classified as 21 percent farm land; 40 percent forested and grazing; 0.37 percent swamp land; and 38 percent unclassified lands (Ministry of Agriculture, 1963). The high Korat Plateau is a typical feature of the region.

3. The Northern Region. The northern region, about 17 percent of the country's area, is characterized by mountain ranges, mixed deciduous and evergreen forests, rivers, alluvial valleys, fertile soils, good irrigation, and a comfortable climate. Its land types consist of 7 percent farm-land; 76 percent forested and grazing; 0.03 percent swamp land; and 17 percent unclassified lands (Ministry of Agriculture, 1963).

4. The Southern Region. This is the smallest in area, covering only 14 percent of the whole country. Mountain ranges run southward paralleling the west coast portion. The sandy soil and frequent rains make it ideal for rubber plantations, coconut, and fruit crop farming (Ministry of Agriculture, 1961). About 31 percent of its total area is farmland; 53 percent forested and grazing; 1 percent swamp land; and 15 percent unclassified (Ministry of Agriculture, 1963). Figure 2 shows the location of each administrative region and provinces.

The relatively high percentage of forested and grazing lands in each of these four regions suggests that there is still considerable habitat for wild animals.
Fig. 2 Location of the administrative regions and provinces of Thailand.
Climate

The climate of Thailand is very regular. Its major pattern is imposed by seasonal monsoon and it is modified by the local topography. According to Banijbhatana (1957), two types of climate are recognized: the tropical rain, and the tropical savannah. The former type is characterized by uniformly high temperature and heavy rainfall almost all year round, with no distinct season. The amount of annual rainfall is about 80 inches or above. This type of climate is typically found in the southern and eastern portions of the country. The tropical savannah climate is distinguished by less precipitation and a distinction between wet and dry seasons. This climatic type is considerably modified by local altitude. It is sometimes called a mountain climate. The wet season, the main season of plant growth, extends from about May to September or October, while the dry season falls between October to early May. A record of annual rainfall, annual temperature, and humidity for each region during the period of 1940-1950 is summarized in Appendix A.

Forest Types and Their Soils

Forests are broadly classified as evergreen and deciduous. The evergreen type occupies about 30 percent of the whole forested area and is subdivided into four categories, namely tropical evergreen, hill evergreen, mangrove, and coniferous or pine forests. The deciduous type covers about 70 percent of the total forested land and contains two distinct categories: mixed-deciduous with and without teak, and deciduous dipterocarp forests.

Unlike the climate, soils of Thailand are highly diversified. This is primarily the result of the wide range of parent materials from which the soils are derived. Formation of each forest type is influenced by
many complicated factors. Samapuddhi (1963, p. 64) says

"... the factors leading to the formation of the various forest types could not be any single value of any one property of the soil, but rather, it requires many or a combination of many physical and chemical characters blended together in a specific way. Further, the soil relief, elevation (evident in the case of Hill Evergreen, Pine, and Mangrove Forests), precipitation, and climatic conditions might still play even a more important role than the soil itself in the shaping up of the different forest types."

For more details see Appendix B.

II. BIOTIC ZONATION

Based on variations in climate, soil, vegetation, physiography and geology, four biotic zones are proposed.

1. The Central Valley. This area is characterized by a basic variety of heavy dark clays suitable for rice cultivation; superimposed upon these by the Chao Phya floods are deposits of fine sandy and silty soils. Dry evergreen trees predominate in the area where the forests have not been opened for agriculture. The topography of this area is, in general, flat and low in elevation.

2. The North and West Highlands. This zone possesses dark clay soils and alluvial deposits along the river valleys. The area is represented by high elevation, mountain ranges, mixed-deciduous and coniferous forests, and tropical savannah climate.

3. The Korat Plateau. This biotic zone is characterized by a high plateau, sandy loam soils abnormally low in plant nutrients, relatively dry climate, and the open dry dipterocarp forest.

4. The Southeast Coast and the Peninsula South. This zone is high in humidity and precipitation. Dense vegetation of tropical evergreen trees predominates in this zone. Soils vary from deep reddish
Fig. 3 Biotic zones of Thailand (based on variations in climate, soil, vegetation, physiography, and geology)

clay in the southeast coast to the poor sandy loam and clay loam in the southern portion of the Peninsula.

Figure 3 demonstrates this biotic classification.
THE PEOPLE OF THAILAND AS THEY AFFECT THE CONSERVATION OF WILDLIFE

Thailand's 1960 census totalled approximately 26,257,916 people* (about 131 per square mile), of which 21.50 percent, 34.24 percent, 31.50 percent, and 12.96 percent are distributed in the northern, northeastern, central, and southern regions respectively (National Economic Development Board, 1962). Density of the population by Amphurs** (districts) is illustrated in Figure 4. The human population is increasing about 2.8 percent each year; in 1961 it totalled 29,700,000.

The 1960 census also revealed that 71.8 percent of the Thai people were literate (see Appendix C).

In addition to general public education, principally administered by the Ministry of Education, Thailand has two other particular institutions directly offering education in Forestry and Natural Resource Conservation. One is the School of Forestry at Kasetsart University, where curricula of three and five years leading to the diploma and bachelor's degree in Forestry respectively are offered. The other is the Forestry Training School, Prae, conducted by the Royal Forest Department. It is a two-year ranger course arranged for qualified junior staff or those who hold the high school certificate.

---

*This figure excludes nomadic hill-tribes and all foreigners.

**Thailand is administratively composed of 71 provinces; each province contains a different number of Amphurs (Districts). As of 1964 there are 1,445 districts and 1,49 subdistricts in the country.
Fig. 4 Thai population density by Amphurs (after the National Economic Development Board, 1962)
The main religion in Thailand is Buddhism; approximately 93.6 percent of the total population are Buddhists. The rest of the population, 3.9 percent, 0.6 percent, 0.1 percent, 1.7 percent, and 0.1 percent are Moslems, Christians, Hindus, Confucianists, and others, respectively (National Economic Development Board, 1962). The Buddhist injunctions against killing animals influences only women and people over sixty years of age.

A study of Thailand's economic situation during the past ten years reveals that the country enjoyed a satisfactory rate of economic growth during that period. The national income increased at the rate of approximately 5 percent a year, permitting an annual rise of more than 2 percent in per capita income (National Economic Development Board, 1964). This agency also reports that although the economy is growing, some basic economic problems exist, such as the rapid rate of population growth, the danger of unemployment, low agricultural and industrial productivity, high cost of capital, and the growing need for conserving natural resources. Unemployment, however, has not yet become a serious problem in Thailand, where a vast majority of the people still live in the rural areas. Only about 12.7 percent of the Thai people live in the urban area.

IV. WILDLIFE LAW AND WILDLIFE CONSERVATION

History of Wildlife Conservation

As in the case of other tropical countries, Thailand's wildlife is diversified, but most species are not very abundant. Before the Second World War, it was said that wild animals were still plentiful in every part of the country. Soon after the war, the impact of a rapidly increasing human population, declining economic wealth, and greater numbers of
firearms and vehicles resulted in both game populations and their habitats being severely reduced. At the present time numbers of wildlife species have been reduced to very low levels of population.

Before 1960 the only game law in existence was the Wild Elephant Act of 1921. This act, however, was limited in its scope and provided protection only to the wild elephant. However, the idea of protecting some important wild animals is not new for Thailand. In 1931 the Siam Society recommended that the cows of wild buffalo and some other big mammals be protected (Harper, 1945). Unfortunately such proposals failed to find the support necessary to become law.

When it appeared that many wildlife species were being threatened with extinction, the Royal Forest Department and some societies, such as the Nature Reserve Society, proposed to enact the present wildlife law. Finally, because of the understanding attitudes of the government in the conservation of natural resources, the new game law known as the Wild Animal Preservation and Protection Act B.E. 2503 was passed in 1960 and came into effect in January 1, 1961.

From Leopold's sequence of game management point of view, the present wildlife conservation of Thailand is falling into the first and third stages. The second stage, predator control, has not been undertaken, unless the attention paid to protection against poachers can be so considered.

Leopold (1932) gives the following sequence of game management history:
1. Restriction of hunting
2. Predator control
3. Reservation of game lands (Parks, forests, refuges, etc.)
4. Artificial replenishment (restocking, game farming)
5. Environmental controls (of food, cover, disease, etc.)
The Present Game Law and its Enforcement

According to the act, two major groups of wild animals are established: the reserved and the protected. The reserved wild animals are those animals which are considered rare or endangered; they are not allowed to be hunted either for sport or meat. The protected group is composed of two categories. The killing of the first category, except for scientific purposes, is prohibited, while hunting of the second can be done by securing a hunting license authorized by an appointed official. This act is further described in Appendix D.

Since the law was enacted, the Royal Forest Department, which is directly in charge of controlling wild animals, has carried out the law enforcement and wildlife conservation as shown in the table below.

Table 1. Records of annual licenses, special permits, number of arrests for violations, and establishment of game sanctuaries.

<table>
<thead>
<tr>
<th>Year</th>
<th>Licenses Issued</th>
<th>Arreets For Violations</th>
<th>Sanctuary Establishment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hunting</td>
<td>Trading Animals</td>
<td>Trading Meat</td>
</tr>
<tr>
<td>1962</td>
<td>180</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>1963</td>
<td>961</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>1964</td>
<td>844</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>1965</td>
<td>747*</td>
<td>17</td>
<td>--</td>
</tr>
<tr>
<td>Total</td>
<td>2732</td>
<td>54</td>
<td>16</td>
</tr>
</tbody>
</table>

*All big game except the chevrotain have been temporarily closed to hunting since 1965.
**Closed to trading of all big game meat.

The game law is generally enforced by many authorities from different government agencies. They are:

1) All police officials of the Police Department, Ministry of In-
terior, are directly responsible for the enforcement of every kind of law in the country including the game law.

2) All forest police officials supervised by the Forest Police Division, Royal Forest Department, are responsible for the enforcement of all the forestry laws including the game law.

3) The forest officials who are empowered to enforce the game law by the Minister of Agriculture.

4) All provincial governors and district officers (nai amphur) are empowered to enforce the game law within the province or district respectively. These officials belong to the Ministry of Interior, but they are empowered to enforce this law by the Minister of Agriculture.

Wildlife Administration

The Royal Forest Department is included in the Ministry of Agriculture. Its present administrative formulation consists of central and territorial administrations. The former is composed of six divisions and many other equivalent offices. Each division is subdivided into sections. The section of wildlife conservation was established within the Division of Silviculture in 1961, a year after the Wildlife Act was passed.

The territorial administration consists of 61 Provincial Forest Offices and 382 Township Forest Offices. Both administrative formulations are explained in detail and shown in Appendix E.

The Royal Forest Department (1963) reports that there were 3,244 forest personnel employed by the Department in 1963, which could be classified by official ranks as: 44 special-grade, 34 first-grade, 160 second grade, 459 third-grade, 1,343 subordinates, and 1,244 temporary employees. As of 1965, there were a total of 30 personnel working in
the Wildlife Conservation Section

Table 2. Record of personnel employed by the Section of Wildlife Conservation during the period of 1962-1965.

Personnel Employment by Ranks

<table>
<thead>
<tr>
<th>Year</th>
<th>Second Grade</th>
<th>Third Grade</th>
<th>Subordinates</th>
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<tbody>
<tr>
<td>1962</td>
<td>--</td>
<td>2</td>
<td>--</td>
</tr>
<tr>
<td>1963</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>1964</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>1965</td>
<td>2</td>
<td>5</td>
<td>4</td>
</tr>
</tbody>
</table>

V. LARGE MAMMALS AS CURRENTLY PROTECTED BY LAW

There are sixteen species of large mammals classified under six different families that are currently protected by law.

Family Rhinocerotidae

1. Javan rhinoceros  
2. Sumatran rhinoceros

Family Bovidae

1. Wild buffalo  
2. Kouprey  
3. Gaur  
4. Banteng  
5. Serow  
6. Goral

Family Cervidae

1. Eld's deer  
2. Hog-deer  
3. Schomburgk's deer  
4. Sambar deer  
5. Barking deer

Family Tragulidae

1. Mouse deer or chevrotain

Family Tapiridae

1. Malay tapir

Family Elephantidae

1. Wild Asiatic elephant

These mammals will be discussed in the following sections.
RHINOCEROTIDAE

Introduction: There are five living species of this family, of which two are native to Africa and three to Asia. According to Shebbeare (1953), the following species of four genera are recognized:

1. Rhinoceros unicornis (the great one-horned or Indian rhinoceros).
2. Rhinoceros sondaicus (the smaller one-horned or Javan Rhinoceros).
3. Dicerorhinus (Didermocerus) sumatrensis (the Asiatic two-horned or Sumatran Rhinoceros).
4. Dicerorhinus bicornis (the black rhinoceros).
5. Ceratotherium simum (the white or square-lipped rhinoceros).

The First World Conference on National Parks, held in Seattle, Washington in 1962, reported the approximate populations of all of the rhinoceroses as 11,300-13,500 for the black, 2,500-3,500 for the white, 600 for the Great Indian, 100-170 for the Sumatran, and 24-50 for the Javan forms (Adams, 1964).

Gee (1958 in Crandall, 1964) estimates a total of only 400 for the Indian rhinoceros in India and 35 in Nepal. Stracey (1957 in Crandall, 1964) quotes the official figure for the latter area as 500 - 600. The more recent report made by Gee (1959 in Crandall, 1964) states that there are 300 Indian rhinos in Nepal.

The Javan rhino appears now to be represented only by 30 - 40 animals living in the Adjung Kulon Reservation, Western Java (Boyle, 1959) and one or two individuals in Burma (Milton, 1961). According to Street (1961), its total population ranges from 24 - 80.

The Sumatran rhino is at present known to survive only in Burma where Prater (1965) estimates a total population of 21 - 25 currently
existing in the areas of Shwe-U-Duang, Arakan, the Pegu Yumas, Kahlilu,
also gives a total number of about 20 - 30 in Burma.

Characteristics of all five species are compared in the table below.

Table 3. Notes on all five species of rhinoceros (after Metcalfe, 1961).

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
<th>Number and Length of Horns</th>
<th>Height at Shoulder</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Square-lipped or white Rhinoceros</td>
<td>Ceratotherium simus</td>
<td>two; anterior up to over 50&quot;</td>
<td>6' (second largest land animal)</td>
<td>Africa; confined to Zu-luland Reserves and small area west of upper Nile</td>
</tr>
<tr>
<td>Black or Prehensile-lipped Rhinoceros</td>
<td>Diceros bicornis</td>
<td>two; anterior up to over 50&quot;</td>
<td>6' (third largest land animal)</td>
<td>Africa</td>
</tr>
<tr>
<td>Great Indian Rhinoceros, or Indian Rhinoceros, or Great One-horned Rhinoceros</td>
<td>Rhinoceros unicornis</td>
<td>one; up to 24&quot;, average 10&quot;</td>
<td>6'</td>
<td>India and Nepal</td>
</tr>
<tr>
<td>Javan or Lesser One-horned Rhinoceros</td>
<td>Rhinoceros sondaicus</td>
<td>one; about 10&quot; long. Female horn extremely small or totally lacking</td>
<td>5'</td>
<td>Java and Malaya (?) (probably Burma)</td>
</tr>
<tr>
<td>Sumatran Rhinoceros</td>
<td>Dicerorhinus sumatrensis</td>
<td>two; anterior up to 32&quot; long, average 10&quot;, posterior horn small</td>
<td>4'</td>
<td>Burma, Thailand, Malaya, Sumatra, Borneo, Cambodia, Laos, and Vietnam</td>
</tr>
</tbody>
</table>
Of the three living Asiatic Rhinoceroses, two are indigenous to Thailand—the Javan and the Sumatran. This paper will deal only with these two forms.

**Javan Rhinoceros or Smaller One-horned Rhinoceros (Rhinoceros sondaicus)**

**Worldwide Distribution.** Formerly this rhino had an extensive range including Sikkim, Bengal, Assam, Burma, Thailand, Indo-China, Malaysia, and Sumatra, but may now be restricted entirely to Java, where no more than four dozen individuals survive. A total number of only 66 living Javan rhinos was reported by Loch (1937). His estimate is shown in the following table.

*Includes Laos, Cambodia, and North and South Vietnam*
Fig. 6 Probable distributions of Javan and Sumatran rhinos.
Table 4. Approximate estimate of the number of living specimens of *Rhinoceros sondaicus* in about 1935. (From Lech, C.W. 1937).

<table>
<thead>
<tr>
<th>Country</th>
<th>Number Alive</th>
<th>Locality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bengal</td>
<td>extinct</td>
<td></td>
</tr>
<tr>
<td>Assam</td>
<td>probably extinct</td>
<td></td>
</tr>
<tr>
<td>Burma</td>
<td>4</td>
<td>Kahilu Game Sanctuary</td>
</tr>
<tr>
<td>Fed. Malay States*</td>
<td>3</td>
<td>Erong &amp; Chawang Area, Perak Lekir District, Perak</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Kuala Selangor-Bernam River District, Selangor</td>
</tr>
<tr>
<td>Sumatra</td>
<td>about 6</td>
<td>Palambang</td>
</tr>
<tr>
<td>Java</td>
<td>about 6</td>
<td>S. of Tasikmalaja</td>
</tr>
<tr>
<td></td>
<td>about 6</td>
<td>S. of Bantam</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Cedjoengkoelen Peninsula</td>
</tr>
<tr>
<td>Siam**</td>
<td>8</td>
<td>Siamese Laos near Mekhong</td>
</tr>
<tr>
<td>Indo-China</td>
<td>2</td>
<td>Cambodia</td>
</tr>
<tr>
<td></td>
<td>about 6</td>
<td>Northern Anam</td>
</tr>
<tr>
<td></td>
<td>about 6</td>
<td>Luang Prabang District, Northern Laos</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Tonkin</td>
</tr>
<tr>
<td>Borneo</td>
<td>probably non-existent</td>
<td>South-Laos</td>
</tr>
<tr>
<td>Yunan and Kwang-si</td>
<td>no record</td>
<td></td>
</tr>
</tbody>
</table>

*Now Malaysia

**Thailand
Although Loch gave a total population of eight specimens living in Thailand near the Mekhong River during his time (1937), it is very doubtful if such animals still exist in any part of the country. An intensive investigation of its possible occurrence in this country is, however, highly desirable.

Habitat Requirements. The ideal habitat of the Javan rhinoceros is considered an area of dense forest with thick undergrowth where a marsh or bog is available for the animal to wallow and drink. Altitude seems unimportant since the animal can occur over wide ranges in elevations from 100 feet to 3,000 feet above sea level. Barbour and Allen (1932, p. 145-46) describe Javan rhinoceros in Burma as

"... having occurred only in certain areas of hilly country in Upper and Lower Burma, preferring this type of terrain to the lowlands, and frequenting even mountainous country."

It is more an inhabitant of tree forest than of grassland (Prater, 1965). Loch (1937, p. 142) quotes the letter of M. E. M. de Villa of Hanoi, written to the "Straits Times" in March, 1932, concerning the Javan Rhinoceros in Indo-China. He said, in part,

"... The animal lives in marshy bush and thick forest undergrowth, where the rattan cane makes fast walking impossible and tracking very difficult and dangerous... I am not sure about the elevation preferred by this animal. It is known and hunted on the Dar Lac Plateau at an elevation of about 3,000 feet, and last year some natives invited me to hunt a party of four rhinos near Cua Rac, about 100 feet above sea level. Rhinoceroses and elephants appear to be found in the same hunting country, and both are met with between Kratie and Sung Treng, south of Saravane (in Cambodia, to the east of the Mekhong) and in many places in Laos. On the west side of the Mekhong, south of Cuben*, in Siamese Laos, there is the Pass of Elephants and Rhinoceros. The horn and feet of a rhinoceros are worth about $2,000 which probably explains why so few specimens find their way to museums."

DeVos and Hoogerwerf (1950) studied the Javan rhinoceros at Oedjong Koelen (apparently Adjung Kulon game reserve, Java). They found that the

*A border province in the Northeastern region of Thailand
vegetation of this area (65,000 acres) consists mainly of second-growth jungle. The area is partially covered by a savannah landscape dotted with palm trees and, to a smaller extent, by bamboo thickets. However, Prater (1965) states that its usual habitat is forested hill country where it has been found at elevations as high as 7,000 feet. It seems to me that this animal primarily prefers undisturbed areas of dense forest where food and water are available. The animal is probably found in the high forested hills as mentioned by Prater (1965) due to the fact that much of the ideal habitat in the lower area is disturbed by human activities, such as logging, cultivation, and settlement. These factors have presumably forced the animal to retreat up to the more inaccessible area of the hills.

**Foods and Habits.** The Javan rhinoceros is a browser, eating many kinds of leaves, twigs, some wild fruits, mangoes and figs. DeVos and Heegerwerf (1950, p. 298, and 332) write of this rhino in the Adjung Kulon game reserve:

"The rhines move through the reserve more or less in a criss-cross fashion, although tunnels are made in the vegetation in places that are often frequented. During their travels, the animals browse on the leaves and twigs of different trees and shrubs, and grasses are also eaten. The colossuses sometimes break or uproot entire trees when feeding.

The Javanese rhino is more nocturnal than diurnal in habits. During the day the animal seeks cover in the dense jungle vegetation, while at night, it feeds and washes itself in some of the numerous mud-wallows present in the area. Bathing, however, takes place in the daytime, and is apparently a favorite pastime. While in the wallows, the animal rolls over and over. Sometimes it stays in such pools for hours at a stretch. After a bath, mud is rubbed off on the trees that surround a pool. Enormous dung heaps are produced, indicating the huge quantities of food digested . . ."

It is partial to water, especially streams with rocky or shingly beds, and it can swim very well (Barbour and Allen, 1932).

**Reproduction and Longevity.** The reproductive rate of the Javan rhin-
oceros is very low. Only one young is born to a cow every four or five years after gestation period of about eight months, and the calf is suckled for at least two years (DeVos and Hoogerwerf, 1950). Its life span is, however, relatively long. A record of over ten years longevity for a captive animal in the Zoological Gardens of London is given by Flower (1931), but Walker et al (1964), estimate that the Javan rhinoceros may have a life span of over fifty years.

**Sumatran Rhinoceros or Asiatic Two-Horned Rhinoceros**

(Didermocerus sumatrensis)

**Worldwide Distribution.** This rhinoceros formerly extended from the hill tracts of Assam, through the hill ranges of Tippera and Chittagong into Arakan and Burma, and thence into Thailand, Indo-China, Malaysia, Sumatra, and Borneo, but not Java (Prater, 1965). Now its range is limited only to Burma (see above).

At the present time, its survival in Thailand is doubtful, although there has been rumored that the animal still exists in the high forested-hill areas of the Thai-Burma frontier.

**Habitat Requirements.** Hubback (1939) made an intensive study on the Sumatran rhinoceros in a very remote part of the Malaysian jungle. He found that the country which this animal frequented was not high but extremely steep and covered with thorns of many sorts. The worst obstruction he found was a palm called by Malays "Chuchar" (*Calamus castaneus*). It grows in dense clumps from the ground to a height of about ten feet, and is very thorny. This palm jungle was interspersed with rattans of several varieties, and most of the terrain followed by the rhino when he was alarmed was along steep hillsides heavily wooded and covered with
Chuchar. He also found that this animal particularly favored the heads of narrow valleys, where it generally had well-used wallows, plenty of thick undergrowth, and precipitous sides to the valley so that it could have plenty of exercise. Its ideal habitat is a jungle so dense that a human can see nothing within five yards except a wall of forest, and so steep that a man cannot walk without holding onto something, but where everything around him is thorny. Another type of jungle favored by the Sumatran rhino is one interspersed with the large bamboo (*Dendrocalamus giganteus*). It seems to me that the habitat of Sumatran rhinos is usually higher in altitude than that of the Javan form.

**Food and Habits.** Like the Javan form, the Sumatran rhinoceros is a browser. Its foods include the small branches, twigs, and leaves of certain trees. Some kinds of wild fruit are also eaten. Hubback (1939) observed that this animal eats bark, lichen, or possibly the fruit of some fungus off a fallen tree; but the main food supply is from young trees that it breaks down. He also mentioned that whereas the other species of large wildlife in Malaysia will often find food in secondary jungle, the rhino invariably feeds only in virgin forest or very old regenerated jungle. From such evidence we can conclude that the Sumatran rhinoceros is a climax animal, depending entirely on the climax stage of succession in virgin or old regenerated forests. In the absence of better information, we assume here that the Javan rhinoceros is also a climax species, since its food and habitat requirements are quite similar to those of the Sumatran form.

The habits of both Sumatran and Javan rhinos are, in general, the same. The animals are fond of wallowing, walking, and swimming. Water
is very essential for their existence since both animals depend on it for wallowing and drinking. Normally the rhino wallows once or twice in twenty-four hours (more often in hot, dry weather). In travelling, it continually makes huge circles coming back on its tracks about once in two days (Hubback, 1939). According to the same author, this animal does not have any regular hours for feeding, although it frequently sleeps during the heat of the day.

Reproductive Rate and Longevity. Little is known about the breeding habits of this rhino, but it is known that one young per birth is the usual rate. The gestation period has been reported as seven to eight months (Walker et al, 1964). The animal can be bred successfully in captivity. The first recorded birth of a captive Sumatran rhino, born in the Zoological Gardens of Culcutta on January 30, 1889 (Sānyāl, 1892 in Crandall, 1964). One longevity is recorded at over thirty-two years (Flower, 1931 in Crandall, 1964).

Relations of Rhinoceroses to Land Use. Both Javan and Sumatran rhinos feed mainly on young trees that they break down, and feed only in the virgin forest, so they can cause damage to such forest regeneration. Considering the part of trees they eat: fallen fruits, small branches, bark and leaves, which are the most important for the security of trees, if these animals ever formed a dense population, the damage to the forest might be substantial. However, their numbers at present are extremely low. They apparently do not damage agriculture. Destruction of their habitats, though, by man for agriculture and settlement is a serious problem in the survival of the rhino.

Reasons for Population Decline. Causes of decline or extinction of
rhinos in Thailand are not well known. The animals have long been rare. However, information from neighboring countries shows that population declines can be attributed to several common causes. The major ones are:

1. **Commercial value.** Rhinos are considered very valuable creatures. Any kinds of articles made from hide, or even urine, are credited with antiseptic properties. In most of the oriental countries, particularly in China, horns of rhinos are in great demand; they are considered an aphrodisiac. Thirty years ago horns and feet were worth about $2,000 (Loch, 1937). Now the cost of horns varies from $105 to $210 per inch (Milton, 1961).

2. **Animal's habits.** Since it follows habitual paths about its territory, using the same muddy area to wallow, and the same place for defecating, the animal can be easily slaughtered by stalking at such places (Street, 1961).

3. **Method of hunting.** Commercial hunting of rhinos for their horns is usually done by inhumane or unsportsmanlike methods such as pits for, and set-guns. Even explosives have been used in killing these animals.

4. **Habitat destruction.** The habitat of rhinos is climax virgin forest, which is vulnerable to change by any kind of disturbance, including fires, logging, cultivation, and human settlement. These activities have resulted in the reduction of potential habitat of the animal.

5. **Disease.** Disease may be another important factor in the animal's decline. A prominent example is the case of the Indian rhinoceros at the Kaziranga Sanctuary, India, in the 1940's. Twenty-two rhinos died from anthrax contracted from domestic cattle around the Sanctuary (Street, 1961).

6. **Political effect.** A change in the government of the country where the rhinos existed can affect the security of these animals. This can be
exemplified by the incident which occurred in Nepal in 1951. A replacement of the former aristocratic government by a more popular democratic one has had the effect of stimulating poaching activities. At least seventy-two rhinoceroses were killed by poachers during that year, and the figure may well have been higher (Street, 1961).

**Census Methods.** A census method involving a "track count" is probably applicable to these animals. Their habits of defecating and wallowing in habitual places leaves characteristic traces. All the rhinoceroses with the exception of the white form are solitary, so the wallows used by the animals should correspond to the numbers of animals in the area.

The rhino's habits of wallowing are a great help to the tracker. Since the hide of this animal is always dirty and frequently rubs itself against the saplings or trees along the path, its presence is clearly marked.

In case the capture of these animals is necessary for marking, biological study, or transplantation, their localization and habitual movements favor successful trapping.

**Future Management.** Although the present survival of rhinos in Thailand is very doubtful, some plans should be made for the future if the animal's restoration is required. In order to restore these animals, some primary measures should be taken:

1. **Animal investigation.** An investigation of the exact occurrence at the present time is urgent. If they still survive, completely rigid protection must be placed on both the animals and their habitat. In such a situation the creation of a game sanctuary in that area is an immediate need.
2. If it appears from the investigation that these animals have been completely wiped out, a consideration should be given to reintroducing them from the neighboring countries, such as the Sumatran rhino from Burma, and Javan rhino from Java. It is, however, essential to have a thorough study on the ecology and biology of these animals before the re-introduction is undertaken.

Tentatively, a one-to-three-square-kilometer enclosure could be used to hold a pair of rhinos for familiarization in a suitable area where the animals are to be further released in the wild. This fenced area is a basic need for any newly introduced animals to get used to their new environment before they return to the wild.

BOVIDAE

Introduction. According to Morris (1964), there are currently 128 species of Bovids in the world. Six are native to Thailand: wild buffalo, kouprey, gaur, banteng, serow, and goral.

Wild Buffalo (Bubalus bubalis)

Worldwide Distribution. Bubalus bubalis is widely domesticated from Egypt to the Philippines and is also said to be found in the wild in Nepal, Bengal, and Assam. Some naturalists think that these are feral animals (Walker et al, 1964). In Thailand, Flower (1900 in Harper, 1945) refers to the buffalo as wild or feral in parts of Burma, Thailand, and Malay Peninsula. He had information of some near Pailin, Thailand, descendants of animals that ran wild about fifty years previously [about 1850 (Harper, 1945)]. Gyldenstolpe (1919 in Harper, 1945) states that some herds of semi-domesticated water buffaloes occur in Thailand, where they have been recorded from

*Bovids include cattle, antelopes, gazelles, goats, sheep.
Muang Pimai in eastern, from Pailin in southeastern, from Khea Sam Rei Yed in southwestern, and from the neighborhood of Raheng in Central Thailand, but really wild water buffaloes do not occur in this country. At present the semi-domesticated wild buffalo is believed to occur rarely in some parts of the country, particularly in the Tung Salaeng Luang National Park.

**Habitat Requirements.** Tall grass jungles interspersed with swamps provide the ideal habitat for wild buffaloes. Grass and jungles provide them food and shelter, while the swamps are vitally necessary for both wallowing and drinking. Lydekker (1891) says of the wild Indian buffalo that its haunts are the tall grass-jungles found in many parts of the plains of India, and generally in the neighborhood of swamps; but it may be also found more rarely in the open plains of short grass, or among low jungle, and occasionally even in forest. In the area of Tung Salaeng Luang National Park (Thailand), this animal is found in both the grassland and woodlands. Water is the most important factor in limiting its distribution.

**Food and Habits.** The wild buffalo is a grazer and ruminant. It feeds chiefly on grass, grazing in the mornings and evenings, and sometimes at night, lying by day in the high grass or dense patches of cover, or submerged in a marsh or pool (Prater, 1965). This animal associates in herds, often large ones. Blandford (1891) has seen fifty individuals together, and he has heard of much larger assemblages. It is active, and shy, but does not avoid the neighborhood of man or other animals. Unless harassed or wounded, this animal seldom attacks man (Walker et al., 1961). Wild buffaloes are usually pestered by insects but can escape by submerging in the water with only the nostrils emerging. The tiger seems to be a rather
Fig. 7 Comparative size and characteristics of gaur, banteng, kouprey, and wild buffalos (A, B, and D adapted from Prater, 1965; C from Ludeckens, 1965)
Fig. 8 Probable distributions of wild buffalo, kouprey, gaur, and banteng (based on the information in appendix H)
ineffective predator of buffalo, unless the prey is crippled, weak, or immature.

Reproductive Rate and Longevity. During the breeding season, a bull leads off several cows to form a small harem. One or two calves are usually born in March, April or May (Walker et al., 1964; Prater, 1965). But Prater says that calves have been observed in other months of the year. This author also states that wild buffaloes usually do not mate with domestic ones. Kenneth (1953) gives the gestation period as from 287-340 days. Brown (1936) gives a gestation period of ten months for a captive wild buffalo. The life span is given by Walker et al. (1964) at about eighteen years, but Flower (1931) records over twenty-nine years for the longevity of a captive animal which lived in the Adelaide Zoological Gardens.

Relation to Land Use. Wild buffalo habitat is not extensive in Thailand. In addition, it is frequently converted to agricultural use, especially rice-growing. Rice plants are their favorite food. When rice is planted, these animals will come to feed and sometimes take possession by keeping out the farm owners. They do great damage to the farmers' crops. The farmers would naturally like to have the buffalo wiped out from most of these areas. In Thailand, consequently, the wild buffalo is now considered a very rare animal. The solution to the problem of crop damage by this animal is still unknown. In the future, if the buffalo populations increase due to overprotection, such damage will increase. In such cases, buffalo populations can be controlled by carefully regulated hunting. However, the situation is still far from that point, because these animals at the present time are extremely rare.

Causes of Decline. A reduction in numbers of wild buffalo almost everywhere is caused by similar factors—poaching, habitat destruction,
and disease. In India, for instance, the animals decreased and became extinct in some localities, primarily because of slaughtering for hides and meat, which are saleable (Harper, 1945). Similarly, in Thailand, in the recent past before the game law was passed, hunting for meat by the natives wiped these animals out from many areas. Encroachment by man through cultivation of former buffalo habitat further restricted the buffalo population.

Among diseases, rinderpest is an important limiting factor of wild buffaloes. This disease was introduced into Vietnam in 1912, and again in 1920, and destroyed a great number of wild buffaloes (Harper, 1945).

**Census Methods.** Wild buffaloes prefer grassland habitat where water is available. Such habitat is fairly open, so that animals can be counted from an airplane. In this case the aerial strip count method might be effective. A total count is another method that should be helpful. Since the animals stay in a herd and are attached to the marshy or muddy areas, a count of all animals could be attempted when they are concentrated in such places.

**Future Management.** Presently wild buffaloes are strictly protected by law. This is the only effective measure to protect an endangered species. However, it is predictable that if the animals have been effectively protected for a certain length of time, their numbers can be expected to increase. In the future when their population has risen to a secure level, management should primarily aim at keeping the buffalo population at the carrying capacity of their range. As wild buffaloes are chiefly grazing animals, overpopulation can cause great damage to the range.

Population control through public hunting might be used to keep
their numbers at a level of the carrying capacity of range. In addition, sanctuaries are very useful for the conservation of wild buffaloes and should be established immediately in the areas where they still survive.

Kouprey (Bibos sauveti)

The kouprey is the last large mammal discovered in the world. It was first described and given a scientific name as Bibos sauveti by Professor Urbain in 1937 (Delano, 1965). This rare animal is native to northeast Cambodia, and some parts of Laos and Vietnam. Although it has been included in the list of reserved wild animals of Thailand and protected by law, its real existence there is still unverified. The kouprey is a very shy animal of the forest glades of northern Cambodia, where it has been seen by very few hunters (Urbain, 1937, in Harper, 1945). According to Coeledge (1964), this animal had estimated number of about 1,000 in 1952. By 1964, probably only 350 individuals remained. If this species occurs in Thailand, it will probably be in the general regions of the north or the east near the Lao and Cambodian borders.

There is a theory that the kouprey is a hybrid between some two of the four species of bosids living in the same region. They are: between gaur and banteng, or banteng and water buffalo, or banteng and domestic cattle (Delano, 1965). The reasons for this hypothesis are presented in Appendix F.

If this hypothesis is true, the kouprey may be a sterile animal because it is an offspring from the hybridization of the two different species. Thus, further research should be carried out regarding the breeding habits of the kouprey to test this hypothesis.

Gaur (Bibos gaurus)

Worldwide Distribution. Harper (1945) refers to three races of the
gaur distributed in India, Burma, Thailand, Malaysia, and Indo-China. The Indian race *Bubos g. gaurus* is native to India; the Burmese race *B. g. readi* ranges through Assam, Burma, Thailand, and Indo-China; and the Malayan race *B. g. hubbacki* occurs in the Malay Peninsula. In Thailand the Burmese race inhabits the northern and northwestern regions, but its southern range limit is not definitely known (Gyldenstolpe, 1919 in Harper, 1945). The Malayan race is believed to be found in southern Thailand. Its range includes the Malay peninsula and may extend northward to Tenasserim (Lydekker, 1913c).

**Habitat Requirements.** The gaur frequents altitudes of 750 to 1,800 meters and prefers rocky, forested hills, with open, grassy tablelands at the summit (Walker, et al 1964). It is essentially a forest animal. Ideal gaur habitat is composed of hilly forest in which salt licks, water, and pasture are available.

**Food and Habits.** Gaur feed principally on grass, including sprigs of bamboo, but will not touch bamboo leaves, although it eats the leaves, and even the bark, of other trees (Lydekker, 1916). It feeds in early morning and the evening, and spends the heat of the day cud-chewing in the thick cover. Young grasses which spring up after burning are its favorite food. Late in the dry season or early in the rainy season, the gaur will come down from the hills to visit a newly burned grassland. In common with many other animals, gaur has the habit of visiting salt licks (Prater, 1965). Lydekker (1894) writes of the habits of the gaur as follows (p.177),

"...The gaur prefers hilly districts to the plains, and in India, it is more generally found at elevations from two thousand to five thousand feet than in the low country. While aged bulls are generally or invariably solitary in their habits, gaur as a rule collect together in small herds of about a dozen individuals, although the number may be increased to twenty or thirty, and one instance is
recorded where the number in a herd was estimated at not less than one hundred heads. Such an unusual gathering was, however, probably but temporary, and due to the scarcity of pasture. Each herd is governed by an old bull; the other members of that sex present being always younger animals."

Old bulls which are not herd leaders are, however, in the habit of wandering about alone; and it is said that the largest and eldest of these always lived by themselves (Lydekker, 1916).

Reproductive Rate and Longevity. Mating takes place during the winter (Merris, 1964). The single calf is dropped in August or September, when the torrential monsoon rains have replenished the region with tender new grass and herbage (Walker et al., 1964). Lydekker (1916) says that some calves are born as early as April. The gestation period is about nine months (Asdell, 1946). Longevity of the captive gaur is approximately twenty-four years (Crandall, 1964).

Causes of Decline. Poaching and disease are the major causes of decline in gaur numbers. Harper (1945) states that in India epidemic disease is the main cause of decline, but he does not specify the kind of disease. In Burma, however, anthrax has been responsible for the devastation of many thriving populations.

"... Some of the best grounds on the flats and in the valleys of northern Burma....are subject to epidemic disease" (Peacock, 1933 in Harper, 1945, p.518).

In most of Laos, Cambodia, North and South Vietnam, gaur populations have been depleted by repeated epizootics of rinderpest, and by night hunting with cressbaws and poisoned arrows (Harper, 1945).

In Thailand the principal cause of population decline in the past, before the game law was passed in 1960, was over-hunting. Although some illegal hunting still goes on at the present time, it is much less than formerly.
Relation to Land Use. Since gaur prefers forest-clad hills which are not suitable for crop growing, the encroachment of permanent cultivation and the extension of communications hardly affect its main habitats. Annual burning of the grasslands, mostly through accidental fires set by man, close to gaur habitat, provides lush new growth, a favorite food of the gaur. Due to the nature of its habitat, combined with the difficulty in hunting, gaur are still fairly common in some mountainous regions of Thailand.

Census Method. Gaur has the habits of visiting salt licks, and grazing in the new burned grasslands, so a proper census method should be to count the animals when they are feeding in the open. Their tracks during the wet season, their droppings, browsed or grazed plants are all easily observed. However, experience in identifying such evidence is required before it can be used for census purposes.

Future Management. The gaur is still far from extinction, although over-harvest has taken place locally. This animal can be legally hunted, but it has been temporarily closed to hunting since 1965 in order to ensure a recovery of its population. This complete protection will be continued for the next few years until the animal population increases to a suitable level which will permit rational exploitation.

Gaur management in the future should aim at the improvement of the habitat. Grasslands provide most of its food; therefore the use of fire might be a good approach to habitat improvement. However, this possibility would require a considerable amount of research.

Banteng (Bos Banteng)

Worldwide Distribution. The range of the banteng includes Burma, Thailand, the Malay Peninsula, Borneo, and Java (Prater, 1965). The banteng
is said not to be found in the southern part of Thailand (Lekhakul, 1962). This author gives the southern limits from the province of Surathani northward. The reason for its absence in the south is probably because of too dense evergreen forests, and scarcity of grasslands in that region. However, an earlier record shows that the banteng once occurred in the southern border region between the Thai-Malaysian frontier. This report is supported by Hubback (1932 in Harper, 1945, p. 526) who writes,

"The ex-Penghulu of Chuping...knew that the herd from which he had shot his two head the previous year frequently crossed and recrossed the Perlis-Siam border, stating that there were salt licks both in Perlis and Siam which these animals periodically visited. He volunteered the information that it was his opinion that this herd went as far as the Ulu Telian salt licks in Kedah (in Malaysia), and if this surmise is correct, it would be reasonable to expect to find Bos banteng distributed between the points mentioned..."

In spite of this, there is no present evidence of the occurrence of the banteng in the southern region. The official report of the Regional Forest Offices in the South did not mention any banteng in that part of the country.

Habitat Requirements. The banteng, unlike the gaur, prefers flat or undulating ground, covered with light deciduous or mixed-deciduous and light evergreen forests where there are glades of grass and bamboo (Prater, 1965). Prater further states that in parts of their range in Burma, they have retreated with the advance of cultivation and deserted their favored grounds for the seclusion of denser hill forests, the accustomed habitat of the gaur. This statement is true of the banteng in Thailand wherever it has suffered from hunting and habitat encroachment.

Food and Habits. The food of this species includes grasses, leaves, and bamboo shoots. Its food varies with the wet and dry seasons. During

*Perlis is in Malaysia
the monsoon season the banteng leaves the lowlands and drifts up into the
hill-forests to feed on tender new herbage, including bamboo shoots,
while during the dry season it returns to the valleys and more open-wood-
ed districts, where it feeds on grasses (Walker et al., 1964). In the
hill country it keeps to the lower slopes (Prater, 1933). Lydekker (1894,
p. 182) refers to Blandford's suggestion that

"from its relatively longer legs, the banteng is less addicted to
climbing among rocky hills than are either of the other members of
the group, and that it is accordingly more restricted to the plains
of tall grass."

Banteng and gaur are similar in being addicted to salt licks and newly
burned young grasses.

Reproduction and Longevity. Banteng have young with them in April
and May (Lydekker, 1900 in Zuckerman, 1953). It is thought that the young
are born at the end of the cold and the beginning of hot weather (Zuck-
erman, 1953). However, this statement disagrees with that of Walker et al
(1964) which says,

"they mate during the dry season and the single calf is born dur-
ing August or September."

The banteng can interbreed with Indian humped cattle, the domesticated
race of India (Lydekker, 1894; and Zeuner, 1963).

The longevity record for a specimen in the Zoological Gardens of
Berlin is listed by Jones (1958, in Crandall, 1964) as eight years, five
months, and twenty-eight days.

Causes of Decline. Hunting for meat and habitat destruction for the
purpose of cultivation are the major causes of the banteng's depletion.
Its meat is good as human food and attracts poaching. Its original habitat
is a flat or undulating area where water, grassland, and forest are inter-
spersed. Such areas are usually ideal for agriculture, and so tend to be
vulnerable to destruction.

Relation to Land Use. The banteng does some harm to paddy, rubber, and fiber plantations (Harper, 1945). If the habitat is disturbed by human activities, the animal will disappear because of its shyness. The occupancy of the habitat by man will lead to increased hunting pressure.

It is possible that the population of banteng can be raised by maintaining the pasture because the animal is addicted to young grass following fires in the dry season. However, the effect of fire on grassland has not been studied yet.

Future Management. Gaur and banteng are very similar in many aspects of their habits. In some places they share the same type of habitat. In Burma, for example, Walker et al. (1964) state that gaur and banteng occur together in the same forest. The same management techniques may be applicable to both gaur and banteng. It is predictable that in the future when both kinds of these animals increase to a level exceeding the range carrying capacity, there will be an interspecific competition for forage; unless populations are properly controlled, range depletion will result. Therefore, protection from over-hunting will have to be accompanied by studies of these animals and their habitat.

Serow (Capricornis sumatraensis)

Worldwide Distribution. The genus Capricornis comprises of two species: C. sumatraensis distributed from northern India eastward to central and southern China and southward through Burma, Indo-China, Thailand, and the Malay States to Sumatra; and C. crispus, native to Formosa and Java (Walker et al., 1964). The former species is subdivided into several races. Harper (1945) refers to the sub-species C.s.annectens (Kless) occurring in
Fig. 9 Comparative size and characteristics of serow and goral (adapted from Prater, 1965)

the west; and probably the *C. maritimus* (Heude) on the upper Mekhong in the area between the Thai-Laos border; and the *C. s. swettenhami* (Butler) in the south of Thailand.

In Thailand the serow ranges throughout the country, but occurs only in wooded ravines with dense undergrowth and on the steep mountain slopes with sufficient shelter and water.

**Habitat Requirements.** The serow lives in the recesses of thickly wooded gorges where boulder-strewn slopes and shallow caves give it shelter from the weather (Prater, 1933 and 1965). Prater (1965) found that in the Himalayas the serow favors an elevation between 6,000 to 10,000 feet, and that in the Burmese hill ranges it may be found at a height ranging from 700 to 8,000 feet.

**Food and Habits.** In the mornings and evenings the serow comes out to
Fig. 10  Probable distributions of serow and goral (based on the information in appendix H)
feed on the rank herbage of the more open slopes (Prater, 1965). Its food consists of grass and leaves, eaten in the shelter of thickets and on grassy ridges. During the day it returns to favorite resting places, often under the shelter of overhanging rocks and cliffs (Walker et al., 1964). The serow is more or less solitary, and secretive, although sometimes four or five may be found feeding together (Morris, 1964). It is an active creature and keen in climbing up the steep, rocky slopes.

Reproduction and Longevity. Little is known regarding its breeding habits. In Burma the young are born in September or October, after a gestation period of about eight months (Walker et al., 1964). In the Himalayas the rut begins at the end of October and the young are born in May or June after a gestation period of seven months (Prater, 1933 and 1965). No record of its longevity has been found.

Causes of Decline. At present, the serow is considered a rare or endangered animal. Formerly this species was not uncommon in the mountainous regions throughout the country. Much information shows that they have mostly been heavily reduced by two main causes: poaching and habitat destruction. Although serow is well protected by its natural habitat and its extreme shyness, the animal can be killed easily with the aid of dogs. Capturing this animal alive with snares for market was quite successful and widely used before the protective law was passed. In other countries, such as Sumatra, for example, hunting with dogs and capture with snares and pitfalls caused the animals to become extinct in many localities (Harper, 1945).

In China, a belief in a great healing property of the animals' horns, skins and other parts of the body leads the people to hunt them.
Relation to Land Use. The habitat of serow is very rough country. The soil, in general, is rocky and unsuitable for agriculture, but soils in the bottom of the hills are quite fertile and favor crop-growing. When cultivation is introduced, the animal will disappear because of its shyness.

Census Method. It is very difficult to make an accurate census on the serow due to the inaccessibility of its habitat.

Future Management. Currently the serow is strictly protected by law; hunting, live-capturing, keeping in possession, meat marketing, and exportting are absolutely prohibited. If such measures of protection are effectively enforced, the population of this animal is expected to increase. In managing the serow, protection of its original habitat is highly important. All the habitat disturbances such as fires, logging, cultivation, and probably grazing by livestock should be prevented. In order to achieve this objective of management, a sanctuary must be created in the area where the animal still survives.

Goral (Nemorhaedus goral)

Worldwide Distribution. The goral is a close relative of the serow. Many different scientific names of this animal have been referred to by different authors. The distribution is not definitely known. However, Morris (1961) gives the range from the Himalayan Mountains east through the mountains of west China and north to Korea. According to Walker et al. (1964), there are two species of goral: N. goral occurs from southeastern Siberia southward through Manchuria, Korea, Mongolia, and most of China to northern India and Burma; N. cranbrooki lives in parts of Tibet, Assam, and Burma. These authors further state that there seems to be no record of N. goral from the area occupied by N. cranbrooki. Prater (1965) mentions two races of goral found within
India's limits: the grey goral, *N. g. goral* (Hardwicke) of Kashmir and the western Himalayas; and the brown goral, *N. g. hedgsoni* (Pececk) of Nepal and Sikkim. It seems that a race of brown goral (*N. g. hedgsoni*) is found in the northern part of Thailand. Lekhakul (1962) refers to the scientific name of goral as *Nemerhaedus hodgsoni* and gives it as occurring in the mountain ranges along the Meping in the northern parts of the country. He described this goral as greyish-brown, and slightly reddish. The animal is probably of the race *N. g. hodgsoni* of Nepal and Sikkim as referred to by Prater (1965).

**Habitat Requirements.** Like the serow, the goral is a mountain-dwelling animal. It is more often found in the open than is the serow. It frequents rocky hillsides from 3,000 to 14,000 feet during the summer (Morris, 1964). In the Himalayas, Prater (1965) found that this animal favors an elevation of 3,000 to 9,000 feet (900 to 2,750 m.), though it may ascend to and has been observed at 13,000 to 14,000 feet (3,950 to 4,250 m.).

**Feed and Habits.** It lives entirely on the sparse vegetation of the rocky slopes. The active period is early morning and late evening. Its habits, in general, are the same as the serow's. The goral usually is found in family groups of four to eight members, although old bucks generally live alone most of the year. It is undoubtedly skillful in climbing cliffs. During the day it can sometimes be seen high up on a rocky outcrop, sitting on its haunches like a dog, or lying stretched out in the sun (Morris, 1964).

**Reproduction and Longevity.** Little or nothing is known about its breeding habits. According to Walker et al (1964), the young are born in May or June, usually singles, but sometimes twins, after a gestation period.
of about six months.

The longevities of two specimens living in the Zoological Gardens of London were recorded as over eleven years (Flower, 1931 in Harper, 1965).

Causes of Decline. In former times, goral were frequently seen on the hillsides along the river banks of northern Thailand. At the present time, this animal is extremely rare and restricted only to the remote mountains where human access is almost impossible. It is presumed that human settlement and over-killing in the past are the main causes of its decline.

Most of the mountain ranges in the north have been occupied by different tribes of hillmen for many years; these people not only clear the land for growing their crops, but also poach animals for food. The shifting cultivation of these tribesmen along the hill-sides combined with agricultural practices and settlement by the local Thai people near foothill areas have reduced goral habitat in many localities.

Relation to Land Use. As in the case of the serow, the goral will leave an area occupied by man. Any type of habitat change which also results in the reduction of the protective cover will decrease the possibility of maintaining population levels.

Future Management. The goral is strictly protected by law like the other endangered species. An important conservation measure is to protect both the animal and the habitat. An investigation of the exact areas in which it survives at the present time must be carried out; these could be set aside as sanctuaries to perpetuate remaining stocks.
CERVIDAE

Introduction. Five species of deer are native to Thailand: hog-deer *Axis porcinus*, Eld's deer *C. eldi*, Schomburgk's deer *C. schomburgki*, sambar deer *C. unicolor*, and barking deer *Muntiacus muntjak*.

Hog-Deer (*Axis porcinus*)

Worldwide Distribution. The hog-deer is a relative of the Chital deer *Axis axis* and interbreeding between the two species is known to take place (Prater, 1965). Three species of this genus are recognized: *Axis axis*, native to Ceylon and India; *A. calamianensis*, known only from Calamian Islands in the western portion of the Philippines; and *Axis porcinus*, native to India, Burma, Thailand, and Indo-China, and introduced into Ceylon (Walker et al., 1964). An eastern sub-species, *A. p. annamiticus* is indigenous to Thailand and Indo-China. Formerly, hog-deer were plentiful in every part of Thailand except in the south, where dense evergreen forests predominate. According to recent reports from some regional forest offices, however, hog-deer now occur only in a limited area and in small numbers.

Habitat Requirements. Prater (1965) states that the hog-deer favors grass jungles near river banks, grass-covered delta islands, or open grass plains. This deer is always found in areas where the grass is not too high. He also mentioned that this species was once common in the mangrove forests of Burma. In Thailand the hog-deer lives in the open forests, especially in the grass plains near some big rivers such as the Mekhong, the Mun, the Chi, and some tributaries of the Chao Phya. When I accompanied an expedition to Nongkai, one of the northeastern provinces on the Mekhong, in November of 1963, to investigate habitat conditions in the area of Bungkarn district, we found hog-deer living in a habitat of open grassland inter-
Fig. 11 Comparative size and characteristics of Schomburgk's deer, Eld's-deer, sambar deer, hog-deer, barking deer, and chevrotain (A. adapted from Harper, 1945; B, C, D, E, and F from Prater, 1965)
Fig. 12 Probable distributions of hog-deer, Eld's deer, sambar deer and barking deer (based on the information in appendix H)
spersed with open dry dipterocarp forests and streams. Small bushes and
trees were scattered throughout the grasslands. When the grasslands are
annually flooded during the wet season, which is about five months in dura-
tion, the hog-deer shifts to the higher dry dipterocarp forest nearby. It
returns to the grasslands in the dry season. One of the local natives
told me that hog-deer favors the green rice plants growing in the wet sea-
son. When it feeds on their crops, the local people can easily stalk and
kill it. It is suspected that hog-deer still exists in the similar areas
of the neighboring provinces located on the Mekhong.

**Feed and Habits.** The hog-deer is a grazing animal which favors the
grassland and open forests. Other kinds of vegetation such as young leaves,
fruits, seeds, agricultural crops, and plants are greedily consumed. Hog-
deer frequents open grasslands and light jungle, seldom penetrating into
its habits,

"Hog-deer are generally solitary creatures. A pair will continue
to frequent a particular stretch of grassland. Sometimes small
parties up to eighteen or so may be found grazing together. They
come out to feed early in the mornings and evenings, and shelter
in long grass during the hot hours of the day. They are wary crea-
tures; their senses of sight, smell, and hearing are acute. Per-
secution has made them almost nocturnal in many parts of their range."

**Reproduction and Longevity.** The main pairing season is believed to
be in September and October and the young are dropped in April and May af-
fer a gestation period of eight months (Lydekker, 1916; Prater, 1965).
Usually two young, but not uncommonly one or three are born in dense cover
(Walker *et al.*, 1964). In captivity, hog-deer are reported to breed success-
fully. Records are provided by Crandall (1964) which show a total of thir-
ty-two single births having occurred at the New York Zoological Park as
follows: January, four; February, two; March, three; April, eight; May, four; June, three; July, three; September, three; October, one; November, one. It is noticeable from this record that captive hog-deer breed almost every month of the year. A similar birth distribution is also provided by Zuckerman (1953, in Crandall, 1964), for seventy-eight births in the Zoological Gardens of London. A gestation period of a captive animal is recorded at eight months by Brown (1936). The life span of the hog-deer is fairly long. Flower (1931) gives a longevity record of over seventeen years for a female hog-deer kept in captivity at Rotterdam Zoological Gardens.

Causes of Decline. This is another species which is considered a very rare animal in Thailand. It is strictly protected by law as are the other rare species; hunting, marketing of meat or live animals, possessing either meat or live animal, and exporting are prohibited by law. Generally speaking there are two principal pressures that caused the hog-deer decline in the past—hunting and habitat change. As has been described above, the hog-deer, for the most part, favors grass-jungles or open grass-plains along river banks. Such areas are usually characterized by fertile, alluvial soil suited for the growing of domestic crops such as rice. In this circumstance, human competition for land use eliminates much of its habitat. In addition, when the crops, predominantly rice, are grown in such areas, the animal frequently becomes a pest and subsequently is slaughtered by the cultivators. The meat of hog-deer is said to be very delicious and highly sought after. This leads to hunting, which is comparatively easy because of the openness of its habitat. Experiences have shown that it can be slaughtered successfully with only the aid of a domestic dog. Excessive killing for food by man has caused the sharp decline of hog-deer, and ex-
tion has resulted in many localities.

Besides, the hog-deer is greatly affected by dam construction. During the past five years, Thailand has initiated a major program of irrigation development throughout the country. Many sizable dams have been erected across some major rivers and their tributaries, the grassland basins along which were previously inhabited by hog-deer. The reservoirs above these huge dams have replaced much of its habitat and so the animal has disappeared from such areas.

Flood in the wet season is another factor that affects the security of hog-deer. During this time, the animals will concentrate in a limited area of the higher lands where flooding is impossible. These crowded animals are especially vulnerable to poaching.

Relation to Land Use. As stated in the preceding section, opening up the land for agriculture, and dam construction are the main factors that bring about the shrinkage of the animal's habitat. If the protection, usually almost impossible, of the animal in these areas is not adequately enforced, the animal will be threatened with extinction. On the other hand, the hog-deer habitat can be improved by burning of the grazing lands and the introduction of some agriculture.

Census Method. Although hog-deer frequent the open grassland, their feeding habits make aerial counts almost impossible. They spend most of the time during the heat of the day resting in a thick shelter. In such situations, the animal count from the air will not result in an accurate figure. The presence of these animals should be indicated by their tracks. A possible census method is the use of pellet-groups in sample feeding areas.

Future Management. Besides effective law enforcement, the following
measures should be taken in order to insure the security of hog-deer.

A. **Game sanctuaries.** The game sanctuary is a primary tool needed for the protection of an endangered species. As a result of hog-deer investigation in November of 1963, the Wildlife Section of the Royal Forest Department took steps to set aside the Peowea Forest in Nengkai Province, as a sanctuary to insure the continued existence of hog-deer. The sanctuary was partially established in 1964. The area chosen provides habitat not only for hog-deer, but also for many other important species, such as gaur, banteng, sambar deer, serow, and probably Eld's deer, barking deer, wild elephants, tigers, and monkeys, etc. In the future when the animals of the sanctuary build up their populations to the level that endangers the range, the management must be aimed at controlling the more common species and assisting the rare species. Further surveys of hog-deer occurrence should be made, and possibly more sanctuaries established, since the hog-deer is an endangered species.

B. **Habitat Improvement.** The work of habitat improvement on the hog-deer sanctuary area has hardly been started yet. According to the Wild Animals Preservation and Protection Act of 1960, burning by any means for any purposes in game sanctuaries is completely prohibited. This prohibition limits the habitat improvement to a great extent. If the law is complied with, habitat manipulation by the use of recurrent fire on the grassland is impossible. It has been noted that during the dry seasons, annual burning results in the growth of young palatable grasses and other plants which attract many grazing animals.

Since the hog-deer is mainly a grazing animal, which favors the grassland and open forests, improvement of its habitat through the use of fires...
is probably an important tool for the restoration of this species. Before the work starts, however, the law must be amended in order to empower a game manager to improve the habitat in this way.

**Eld's Deer (Cervus eldi)**

**Worldwide Distribution.** Many vernacular names are given to this deer. Some of these, besides Eld's, are Thamin, brow-antlered deer, La-ang, and La-mang. The latter two names are locally known in Thai. Three subspecies of Eld's deer occur, according to Harper (1945):

1. *Cervus eldi siamensis* (Lydekker) or *Rucervus eldi platyceros* (Gray) occurs in Thailand and Indo-China.

2. *Cervus eldi eldi* or *Rucervus eldi eldi* (M'Clelland) occurs in Burma and Assam.

3. *Rucervus eldi hainanus* (Thomas) is restricted to the Hainan Island.

Earlier records show that Eld's deer was not uncommon throughout Thailand, but their southern limit of range was not ascertained (Gyldenstolpe, 1919, as quoted by Harper, 1945). Harper (1945) refers to the records of its occurrence provided by Irwin (1911b) and Gyldenstolpe (1919) as follows:

1. The swampy plain of Chawm Bung and Nong Pla-duk of Ratburi Province about lat. 13° 14', long. 99° 35'.

2. The plain of Nakornchaisiri in the Province of Nakornpathem where the "la-mang" occasionally enter and feed on the rice crops during the wet season.

3. In the patches of high grass-jungle between the railway and the river, north of Lopburi in Krung Kae Province, lat. 14° 55' where he (Irwin) saw them in 1906.

4. In the area of MaeLua of Chiangrai Province (northern region), Men
Luum (eastern region) and Charaké Sampan of Karnchanaburi Province (central region).

A present range of Eld's deer is very limited. According to more recent reports from Regional and the Provincial Forest Offices in 1961, this species still exists in some limited areas of the northern, northeastern, and central regions. Most of these areas are restricted to river basins and open forest away from communities. Ruhle (1961) says that in the area of Khao Salob, Karnchanaburi Province, the Eld's deer still survive in small numbers.

Another useful bit of information appears in the journal notes of Sanborn and Watkins (1950, p. 430), members of an expedition which went to explore the fauna of Thailand sixteen years ago. Parts of their notes are quoted here as,

"...A small herd of Eld's deer was found at the Gairdner's rice plantation, Wang Pratat Farm, on the Mae-Ping River about fifty miles from Pak Nam Pe and ten miles from Kam-Pang-Pet. The expedition secured an old buck and a yearling buck and saw evidences of seven or eight other individuals. More are seen in dry season from January to April when they come into the rice fields. Mr. Jim Gairdner had a pet buck for a number of years and said that July 11 was as late as it kept its antlers. The old buck secured by the Expedition on July 11, had very recently dropped its antlers. Mr. Gairdner presented the Expedition with three very fine pairs of antlers. - - - - The young Eld's deer are born about October. In summer the coat is red with white spots and in the hot seasons, winter, it is grey. In the opinion of local hunters, the animal will be extinct in Thailand in the next four or five years. Like Schomburgk's deer, it is an open country animal and the extension of the rice plantations with setting of the country and more shooting is slowly exterminating it."

Habitat Requirements. Eld's deer inhabit open swampy ground (Street, 1961). It avoids hills or heavy forests and prefers open scrub jungle, or flat or undulating land between rivers and hill ranges (Prater, 1965). Briefly, its habitat, in general, is the same as that of the hog-deer.
Food and Habits. Like hog-deer, the Eld's deer is mainly a grazing animal. Besides wild grasses, it often feeds on different kinds of leaves, fruits, seeds, and many kinds of domestic crops, including rice plants. This animal also favors young grasses after annual burning. Eld (1842, as quoted by Harper, 1945) often saw herds of two or three hundred animals in the Valley of Manipur.

In habits, the Eld's deer forms a small herd. It is mostly nocturnal, lying up in cover during the heat of the day. It feeds in the morning and evening. The animal often becomes an agricultural pest.

Crandall (1964) made an observation on captive Eld's deer in the New York Zoological Park and found that this deer appears more sensitive to cold than other members of the Cervidae. The animal's speed and keen sight provide important means of self-protection (Prater, 1965).

In movements, the Eld's deer is influenced by seasonal changes. During the rainy period, it takes to wandering and migrates to drier areas, where it is much easier for the poacher to kill it (Street, 1961).

Reproduction and Longevity. The Eld's deer breeds between March and May (Blandford, 1888-91, as referred to by Crandall, 1964). Fawns, usually one, are born after a gestation period of about 239-256 days (Prater, 1965). Following the rut the mature stag generally leaves the hinds and withdraws alone, but occasionally attended by one or two females (Prater, 1965). In captivity, Eld's deer can breed successfully and lives up to twenty years (Crandall, 1964).

Causes of Decline. Eld's deer, like hog-deer, are threatened by two major pressures—poaching and habitat destruction through conversion to agriculture. Since both kinds of these animals frequent the same type of
habitat, causes of decrease in their numbers are quite comparable. Presently the Eld's deer is an endangered species and is so listed with the hog-deer.

**Future Management.** Protected habitat is very important for the preservation of this animal. Habitat improvement through the use of controlled burning in order to increase its forage grasses and shrubs, as suggested for the hog-deer may ultimately prove useful.

**Schomburgk's Deer (Cervus schomburgki)**

This deer was first scientifically reported in 1863 (Kemp, 1918; Harper, 1945). It belongs to the same group as *Cervus duvauceli* (swamp deer of India) and *Cervus eldi* (La-mang of Thailand and Thamin of Burma (Kemp, 1918)). Schomburgk's deer was known to occur only in the Chao Phya Basin (Lekhakul, 1962). During the last century, this kind of deer frequented the river basins of the central provinces including Supanburi, Nakornnayok, Nakornswan, Krungkao, Bangpakong basin, and the Rungsit Plains. Although the animal had been thought at one time to be found in the neighboring countries such as Laos and Cambodia, later investigations have proven that these specimens were wrongly identified. Kemp (1918) believes that Schomburgk's deer is native to Thailand only and restricted to a small area formed by a quadrilateral combined between latitudes 15° and 17° N., and longitudes 101° and 103° E. It is probable that Schomburgk's deer is now extinct. The last buck was shot in 1913 at the Kanchanaburi Plains. There are two main reasons for the animal's extinction: unlimited persecution and habitat change. Since this deer is confined only to open grassland, where extensive hunting could be carried out effectively. Its delicious meat attracted the local people who slaughtered it for food. Much
of the habitat was flat grassland and water was not scarce for agriculture. These areas were rapidly converted into paddy fields where no more deer could exist. When the agriculture expanded more and more, a need for irrigation increased. Consequently, whole areas were entirely converted into farmlands and irrigation canals.

**Sambar Deer (Cervus unicolor)**

**Worldwide Distribution.** The sambar deer is the typical forest deer of southeastern Asia. Its range extends, in numerous forms, over much of southern Asia and neighboring islands (Crandall, 1964). This range includes India, Ceylon, Burma, Thailand, Indochina, Malaysia, and eastward to the Philippines (Prater, 1965). This deer also occurs in Sze-Chaun in southwestern China (Lydekker, 1894).

In Thailand the sambar deer is found in every part of the country.

**Habitat Requirements.** Forested hillsides, especially near the areas of shifting cultivation on the edge of the forest are the favorite haunts of sambar deer (Burgess, 1961). This animal, however, can live in a great variety of habitats. In the Himalayas it may occur at elevations of 9,000 to 10,000 feet, and it is commonly found on the highest mountains of southern India and Ceylon (Lydekker, 1894).

In Thailand the sambar deer is present in all regions, but is most common in the evergreen and mixed-deciduous forest types where water is available. It also frequents the abandoned shifting cultivation areas near the forest edges where food is abundant.

**Food and Habits.** Its food consists of grasses, leaves, fruits, and agricultural crops. It prefers the bamboo shoots sprouting in the wet season. Sambar deer drinks daily, so it certainly travels long distances to
its drinking places at times (Blandford, as quoted by Lydekker, 1894).

It also is addicted to salt licks. Hubback (1937) states that he has often seen seladeng (gaur) and sambar deer at a salt lick at the same time within twenty or thirty yards of each other.

In reference to its habits, Prater (1965, p. 291) writes

"... They feed mainly at night and retire into heavy cover at daybreak and usually do not come out till dusk. Their powers of sight are moderate, their scent and hearing are acute. The capacity of so heavy an animal to move silently through dense jungle is amazing. Sambar take to water readily and swim with the body submerged, only the face and the antlers showing above the surface. In central and southern India, the majority of stags cast their antlers between the end of March and mid-April. The antlers commence to grow in May and are in velvet during the rains and clear of velvet by November ... The males fight for territory. Each stag fights to obtain sole rights over some favored valley. The victor becomes the master of the hinds which enter it."

Crandall (1964) states that the bucks at the New York Zoological Park drop their antlers in February and March. However, some stags have been known to retain their antlers for two or more years (Lydekker, 1894).

The animal is shy in nature. It is but rarely found associating in any numbers; both stags and hinds are often found singly, but small herds from four or five to a dozen in number are commonly met with (Blandford, as quoted by Lydekker, 1894).

Reproduction and Longevity. Young are born in late May or early June after a gestation period of about seven months and reach sexual maturity at two years of age (Prater, 1965).

The life span of sambar deer is quite long. Manville (1957) gives a longevity record of twenty-six years for a female sambar in the Bronx Zoo.

Causes of Decline. The main factor of the decline of the sambar deer population is hunting both for food and for crop protection. This deer is a gregarious animal favoring a sub-climax vegetation produced by shifting
cultivation practiced near the edges of the forests. Wherever the forest is opened up, the sambar deer will come out to feed on young vegetative growths and agricultural crops. In addition, an exposed area along timber extraction routes within the forests results in palatable young growths which are high in food quality. These areas, on one hand, supply lots of food for deer, but on the other hand, provide good hunting spots for the poachers. This will explain why the sambar has been recently reduced in numbers in spite of the fact that the food supply has increased. This also happened to the sambar deer in Borneo (Burgess 1961).

Relation to Land Use. No research has been done about the interrelationships between deer and the effects of land use, such as logging, clearing, and burning. From the theoretical point of view, it is expected that such activities would cause an increase in young forage supply of high quality, increasing the carrying capacity for the deer. Nevertheless, it must be remembered that plant succession in the tropical zones is relatively rapid due to the excellent conditions for plant growth. Consequently, it is presumed that these habitat changes could support a high population of deer for only a short time.

Census Method. The sambar deer has a habit of drinking water daily and probably at a specific time. A census might be made by counting the individuals coming to the drinking places at a given time of the day. Before the count is started, water sources in the area must be known. This method would be practical only during the summer months.

Future Management. This animal is still far from extinct. At the present time, it is protected by law. Hunting can be done only under the jurisdiction of the law. In the future, extensive logging, followed by fires,
will probably increase the deer's food. This will result in the building up of deer population, provided that the protection against poaching is adequate. When numerous, the sambar can do great harm to farm crops. To manage this deer in the future, plans should be made to set aside some particular areas for it and to manage it so as to cause less conflict with land-uses, at the same time perpetuating a reasonable level of population for recreational harvest. Such areas may be called "game management units."

**Barking Deer or Muntjak (Muntiacus muntjak)**

**Worldwide Distribution.** The barking deer or muntjak ranges over India, Burma, Thailand, Cambodia, Hainan, Malaysia, Sumatra, Java, Lombok and Borneo (Flower, 1900). It is also found in China, Formosa, and Japan (Prater, 1965). Several species of barking deer have been recognized. At least two species are currently found in Thailand: the Indian muntjak *M. muntjak* and the Tenasserim muntjak *M. feae*. They are distributed throughout the country and can be considered common big game in Thailand.

**Habitat Requirements.** The haunts of the barking deer are thickly weeded hills (Prater, 1965). In Thailand this animal usually keeps to dense forest and comes out to graze in the spots along the forest edges. It occurs in a wide range of elevations. In the Himalayas, it lives up to the elevations of 5,000 to 8,000 feet (Prater, 1965).

**Food and Habits.** The barking deer seems to be primarily a browser rather than a grazer, but when leaves and bark are not available, it will eat grass readily (Crandall, 1964). Besides grasses and leaves, various kinds of wild fruits, seeds, and tender shoots are also favored. Fruits of Makgpa Spendias and Ma-khampem Ailanthus are the indicators of barking deer abundance (Lekhakul, 1962). Like the sambar deer, this animal drinks daily. It
is chiefly nocturnal and usually found alone or in pairs.

**Reproduction and Longevity.** This is a prolific animal which is believed to breed almost all year round. However, Allen (1940) gives the breeding season as late as January and February and the time of birth as early June. One or sometimes two young are born after a gestation period of about 180 days (Walker et al., 1964). The life span is relatively long. The record of over fifteen years longevity for a captive animal is given by Jones (1958 in Crandall, 1964).

**Causes of Decline.** The major factor that holds its population down is a hunting pressure. The meat of the barking deer is excellent and sought by people. However, this animal is very prolific. Perhaps this is why this animal is still common, although hunting was quite extensive in the past.

**Relation to Land Use.** The barking deer is less likely to occur near cultivation than the sambar deer and is more an animal of primary forest (Burgess, 1961). This animal prefers the dense jungle. This gives it a greater measure of safety than the Sambar. Since no studies have been made on the effect of land-use on barking deer ecology, it is hard to say whether habitat disturbances by logging, burning, or cultivating are favorable to the barking deer or not. Considering the browsing habits of this species, it is suspected that the creation of subclimax conditions in the forest would improve forage conditions for it.

**Future Management.** In many areas, barking deer and sambar deer are found to share the same habitat. These two kinds of animals have somewhat similar habitat requirements. In the future when the barking deer and the sambar deer have increased a food shortage might occur. In the meantime, much ecological research on this species remains to be done.
TRAGULIDAE

Introduction. There are two genera in this family: Tragulus, confined to Asia and nearby islands; and Hyemoschus*, of Africa (Crandall, 1964). The former contains three species: T. meminna (the Indian Chevrotain), of India and Ceylon; T. napu (the larger Malayan Chevrotain), found in southeastern Asia, Sumatra, Borneo, and nearby islands; T. javanicus (the lesser Malayan Chevrotain), of similar distribution, but including Java (Ellerman and Merrison-Scott, 1951). Flower and Lydekker (1819) give four species of the genus Tragulus by adding T. stanleyanus as a distinct species. The second genus, Hyemoschus contains only one existing species, H. aquaticus (the water Chevrotain) found in the dense forests of West Coast Africa (Flower and Lydekker, 1819; Crandall, 1964). T. javanicus occurs in Thailand (Flower, 1900). This author does not mention the existence of T. napu in any part of Thailand. However, he gives its range as Tenasserim, Malay Peninsula (Perak, Selangor, Pahang), Sumatra, Java, and Borneo. Therefore, it is possible that T. napu can be found at least in the Southern provinces near the Malaysian border.

The Lesser Malayan Chevrotain (Tragulus javanicus)

This is the smallest living ungulate of Thailand, having a shoulder height of about one foot. Its distribution includes Tenasserim, Thailand, Cambodia, Chechinchina, Malay Peninsula (Junkceylon, Lancary, Penang, Perak, Selangor, Pahang, Singapore), Sumatra, Java, and Borneo. In former times, this animal was known to exist in relatively large numbers in the evergreen forests of the southern and eastern part of Thailand. At present a sizable population is still found in some areas. The northern

*Flower and Lydekker (1819) use the generic name Dercatherium
limits of distribution are not exactly known. A specimen from the Dong Phya Fai Forest, central region, was recorded by Flower (1900). Much of this area at the present time has been converted into agricultural land and the animal is restricted to the remote forests.

Generally the chevrotain prefers the dense bamboo clumps and heavy jungles which provide excellent shelter from harassment (Lekhakul, 1962). This animal is a ruminant, feeding primarily on grasses, leaves of low-growing shrubs, seedlings, seeds, fruits, and berries. It is nocturnal, active in the mornings, at night, and at dusk. Being shy and retiring, the animal is seldom seen during daytime (Walker et al, 1964).

The breeding habits of neither T. javanicus nor T. napu are known, but Blandford (1888-91 in Crandall, 1964) gives the rutting season for T. meminna of India as about June or July with a gestation period of 120 days. In areas where sambar and barking deer are present, the hunting of chevrotain is not so popular, due to its small body size and less tasty meat. It is, however, preyed upon by many carnivores and some kinds of snakes, like pythons.

Nothing is known about the effects of land use upon these animals. It is believed that the opening of the original dense jungles would reduce the carrying capacity for chevrotain, however, because of the reduction of cover.

TAPIRIDAE

Introduction. The family Tapiridae has been classified in several ways. But according to the recent review by Walker et al (1964), this family contains only one genus, Tapirus, with four different species:
T. terrestris (Brazilian tapir); T. reulini (mountain tapir); T. bairdi (Baird's tapir); and T. indicus (the Asiatic tapir). The Asiatic or Malay tapir, being found in Thailand, will be discussed in this paper.

**Malay Tapir (Tapirus indicus)**

**Worldwide Distribution.** The tapir is found in Burma, Thailand, the Inde-Chinese peninsula, the Malay States, and Sumatra (there are no definite records of living tapir from Borneo (Walker et al, 1964)). It was extinct in Borneo before historic time (Harrisson, 1961).

In Thailand the tapir lives in the lower elevations of the country which lies mostly in the south.

"The distribution of the tapir in Siam is very imperfectly known, but it seems to occur in Peninsular and Southwestern Siam. Said to be fairly common in Patani, and recorded from Hat Sanuk and Hue Sai near the Siam-Tenasserim frontier." (Gyldenstolpe, 1919 as quoted by Harper, 1945).

Its northern limits are at least as far as Kampaengpet province; southerly it occurs throughout the Peninsula (Sanbern and Watkins, 1950).

**Habitat Requirements.** The tapir frequents the depths of shady forests in the neighborhood of water, to which it frequently resorts for the purpose of bathing, and in which it often takes refuge when pursued (Flower and Lydekker, 1891). In Taman Negara or King George V National Park, Malaysia, this animal is quite numerous from lowland swamps to the steepest slopes and high ridges up to an elevation of at least 4,000 feet (Hislop, 1961).

**Feed and Habits and Reproduction.** A very valuable review of the biology of the Malay tapir is given by Sanbern and Watkins (1950, p. 430). This information may be partially quoted here:

"... From information given us by hunters, it was estimated that the young were born in November or December. Whether the tapir
breed every year or every other year was not definitely ascertained, but from the large size of young still with the mothers, it seems probable that it breeds every other year.

The junior author spent many hours and days with the hunters trailing tapir, and found that it follows a zig-zag course during its nocturnal feeding, taking a few leaves from one bush and then moving on to another. It appears to keep moving, never staying long in one spot and never eating all the leaves on a bush. In the north they were feeding on an unidentified thorny bush and on four kinds of bushes in the south. During their feeding they often leave the jungle to cross open areas. We were warned against general shooting around camp that would frighten away the tapir.

"In hunting tapir it is desirable to have a light camp, easily moved, as when the animals are shot at or driven, they are said to change their grounds, usually going towards the forested hills. The author found this to be the case."

"Before the tapir beds down for its daily rest in some thick jungles, it makes a hairpin turn down-wind from its trail when escaping. Knowledge of this fact is the secret of successful tapir hunting . . ."

"The Malay tapir is preyed on by the leopard and tiger . . ."

"The total of seventeen tapirs was recorded during three months in Siam. In the south the Expedition collected two; a female accompanied by a male was shot by a Malay . . ; a male was captured in a pit by some Malays . . ."
Fig. 1h Probable distributions of chevrotain and Malay tapir (based on the information in appendix H)
"Tapir were most plentiful in the south, perhaps because the Malays associate them with the pig and will not touch them. It is not hunted in northern Siam and these killed are either shot for sport or through ignorance of what the animal is. The animal dealers get some young ones every year and the mother is sometimes killed in order to capture the young."

Brown (1936) gives the gestation period as thirteen months. The life span of the tapir is relatively long. The longevity of the captive animal given by Flower (1931) is over eleven years.

Relation to Land Use. The tapir is very shy, so a disturbance of the habitat will cause the animal to disappear and retreat to the more inaccessible areas.

Future Management. Presently tapir are a protected animal of the first category* by law. Slaying of this animal in any case, except for educational or scientific purposes, is entirely prohibited. Its present population size is relatively large. This is probably due to the fact that it is not a popular game species, being less tasty than the deer. In addition, religious beliefs among the Moslems, who are predominantly concentrated in the south where tapir are abundant, contributed to its safety. Its continual existence can be best assured by preventing the original habitats from being changed.

* see the definition of the animal of the first category in the appendix D
ELEPHANTIDAE

Introduction. This family contains two genera: Elephas (Asiatic elephant), and Loxodonta (African elephant).

"Lydekker (1916) recognizes four Asiatic forms and eleven African forms, but Dr. Allen (1939b) questions the taxonomic status of all but four in the latter group," (Harper, 1945, p. 111).

Today a single species in each genus—Elephas maximus, and Loxodonta africana is recognized. According to Carrington (1959), two distinctive subspecies of Loxodonta africana are described. The African forest elephant, L. a. cyclotis of the western rain forest, and the African bush elephant, L. africana of the eastern and southern plains. This paper will concern only with the Asiatic genus (E. maximus) which is native to Thailand.

Wild Elephant (Elephas maximus)

Worldwide Distribution. This species is found in India, Pakistan, Ceylon, Burma, Thailand, Inde-China, Malaysia, Sumatra, and Borneo (Carrington, 1959).

Formerly elephants were abundant throughout the country, but are now confined mostly to the undisturbed primary forests in every region. Harper (1945, p. 313) quotes the following two accounts of the elephant in Thailand in the old days as:

"On the plain and in the forest, a herd of about 300 wild elephants are roaming . . . These elephants have from time to time been captured, but their death has always resulted after some comparatively short time," (Havmöller, 1926).

"From government officials with whom I was traveling, I learned that a herd of at least 200 elephants ranges over the vast grassy plain extending southward from near Nakorn Sritamarat almost to Singora on the west side of the Inland Sea and practically from the Gulf of Siam to the high mountains in the west. This plain, suitable for rice growing, is entirely uncultivated owing to the
Fig. 15 Comparative size and characteristics of African and Asiatic elephants (adapted from Haberly, 1963)
Fig. 16 Probable distribution of wild elephant (based on the information in appendix H)
ravages of the elephants," (Smith 1926 in Harper, 1945, p. 313).

Habitat Requirements. A tropical evergreen forest rich in bamboo, palm trees, other food plants and water sources is an ideal habitat of the elephants. The Asiatic elephants do not migrate. This is because of the food abundance in the evergreen forest of Asia. In Africa, on the other hand, the animals predominantly live in the open scrub and savannah areas where the climate is semi-arid, and often migrate.

Food and Habits. The elephant is an herbivore, feeding mainly on leaves of palms and bamboo and grasses. Agricultural crops such as rice plants, sugar cane, and coconut palms are favorite foods. Elephants are extremely adaptable and live in steamy humid jungle or in cool elevated forests (Prater, 1965). This author stated that,

"... in Burma they wander at all seasons of the year into bamboo forests at a height of 10,000 feet; while in Sikkim their tracks have been seen in the snow 12,000 feet above sea level. In the dry season the herds generally keep to the denser forests, but during the rains they come out into open glades and frequently enter cultivation. Individuals of various sizes and ages associate in herds which may vary from five to sixty or more animals. Herds are believed to be composed of single families. Different herds do not mix, but stray females and young males may migrate from one herd into another. When fodder is scarce, the larger herds break up into small parties, which reunitate when conditions are favorable. The big tuskers are usually seen feeding at some distance from the main herd. The bulls, when they arrive at a certain age, live alone, or two males of equal age may associate together..."

"When undisturbed, the herd pursues a regular and ordered routine, drinking and feeding in accustomed places and lying up to rest in its usual retreat. Elephant sleep during the hot hours of the day, being intolerant of the sun, feed early in the morning and evening, and come out after nightfall to feed in open forest or to raid crops, retiring to sleep after midnight."

Reproduction and Longevity. There seems to be no definite breeding season. The gestation period is 607 to 614 days and one or sometimes two young are born (Walker et al, 1964). Males and females usually reach
sexual maturity at fourteen to fifteen, and fifteen to sixteen years of age respectively (Flower, 1931). Foenander (1961) gives a breeding rate as one calf to a cow every two and a half years, and cows mature as early as fifteen years and live for approximately seventy years. Thus with a herd of one bull and six sexually mature young cows, there is a maximum possibility of forty-two progeny, six of which would be freshly sexually mature, thirty immature and newly born in the short period of seventeen and a half years.

**Relation to Land Use.** "It would appear that forest exploitation and regeneration operations, in general, favor elephants, since the regenerated forest contains more feed than did the primary forest which it replaces," (Burgess, 1961, p. 148). But the disturbance from human activities tends to force the animal to retreat to the undisturbed dense forests. Wild animals, such as elephants, when they are disturbed have the habit of curtailing their breeding (Hubback, 1932 in Harper, 1945).

Elephants can do a great deal of harm to agricultural crops. In former times when they were abundant, farmers suffered from the damage to their crops (particularly rice) caused by the animals.

"Where elephants have been forced to live in jungle areas which are insufficient for their normal existence, and where they have become a serious menace to cultivation, it advocated that they should be destroyed by persons whose business it would be to undertake the work . . . ."

"Raids on native cultivation are often due to neglect. Persons familiar with the habits of elephants can often move a herd from the vicinity of cultivation by following them all day until they are miles away from the locality they visited the previous night . . . ." (Hubback, 1932 as quoted by Harper, 1945, pp. 312-313).

Presently crop damage by elephants hardly ever occurs due to the great reduction in their number caused by heavy hunting for tusks, as well as
live capture for domestication.

**Future Management.** The elephant is a large mammal; if its population increases to a level of overabundance, damage to both the range and private crops would be great. A management technique should adhere to the principle that the number of animals should be kept in balance with the natural habitat. Complete protection of elephants should be provided to those animals living in the national parks or in the sanctuaries. The overflow of animals outside these areas should be taken by public hunting or captured for domestication. The latter activity at the present time, however, is no longer important due to the gradual replacement of more advanced machinery.

**VI. DISCUSSIONS AND SUGGESTED PLANS FOR CONSERVATION**

The important current problems in the conservation of large mammals in Thailand are overhunting and the destruction of their habitats. Many species are suffering from these pressures. Some large mammals, for example—the hog-deer, the Eld's deer, and the wild buffalo, have become endangered and are going to be wiped out unless effective measures in conservation are taken. The extinction of the Schomburgk's deer in the past forty-three years is an obvious example of this danger. The extensive clearing of the forested areas in the past has rapidly reduced the animals' habitats. Wherever the forest is opened up, these animals become more vulnerable to poaching. These developments have been rapid, especially during the post-World War period and particularly in the more accessible areas such as the forests near the towns.

The watersheds of the important rivers have also been damaged. No less than three to four million hectares of such areas in the north have
been cleared by the nomadic hill-tribes, who have a population of between 300,000-400,000 people (Banijbhatana, 1962). They predominantly subsist by hunting and shifting cultivation (slash farming). Much of the valuable timberland in the accessible areas, the lower hill slopes, at the feet of the mountains, or in the valleys in which the sandy loam and alluvial soils are favorable for cultivation, have been extensively cleared and turned into sugar cane plantations, paddy fields, and other farm cropped areas. These areas were previously inhabited by many kinds of large mammals and other game in abundance.

Hunting activities are generally due to population increase, better transportation, and more effective firearms. When the human population increases, the need of agricultural land, and better communication also increases. Greater prosperity, in general, enables the people to afford better firearms. These factors combined with ineffective law enforcement have caused the reduction of the game populations.

In the northeastern region, which is considered the poorest part of the country, both in productivity and personal income, the animals' habitats had been denuded by the same practices. Besides, the open dry dipterocarp forests and grasslands, which are the important habitat of hog-deer and Eld's deer, have been turned into paddy fields.

The clearing of the tropical rain forest in the South for pararubber plantations, orchards, and tin mines, are responsible for the disappearance of the gaur, sambar deer, barking deer, and other big game. This situation is also very critical in the eastern part of the country which is near the sea coast and the city of Bangkok. More than 60 percent of the tropical evergreen forest has been lost by illegal cutting by selfish
sawmillers and the opening of these areas for the purpose of growing tapioca, sugar cane, cassava, and other orchards (Banijbhatana, 1962). These crops are usually grown in areas where heavy logging was conducted in the past.

Comparatively speaking, it is not too late for Thailand to embark on a large scale wildlife restoration program by creating game sanctuaries, national parks, and other similar areas, and enforcing the law effectively. However, the problems cannot be tackled individually, as they are more or less the concern of all the people in the nation. The solution of these problems can be attained in the following ways:

A. Law Enforcement. It is obvious that illegal hunting and destroying of habitats are most critical problems that must be urgently checked. Since the Wildlife Act was passed in 1960, law enforcement has been largely ineffective. This can be confirmed by the record of only thirty-eight offenders having been arrested during the past period of five years. This figure does not indicate that there is little violation of the law. Poaching is conducted by people from all walks of life whenever they have a chance. Their attitude is to kill animals basically for feed; sport is not important. This problem should be overcome by:

(1) The officials concerned must be fully empowered to enforce the law effectively. In addition, they should be encouraged to carry out their duties firmly and impartially.

(2) The penalty must be high enough to stop violations of the law.

(3) Enforcement budgets and personnel must be increased proportionally as the workload increases.

B. Education. Education of the public is most important for the
conservation of any kinds of natural resources. Subjects on Natural Resource Conservation should be extended from the primary school level up to the university level. This measure was partly started by the Ministry of Education about five years ago. This program should be encouraged to continue. Besides, the Royal Forest Department is also directly responsible for this function and is distributing information and exhibiting wildlife displays to the public on many occasions during the year. Such activities should be extended to the rural communities.

C. Restoration. In order to conserve rare species, such as the hog-deer, Eld's deer, wild buffalos, rhinoceroses, and goral, game sanctuaries should be provided in suitable areas where such species previously lived. The creation of national parks is another measure of wildlife restoration that is being proven successful at the present time. These works should be fully supported.

D. The Establishment of Demonstration Game Management Areas. Although the above mentioned measures have been taken to conserve the wildlife of Thailand, it must be remembered that the Wildlife Act is only five years old, and the public has not yet become accustomed to it. Law enforcement alone will never succeed unless the cooperation from the public is obtained. Education of the public through extension is necessary, but it will take a very long time and is probably too uncertain to insure the survival of those mammals which are already rare. In order to assure their immediate conservation, the following plans should be considered by the government agency concerned:

(1) Establishment of demonstration game management areas. In managing the common species of big game animals like gaur, banteng, s\mbar
deer, and barking deer, the objectives of management coincide with the public interest. In a typical case, the Royal Forest Department should set aside a suitable area which was an original habitat of these animals and manage the area on the basis of game management techniques. When the animals increase up to the level of harvestable standard, this game management area may be opened for public hunting on a permit basis. If this pilot work is successful, it is hoped that the people will come to realize the importance of wildlife conservation automatically. Psychologically, whenever the people can get a harvest from the crops on a reasonable scale, they will undoubtedly cooperate with the government work. By this means, conservation can become a reality in a relatively short period of time.

E. Wildlife Conservation Policy. In order to conserve the large mammals, management policies should be developed on the following principles:

(1) Perpetuate the present species and maintain them at the level of balance between the animal population and their range carrying capacity.

(2) Wildlife management should be compatible with the private land-uses, such as minimizing damage that might be caused by the animals.

(3) Provide the greatest recreational harvest to the public. Exploitation of game must be conducted on the basis of sustained yield.

(4) Rare species should be restocked in the suitable areas where they previously occurred.
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APPENDIX A

THE MEAN ANNUAL RAINFALL, TEMPERATURE, AND HUMIDITY OF THAILAND

Table 5. The mean annual rainfall, temperature, and humidity of each region during the period of 1940-1950 (adapted from Tararak, 1952, in Samapuddhi, 1963).

<table>
<thead>
<tr>
<th>Regions</th>
<th>annual rainfall mean (inches)</th>
<th>mean rainy days</th>
<th>temperature mean ann. (F)</th>
<th>mean max. (F)</th>
<th>mean min. (F)</th>
<th>mean humidity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern</td>
<td>55</td>
<td>81.6</td>
<td>68.9</td>
<td>89</td>
<td>66.9</td>
<td>74.5</td>
</tr>
<tr>
<td>Northeastern (Korat Plateau)</td>
<td>55</td>
<td>81.6</td>
<td>79.8</td>
<td>91</td>
<td>70.3</td>
<td>73.9</td>
</tr>
<tr>
<td>Central</td>
<td>53</td>
<td>81.1</td>
<td>79.3</td>
<td>91.6</td>
<td>73.7</td>
<td>78.5</td>
</tr>
<tr>
<td>Eastern</td>
<td>73</td>
<td>115.6</td>
<td>81.7</td>
<td>90.7</td>
<td>72.7</td>
<td>80</td>
</tr>
<tr>
<td>Southern</td>
<td>87</td>
<td>129.5</td>
<td>79.7</td>
<td>89.2</td>
<td>73.9</td>
<td>82</td>
</tr>
</tbody>
</table>

Figure 17. Mean annual rainfall of each region during the period of 1940-1950.
Figure 18. Mean annual temperature of each region during the period of 1940-1950.

Figure 19. Mean annual humidity of each region during the period of 1940-1950.
APPENDIX B

TYPES OF FORESTS AND THEIR SOILS

(Summarized from Samapuddhi (1963))

A. EVERGREEN FOREST

(1) TROPICAL EVERGREEN FOREST. This type of forest is found throughout the country and reaches its greatest development in the southern region. The vegetation representing this type is very complicated, but typical species which are worth mentioning here include: Dipterocarpus alatus, D. turbinatus, D. costatus, D. dyeri, D. grandifolius, D. pilosus, Hopea ferrea, H. odorata, Cotylodium lanceolatum, Intsia bakeri, Afzelia xylocarpa, Vatica cineria, V. wallichii, Shorea curtisii, S. glauca, Anisoptera sp., Mesua ferrea, Litsea grandis, Balanocarpus heimii, Ailanthus fauveliane, Cinnamomum iners, Parashorea stellata, Sandoricum indicum, etc. The characteristic understories and undergrowth are canes (Calamus spp.), ferns, palms, Hydnocarpus kurzii, etc.

Soil textures are of great variety ranging from fine sand, sandy loam to clay. Soil depth varies from 10-15 cm. in A- horizon and 30-150 cm. in B- horizon, depending on topography. The parent rocks are limestone, red sandstone, quartzite rocks, granites, feldspars, and some other rocks of igneous origin.

(2) HILL EVERGREEN FOREST. This type of forest is characterized by the prevalence of various species of Quercus, Lithocarpus, and Castanopsis. This forest occurs in the limited area in mountainous regions at an altitude of about 3,000 feet and upwards. The characteristic trees of this forest type, apart from oaks and chestnut, are Schima wallichii, S. noienhae, Michelia champaca, Helicia robusta, etc. The
understory is composed of *Macaranga* sp., *Wendlandia* sp., *Smilax* sp., *Styrax* benzoin, etc. Soil textures range from fine sand, sandy loam to clay.

(3) **MANGROVE FOREST.** The coastline of the country is about 1,250 miles in length and the greater part of it is occupied by mangrove forest. This type of forest thrives along muddy coasts but is absent on the sandy ones. This forest is sometimes called "tidal forest" and predominantly represented by the family Rhizophoraceae, which is generally known as: *Rhizophora mucronata*, *R. candelaria*, *Bruguiera conjugata*, *B. cylindrica*, *Ceriops roxburghiana*, *C. tagal*. Other associated species are *Xylocarpus maluccensis*, *X. obovatus*, *Avicenia officinalis*, etc. In the drier parts further inland will probably be found *Sonneretia caseolaris* with an undergrowth of *Excoecaria galloccha* and *Acanthus ebracteatus*, etc. This type of forest has its own specific requirement, that is, its site must be close to the seaside, and its soils of a saline, muddy nature absolutely in an undeveloped state.

(4) **CONIFEROUS OR PINE FOREST.** This forest occupies approximately 8,200 square miles of the total forest area and is found in the northeastern part of the country at elevations of 2,100 to 3,000 feet and upwards. Its species are also found occasionally mixed with trees of the Deciduous Dipterocarp type. The stands consist of mainly two pine species: *Pinus khasya* and *Pinus merkusii*. The latter descends to much lower altitudes than the former. Soil textures are loamy to sandy clay loam. Depths are: A- horizon, 15-23 cm.; B- horizon, 80-150 cm. Parent material is an acidic igneous origin.
B. DECIDUOUS FOREST

(1) MIXED DECIDUOUS FOREST WITH AND WITHOUT TEAK. It covers 25% of the deciduous type. The general appearance of the mixed deciduous with teak and without teak is the same, except that the teak bearing type is especially confined to the northern part of the country. The typical timber trees of this forest are Tectona grandis, Pterocarpus macrocarpus, Xylica kerrii, X. xylocarpace, Dalbergia cultrata, D. dongnaiensis, D. oliveri, Dyospyros mollis, Adina cordifolia, Vitex sp., Afzelia xylocarpace, Tetramelis nudiflora, Nauclea orientalis, Albizia lebbek, Wrightia tomentosa, Spondias sp. etc.

In the type of mixed deciduous with teak, soil textures belong to the clayey side and are entirely exclusive of sandy loam or sandy soils. The depth of the A- horizon is 10-22 cm. and that of B- horizon is 40-120 cm. Parent materials are generally limestone, shale, sandstones, rhyolites and some basaltic rocks. In the mixed deciduous forest without teak, soil textures include both sandy and clayey soils. The moisture requirement is probably less than that of mixed deciduous with teak. Depths are 11-34 cm. and 34-100 cm. at A and B horizons respectively. The parent materials are the same as those of the former type.

(2) DECIDUOUS DIPTEROCARP FOREST. This forest type which totals 45% of the deciduous forest areas, presents vast tracts in the northern, central, and northeastern parts of the country. The general appearance is of a somewhat open character with trees of medium size and height. The forest is dominated by Pentacme siamensis, Shorea obtusa, Dipterocarpus tuberculatus, D. obtusifolius, D. intricatus, Terminalia tomentosa, T. chebula, Sindora siamensis, etc. The undergrowth is predominantly com-
posed of grass and sometimes *Phoenix* sp.; *Strychnos nux-vomica* are associated. Soil textures include a variety of classes from fine loamy sand, sandy loam to clay loam and clay. Depths are 10-30 cm. and 25-120 cm. at A and B horizons respectively. Parent materials are derived from sedimentary or metamorphic rocks.

C. OTHER TYPES OF FOREST.

In addition, there are some other small types which do not have high economic value. The two most significant types are beach and swamp forests.
APPENDIX C

Table 6. The percentage of literacy of the Thai people 10 years of age and older, by age group and by sex, surveyed in 1960 (from the National Economic Development Board, 1962).

<table>
<thead>
<tr>
<th>Age Class (year)</th>
<th>Literates (in percent)</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>10 – 14</td>
<td>86.6</td>
<td>84.8</td>
</tr>
<tr>
<td>15 – 19</td>
<td>91.0</td>
<td>85.8</td>
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<tr>
<td>20 – 24</td>
<td>88.6</td>
<td>79.4</td>
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<tr>
<td>25 – 29</td>
<td>85.7</td>
<td>75.0</td>
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<td>30 – 34</td>
<td>86.0</td>
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<td>35 – 39</td>
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<td>40 – 44</td>
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<td>60 – 64</td>
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APPENDIX D

SIMPLIFICATION AND EXPLANATION OF THE WILDLIFE LAW

According to the Wild Animal Reservation and Protected Act B.E. 2503 (1960), the term wild animal means all wild animals except insects which are classified as reserved and protected. The protected wild animals are further subdivided into first and second categories. Reserved animals are considered very rare and are not allowed to be hunted except for educational or scientific or public zoological garden purposes; each such case requires a special written permit from the Director General of the Royal Forest Department. There are nine species of animals included in this group: Javan rhinoceros, Sumatran rhinoceros, kouprey, wild buffalo, hog-deer, Eld's deer, Schomburgk's deer, serow and goral.

Protected wild animals of the first category legally mean those whose meat is not usually used as human food, or which are not usually hunted for sport, or which destroy plant pests, or which should be reserved for natural beauty or for increasing their population size. Capturing alive animals of this category is permissible, but slaying these animals is not allowed except by collection permit issued only for educational or scientific purposes. Animals in this category include binturong, tapir, lemur, gibbons, lesser adjutant stork, greater adjutant stork, white ibis, open-billed stork, painted stork, black stork, white-necked stork, black-necked stork, sarus crane, pelican, great argus pheasant, peacock pheasant, egrets, oriental darter, cormorants, red-wattled lapwing, green peafowl, all pheasants, all hornbills, all kingfishers, white-breasted water rail, Indian broad-billed roller, koel, cœcal, all woodpeckers, all drongos, all orioles, magpie robin, white-
rumped shama, common myna, grackle, Indian jungle myna, black collared starling, comb duck, white-winged wood duck, and crested wood partridge.

Protected animals of the second category are defined as those which are palatable for human consumption, or which are usually hunted for sport. Hunting of these animals can be done by securing a license authorized by the competent authorities. Animals of this category are represented by gaur, banteng, sambar deer, barking deer, chevrotains, jungle fowl, all wild ducks except comb duck and white-winged wood duck, night heron, purple heron, grey heron, partridge, gallinule, Malay-banded rail, coot, jacana, doves, fantail-snipe, and painted snipe.

There are two kinds of hunting licenses: provincial resident, and the non-provincial resident. The provincial resident license is issued by the provincial governor, in whose jurisdiction the applicant is residing. The non-provincial resident license is issued only by the Director General of R.F.D. in Bangkok.

Hunting license fees for big game animals are 50 baht for non-provincial resident, and 5 baht for provincial resident licenses (20 baht=1 U.S. dollar); plus head fees payable in advance for animals to be hunted, as shown in the table below:

Table 7. List of animals permitted to hunt and rates of license fee

<table>
<thead>
<tr>
<th>Animals to be hunted</th>
<th>Non-provincial resident fee rate per head (Baht)</th>
<th>Provincial resident fee rate per head (Baht)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. gaur, banteng</td>
<td>250</td>
<td>50</td>
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<tr>
<td>2. sambar deer</td>
<td>100</td>
<td>20</td>
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<td>3. barking deer</td>
<td>50</td>
<td>10</td>
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<tr>
<td>4. chevrotain</td>
<td>20</td>
<td>5</td>
</tr>
</tbody>
</table>
Non-provincial resident and provincial resident fees for hunting licenses of small game (bird species) are 25 baht and 5 baht respectively.

HUNTING REGULATIONS. Licensees must strictly comply with the following regulations.

1. Hunting of the animals during the closed seasons is prohibited, as is shown below:

**Table 8. Closed hunting seasons as determined by law**

<table>
<thead>
<tr>
<th>Animals</th>
<th>Closed Seasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. gaur, banteng</td>
<td>January to February, May to August, October to December.</td>
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<tr>
<td>2. sambar deer, barking deer, and chevrotain</td>
<td>January to February and May to December.</td>
</tr>
<tr>
<td>3. jungle fowl</td>
<td>March to June.</td>
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<tr>
<td>4. partridges</td>
<td>February to August.</td>
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<tr>
<td>5. coot</td>
<td>April to June.</td>
</tr>
<tr>
<td>6. ducks, night heron, purple heron, grey heron, gallinule, Malay-banded rail, jacana and painted snipe</td>
<td>April to September.</td>
</tr>
<tr>
<td>7. doves</td>
<td>April to July.</td>
</tr>
</tbody>
</table>

2. The following female animals cannot be hunted unless a written permit is acquired from the Director General: gaur, banteng, sambar deer, barking deer, and jungle fowl.

3. No hunting of the young ones of gaur, banteng, sambar, barking deer is allowed if their horns or antlers are not developed, unless a written permit from the Director General is obtained.
4. Hunting in the manner stated below is not permissible:
   (a) Hunting with the aid of flashlight.
   (b) Firing from an automobile or any vehicle.
   (c) Firing from the backs of elephants, horses, prepared tree shack or hunting stand.
   (d) Firing from or along or across the highway.
   (e) Shooting from sunset to sunrise is not allowed, except the shooting of tigers at the sites of their kill.
   (f) Hunting, collecting, endangering or keeping in possession the eggs or nests of wild animals within the precinct of a monastery or a place provided for religious observance of the public is not permitted
   (g) Hunting with the following weapons or tools is not allowed: a trap, barbed trap, bird lime, net or seine, unmanned-triggered trap, gun trap, machine gun, pit trap, box or crossbow with poison tipped arrow, poison bait, and explosives.
   (h) Hunting within a game sanctuary is illegal.
   (i) The following bag limits are determined for some kinds of birds, such as: 5 jungle fowl, 10 ducks, 2 purple or grey herons, 5 night herons, and 10 doves per day.

TRADING IN AND KEEPING IN POSSESSION THE WILD ANIMALS AND THEIR MEAT.

1. Trading in and keeping in possession the reserved group and their meat are absolutely prohibited. In case of protected animals, the licenses are required.
2. The reserved animals are not allowed to be exported.

3. The protected animals may be exported only in the case of exchanging them with the exotic animals for educational or scientific purposes and this must be arranged by a creditable wildlife institute.

4. Non-protected animals such as clouded leopard, and dugong are not allowed to be exported by any event.

GAME SANCTUARIES. If any area is considered suitable for wildlife habitat, the Royal Forest Department will create it as a game sanctuary by the Royal Decree. No person can enter that area without permission from the official appointed by the Director-General. Hunting in the game sanctuary is completely prohibited.

WILDLIFE COMMITTEE. There is a committee consisting of the Under-Secretary of State for Agriculture as chairman, Director Generals of the Royal Forest Department, Interior Department, and Land Department as ex-officio members, and eleven other members appointed by the Cabinet. The appointed members hold office for a term of two years. This committee has the duty of considering and giving advice to the Minister of Agriculture in the following matters:

(1) Determination of closed hunting season.

(2) Determination of rules and conditions concerning the permission to hunt and trade in wild animals.

(3) Activities to be carried out for the purpose of maintaining game sanctuaries.

(4) Other matters on which consultation is sought by the Minister.

PENALTY.

(1) Whosoever hunts the reserved wild animals shall be punished
with imprisonment not exceeding one year or a fine not exceeding ten thousand baht, or both.

(2) Whosoever hunts the protected wild animals during the closed season shall be punished with imprisonment not exceeding six months or a fine not exceeding five thousand baht, or both.

(3) Whosoever hunts within a game sanctuary shall be punished with imprisonment not exceeding two years or a fine not exceeding twenty thousand baht, or both.

(4) Whosoever hunts the protected animals without securing the hunting license shall be punished with imprisonment not exceeding three months or a fine not exceeding two thousand baht, or both.

(5) Whosoever violates the hunting regulations shall be punished with imprisonment not exceeding one month or a fine not exceeding one thousand baht, or both.
ADMINISTRATION OF THE ROYAL FOREST DEPARTMENT

The Royal Forest Department is included in the Ministry of Agriculture. Its present administrative organization is as follows:

Central Administration

1. Director-General, as head of the department.
2. Two Deputy-Directors-General; one for technical functions and the other for administrative work.
3. Forestry Expert and Advisor.
4. First Grade Technical Officer.
5. Office of Secretary.
6. Division of Finance.
7. Division of Forest Working Plans.
8. Division of Forest Control.
9. Division of Forest Products Research.
10. Division of Forest Silviculture.
11. Forest Duty Stations (2 in all).
12. Divisional Forest Offices (21 in all, spread over various regions).
13. Forest Protection Units (20 at present).
14. Division of Forest Police.

Each division is subdivided into sections. The wildlife and National Park Sections were recently established in the Division of Forest Silviculture, a year after the Wildlife Act was passed in 1960.
Territorial Administration

1. Provincial Forest Offices. There are 61 Provincial Forest Offices and each is under the charge of a provincial forest officer who is directly responsible to the provincial governor.

2. Township Forest Offices. There are 382 Township Forest Offices and each is supervised by a township forest officer, who is under the control of the provincial forest officer.

Both the provincial and township forest officers are directly appointed and promoted by the Royal Forest Department. With regard to the administrative work concerning forestry, wildlife and other related activities, the Director General of the Royal Forest Department has an authority to order them both directly to their offices, or indirectly through the provincial governors.
REASONS FOR THE HYPOTHESIS OF KOUPREY AS A HYBRID

(From Delano, 1965)

"For the following reasons, it is believed that this strange wild ox is a hybrid: 1) According to Pietri and natives, males and females of the kouprey have never been seen together. 2) Edmond-Blanc saw one single kouprey on one occasion, and two individuals on two different occasions, together with herds of bantengs. When disturbed, the herds fled, the strange animals staying behind with bantengs. 3) The young kouprey closely resembles the young banteng. 4) Even though its range is large, the animal is not common in any part of it.

If we assume that this is a hybrid population, then these are the five important points: 1) The kouprey is found very often with herds of bantengs, but is differently colored and has no light rump patch, nor is there any horny tissue between the horns. Furthermore, the kouprey is much larger than the banteng. 2) It resembles the gaur in the shape of the hoof, the presence of white socks and the presence and size of the hump, which is remarkably developed. 3) The dewlap resembles that of domestic cattle of Indochina. 4) The habits and the shape of the head are like those of a water buffalo. 5) The kouprey is found only in the region in which these four species occur together.

Let us now examine the possibility of hybridization between any two of the four species of bovids inhabiting this region.

Gaur and banteng. Edmond-Blanc saw a female gaur together with a calf in the midst of a herd of bantengs. Pietri told him that on several occasions during his many trips into the region he had seen four female
gaurs in herds of bantengs. He believed that they were the same individuals. The kouprey and the gaur resemble each other in the shape of the hoof, the presence of white socks and the presence and size of the hump. Against the hypothesis of a gaur-and-banteng hybrid are the following points: Why should such a hybrid have the habits of a water buffalo? Why should it have the enormous dewlap which appears in neither the gaur nor the banteng, but which is so apparent in the domestic cattle of the region?

**Banteng and water buffalo.** In this particular area in eastern Cambodia, water buffalo inhabit the same region and the same particular territory as bantengs. Although Edmond-Blanc had never seen these two species actually together in the same band or herd, he did see individuals of the two in close proximity to each other, and this is not possible in any other region. The hoofs of the kouprey are smaller, but they are shaped like those of the water buffalo. The shape of the head, the color of the skin and the manner in which the hair is worn off the sides is alike in kouprey and water buffalo. The sheaths of the horns of the banteng and the water buffalo are of entirely different constitutions; a mixture of the two might possibly be the cause of the shedding of the horny sheath. Against this hypothesis of hybridization of water buffalo and banteng we have the hump of the kouprey, which is not a characteristic of either the water buffalo or the banteng.

**Banteng and domestic cattle.** The dewlap and the shape of the head resemble those of domestic cattle, but against this we have the larger size of the kouprey and all the other special characteristics mentioned above.
Since the animal apparently lives with the banteng, it is probable that the banteng must be considered to be one of the parents, and therefore it is not necessary to consider the three other possibilities - gaur and water buffalo, water buffalo and domestic cattle, gaur and domestic cattle."
APPENDIX G

SCIENTIFIC NAMES OF MAMMALS AND BIRDS

A. Mammals

Javan rhinoceros, Rhinoceros sondaicus
Sumatran rhinoceros, Didermocerus sumatrensis
Wild buffalo, Bubalus bubalis
Kouprey, Bibos sauveli
Eld's deer, Cervus eldi
Schomburgk's deer, Cervus schomburgki
Hog-deer, Axis porcinus
Serow, Capricornis sumatraensis
Goral, Nemorhaedus goral
Gaur, Bibos gaurus
Banteng, Bos banteng
Sambar deer, Cervus unicolor
Barking deer, Muntiacus muntjak
Mouse deer or chevrotain, Tragulus javanicus
Tapir, Tapirus indicus
Wild elephant, Elephas maximus
Binturong, Arctictis binturong
Lemur, Nycticebus coucang
Gibbon, Hylobates spp.

B. Birds - as indicated by law.

Lesser adjutant stork, Leptoptilos javanicus
Greater adjutant stork, L. dubius
Birds (continued)

White ibis, *Threskiornis melanocephalus*

Open-billed stork, *Anastomus oscitans*

Painted stork, *Ibis leucocephalus*

Black stork, *Ciconia nigra*

White-necked stork, *Xenorhynchus asiaticus*

Sarus crane, *Grus antigone*

Pelican, *Pelecanus* spp.

Great argus pheasant, *Argusianus argus*

Peacock pheasant, *Polyplectron* spp.


Oriental darter, *Anhinga anhinga*


Red-wattled lapwing, *Lobivanellus indicus*

Green peafowl, *Pavo muticus*

All pheasants, *Lophura*, spp.

Great-pied hornbill, *Buceros bicornis*

All kingfishers, Fam. *Alcedinidae*

White-breasted water rail, *Amaurornis phoenicus*

Indian broad-billed roller, *Eurystomus orientalis*

Koel, *Eudynamys scolopaceus*

Coucal, *Centropus sinensis*

All woodpeckers, Fam. *Picidae*

All drongos, Fam. *Dicuridae*

All orioles, *Oriolus* spp.
Birds (continued)

Magpie-robin, Copsychus saularis
White-rumped shama, C. malabaricus
Common myna, Acridotheres tristis
Grackle, Gracula religiosa
Indian jungle myna, Acridotheres fuscus
Black collared starling, Sturnus nigriceps
Comb duck, Sarkidiornis melanotos
White-winged wood duck, Cairina scutulata
Crested wood partridge, Rollulus roulroul
Jungle fowl, Gallus gallus
Night heron, Nycticorax nycticorax
Purple heron, Ardea purpurea
Grey heron, A. cinerea
Field partridge, Francolinus pintoanus
Wood partridge, Caloperdix oculea
Purple water hen, Porphyrio poliocephalus
Malay banded rail, Rallina fasciata
Coot, Fulica, spp.
Jacana, Hydrophasianus chirurgus
Doves, Streptopelia, spp.
Faintail snipe, Gallinago gallinago
Painted snipe, Rostratula benghalensis
Table 9. Data showing present distribution of protected large mammals of Thailand as reported by the Divisional Forest Offices in 1961-1962

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<tr>
<th>Provinces</th>
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1 - Javan rhino  2 - Sumatran rhino  3 - Kouprey  4 - Wild buffalo  
5 - Gaur  6 - Banteng  7 - Serow  8 - Goral  
9 - Hog-deer  10 - Eld's deer  11 - Sambar deer  12 - Barking deer  
13 - Chevrotain  14 - Malay tapir  15 - Wild elephant

* Animal still present  
- No report of its presence