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Oryx - The International Journal of Conservation, is now published quarterly by Cambridge University Press on behalf of Fauna & Flora International. It is a leading scientific journal of biodiversity conservation, conservation policy and sustainable use, with a particular interest in material that has the potential to improve conservation management and practice.

The website, <http://www.oryxthejournal.org/>, plays a vital role in the journal's capacity-building work. Amongst the site's many attributes is a compendium of sources of free software for researchers and details of how to access Oryx at reduced rates or for free in developing countries. The website also includes extracts from Oryx issues 10, 25 and 50 years ago, and a gallery of research photographs that provide a fascinating insight into the places, species and people described in the journal.

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A Look at Threatened Species

A REPORT ON SOME ANIMALS OF THE MIDDLE EAST
AND SOUTHERN ASIA WHICH ARE THREATENED WITH
EXTERMINATION

The International Union for Conservation of Nature and
Natural Resources

Survival Service Field Mission of 1955 and subsequent inquiries

By

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Photographs by the author Great Indian Rhinoceros by E. P. Gee

A LOOK AT THREATENED SPECIES

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FOREWORD

To preserve the last surviving remnants of gravely endangered species of fauna and flora from total extinction becomes more urgent every day, as the spread of civilization takes over their native habitat. In 1931, when the American Committee for International Wild Life Protection was established, it focused attention on the need for gathering information about gravely endangered species of mammals and birds. The Committee raised funds to support research on this subject, which culminated in the publication of *Extinct and Vanishing Mammals of the Western Hemisphere* by Glover M. Allen in 1942, *Extinct and Vanishing Mammals of the Old World* by Francis Harper in 1945, and *Extinct and Vanishing Birds of the World* by James C. Greenway, Jr., in 1958. These volumes furnish a base line of knowledge to assist future efforts in the protection of endangered species.

When the International Union for the Protection of Nature, or Union for the Conservation of Nature and Natural Resources, as it is now called, was founded at Fontainebleau in 1948, with the assistance of UNESCO, the problem of the fate of endangered species was recognized as a principal interest of the Union. It was at the International Technical Conference on the Protection of Nature, at Lake Success in 1949, that the first official list of gravely endangered species was drawn up. Thus the groundwork was laid for the establishment of the Union's Survival Service, whose primary function was to centralize information on endangered species, to keep the existing records up to date, and to focus world attention and seek governmental action in dealing with this problem.

In 1954, the Survival Service Commission was fortunate in obtaining the services of the young Californian ecologist, Lee M. Talbot, who undertook to make an on-the-spot survey of Middle East and Southern Asia countries in order to look into the status of selected species, many of which were on the official list of gravely endangered species. Talbot's mission was made possible by a generous grant from Mr. Russell Arundel, of Warrenton, Virginia. I, as Commission Chairman at that time, felt that we were particularly fortunate in the selection of Mr. Talbot for this assignment. He gathered a large amount of valuable information on the status of eight endangered species

with which the Commission was particularly concerned. He also established for the Union closer relations with governments, organizations, and individuals interested in the subject of conservation, and he served as a goodwill ambassador leaving a lasting favorable impression in the countries which he visited. The success of his mission, as he indicates, depended a great deal on co-operation from many governments and individuals, for which we are most grateful.

Since returning from his mission in 1955, Mr. Talbot has enlarged his knowledge of the areas and species which he studied through bibliographic research and correspondence. This final report sets forth the scientific results of his field work and subsequent research in a semi-popular manner. I have no hesitation in concluding that the important contribution made to our knowledge of threatened species, as a result of his first-hand investigation of their habitat and of his consultation with local observers, gives us unique information not previously available. The story he tells is further enhanced by his excellent photographs, as well as the carefully prepared drawing and maps by Mr. Christman.

The findings set forth in this publication indicate the need of further investigations of the ecology of the three Asian rhinoceros, the Indian Lion, the Arabian Oryx, and the Syrian Wild Ass. Let us hope that this report will encourage further work in this field, and will also encourage governments to take further steps to enforce the laws protecting the species which the author has described, as well as permanently assuring the integrity of parks and reserves which include the native habitat of the endangered species.

We are grateful to the Fauna Preservation Society for the publication of this report and to the following for the financial aid which made its publication possible : Mr. Russell M. Arundel, Mr. Suydam Cutting, the American Committee for International Wild Life Protection.

HAROLD J. COOLIDGE,
Vice-President,
International Union for Conservation
of Nature and Natural Resources.

13th October, 1959.

WASHINGTON, D.C.

ACKNOWLEDGEMENTS

The Survival Service project which resulted in this publication was made possible by Mr. Russell M. Arundel. Endless details of preparation and correspondence were handled by the Secretariat of the International Union for the Conservation of Nature and most especially by Madame Marguerite Caram and Miss Jocelyn Arundel. Mr. Harold Coolidge was the guiding spirit behind the project from its conception.

A field mission such as this is absolutely dependent on the goodwill and co-operation of a great number of people. There were so many people involved in the success of this project that it is not possible to list them individually here. Particular gratitude is due to the representatives of my host governments, the Heads of State, Ministers, Administrative Officials, Parks, Forestry, and Game Departments, whose active co-operation was so essential. Other organizations also helped me greatly. Among them were the UNESCO Science Co-operation Offices, the UNESCO Technical Assistance Board, the American National Parks Association, the Lebanese Society of the Friends of the Trees, the Indian Board for Wild Life, the Bombay Natural History Society, the American International Co-operation Administration field staff, and the Arabian American Oil Company. The personnel of the Museums, Universities, Zoological Gardens and Experiment Stations visited, during both Part I and II, were most generous with their help and information. Indeed, the hospitality and help I received throughout this mission will remain one of my warmest memories.

The maps and drawings are by Mr. Gene Christman, Staff Illustrator of the Museum of Vertebrate Zoology, University of California, at Berkeley, and their accuracy is the result of long and careful work. Finally my thanks are due to those who reviewed and provided advice on parts of this work, and to Mrs. Jean Packard who edited and proofed the rough draft.

INTRODUCTION

The International Union for the Conservation of Nature established its Survival Service in 1949. As the name implies, the concern of this service is the survival of species threatened with extinction, and one of its duties is to collect information about these species and their status. This information serves three chief functions :

1. It is available to the governments or agencies concerned with the management or protection of these threatened species.
2. It can be used by IUCN as a basis for further action.
3. It is a source for workers on the problem of vanishing species.

Another duty of the Service is keeping a list of animals in imminent danger of extinction. This list focuses international attention on the problem, particularly when the listed species are large and spectacular—animals which capture the imagination of the public.

Between 1949 and 1954 the Survival Service collected information on threatened species of animals through library research and correspondence conducted by the IUCN Secretariat at Brussels and by Mr. Jean Jacques Petter of the Museum of Natural History in Paris. Much important information was gathered by this method, but the limitations of any method that relied entirely on published documents and correspondence soon became evident. In most cases very little was known about the animals themselves for the species involved had retreated to the most remote corners of their former ranges, so that even under peaceful conditions, information regarding their status was scarce and hard to obtain. This inherent difficulty was increased by the Second World War and its aftermath. Habitats of many of the species had been the scene of fighting and in the early 1950s these habitats—or the areas of access to them—were still involved in military activities or unsettled civil conditions. The only sure way to obtain information on many of the species was for scientists to survey the areas involved in order to collect information on the spot. Such a program was tentatively planned, but was not financially feasible until 1954 when it was made possible through a generous grant to the Survival Service by Mr. Russell Arundel, an American conservationist deeply concerned with the plight of endangered

species. I had the privilege and good fortune to be asked to carry out this program.

The Mission.—The principal aims of the mission were :

1. To survey the present status of certain threatened species of large mammals.
2. To determine the ways in which IUCN might co-operate most effectively with the local authorities, institutions, or persons concerned with the conservation of these mammals.
3. To collect other information about threatened species in particular, and about conservation in general, in the more remote areas visited.

The mission was divided into two parts.

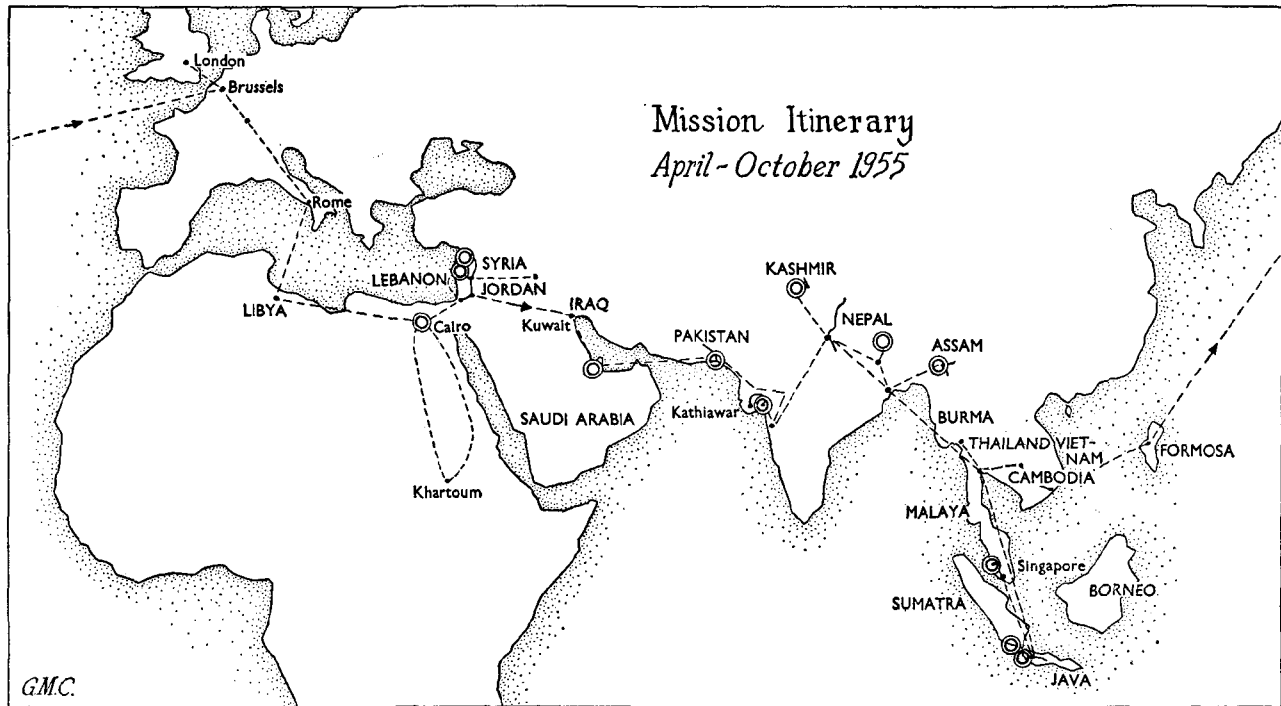
Part I was the period from December, 1954, until April, 1955. I spent part of the time at the Brussels office of IUCN getting accustomed to the Union and its operations. Then I travelled to England, Scotland, Germany, Holland, France and Denmark to consult experts in various fields affected, particularly ecology, getting the background and making contacts for the countries to be visited during Part II. During December, 1954, I carried out a similar program in the United States.

Part II began on 11th April, 1955. After leaving Brussels, I travelled, mostly by air, through about thirty countries on a six month journey of 42,000 miles. My itinerary was as follows :

Belgium, Libya, Egypt, Sudan, Egypt, Lebanon, Syria, Jordan, Iraq, Kuwait, Saudi Arabia, Pakistan, India, Nepal, Thailand, Indonesia, Singapore, Malaya, Burma, Cambodia, Viet Nam, Philippines, Japan, Hawaii, United States, Belgium.

Before leaving Brussels I had of course made contact with people I hoped to meet during my journey, and in each country I enlarged my contact list for the countries still to come. The UNESCO Science Co-operation Offices were very helpful with this. They furnished many facilities, aided with transport, visas, information and contacts, and actively co-operated in every way. The American International Co-operation Administration (Point 4), especially through its branches in forestry, range management, and disease control, provided a great deal of additional aid, transport and information.

Although each local situation differed and required a slightly different approach, the general procedure in all countries was the same :



1. On arrival in a country I was met by a person previously contacted.

2. I consulted Government officials to gain their interest and approval for the project. These officials ranged from the heads of state, such as Prime Minister Nehru in India, or the ministers most directly concerned with conservation, to local administrators and forest guards.

3. Wherever possible, I met the scientific personnel most concerned.

4. Where possible, I visited the remote habitats of the animals in question, or areas of outstanding conservation or of ecological interest. My expeditions were arranged with the co-operation of the local authorities. All told, they involved some 10,000 miles of travel by 37 different kinds of field transport and included :

The Eastern Desert of Egypt, the Wadi Rishrash, formerly an Ibex reserve.

North Lebanon, at 6,000 to 10,000 feet elevation in the Kammouha district where isolation and tribal difficulties have allowed a remnant of the Middle East's once extensive forest cover to remain.

A similar area in north-western Syria north and east of Latakia.

The Gir Forest, Asian lion habitat, in Saurashtra, India.

The Himalayas (to 13,000 feet elevation) in Kashmir, via horse and foot, in search of the Kashmir Stag.

Lower Assam, India, into Kaziranga Indian rhinoceros sanctuary, via elephant.

Kingdom of Nepal, the Rapti Valley, another habitat of the Indian rhinoceros.

South-west Sumatra, searching for the Sumatran rhinoceros, through the trackless jungle mountains.

Udjon Kulon Reserve, western Java ; two weeks observing the Javan rhinoceros and other marvellous wildlife of the area.

This list does not include the many one- or two-day automobile or jeep observation trips in virtually every area visited. Most notable of these, perhaps, were in Saudi Arabia, Jordan, Pakistan, and parts of western India and Java.

5. Before leaving each area I made arrangements to be kept up to date on matters affecting the status of the animals considered and on general conservation.

My mission was as a field investigator gathering information for the Union, not as a visiting expert adviser. Some of the

people I met seemed rather pleased that here was a foreigner who did not come to advise them on how to run their lives. I also stressed that no long-term studies of any animal or area were being attempted; rather, that the aim was an extensive reconnaissance.

Method of Presentation of this Report.

Part I.—Since the ranges of the animals investigated do not follow political boundaries, I have organized the information on the principal animals by species, rather than by country. Within each chapter, information is given under the headings of: "Description", "Distribution and Status", and "Ecological Notes".

Distribution and Status is presented country by country, with sections on "Former" and "Present". Much of the data on former distribution is drawn from Harper's *Extinct and Vanishing Mammals of the Old World* (New York, 1945). This publication is the finest existing compendium on Old World threatened species. I have made frequent references to it, mentioning it in the text without making formal acknowledgement.

The distribution maps drawn by Mr. Gene Christman, are the result of long and careful study. "Former Distribution" has been dated both to increase accuracy and to point out the rapid acceleration of extermination. Where there is doubt about the former range at a given time, this is indicated on the map. Under "Present Distribution" distinction is drawn between reports that are verified and those that are unverified, but which seem probable in the light of my investigations.

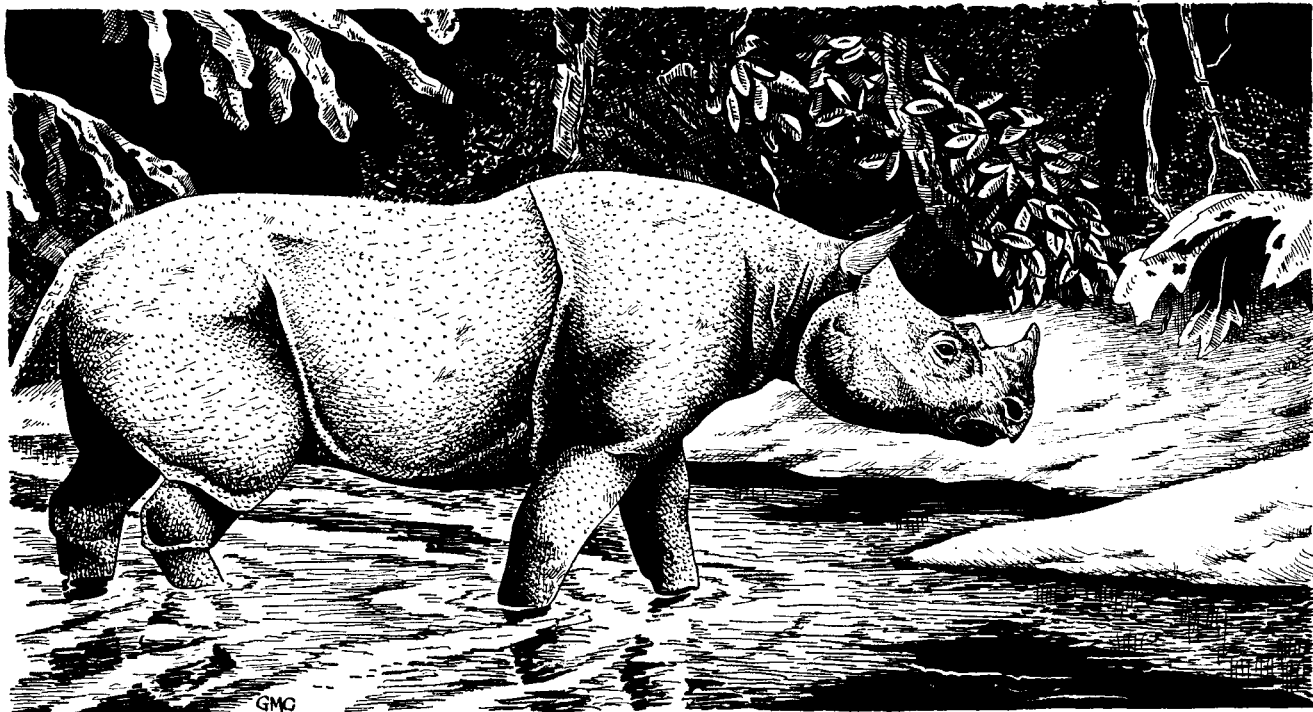
Under "Ecological Notes" I have included a variety of information under such headings as: History and Causes of Extermination, Habitat, Other Animals, and Conclusion and Recommendations. So little is known about these animals that, in many cases, what relatively little I was able to learn seems worthy of presentation. Such details also help to present the reader with a balanced picture of the animal's status.

Part II.—During my rather brief visits to each country there was neither time nor opportunity to get a full and balanced picture of conservation in general, and this section does not claim to present such a picture. Instead, it contains a variety of information of interest to conservationists—highlights of conservation in each area. The information is divided into "General" and "Wild Life" sections. General land use, national parks and reserves, and conservation attitudes are the

sort of thing that appears under "General". These sections are arranged by countries. They provide perspective to aid in a better understanding of the status of the animals of Part I.

This report is of necessity a compromise between a scientific paper and a popular work. I have endeavoured to present the material in such a way that it is interesting, readable, and understandable to a non-technical person ; while organizing it so that a serious worker has easy reference to the data he needs.

PART I
THE PRINCIPAL ANIMALS
INVESTIGATED



THE SUMATRAN RHINOCEROS

SUMATRAN RHINOCEROS: ASIATIC TWO-HORNED RHINOCEROS

Didermocerus sumatrensis Fischer

Under "Sumatran Rhinoceros" I am including the Sumatran Rhinoceros of Borneo and Sumatra, *Didermocerus sumatrensis sumatrensis* (G. Fischer); the Chittagong or Hairy-eared Sumatran Rhinoceros of Bengal and Assam, *Didermocerus sumatrensis lasiotis* (Buckland), and the Malaccan Rhinoceros of Burma, Siam, the former French Indo-China, and the Malay States, *Didermocerus sumatrensis niger* (J. E. Gray).

I. DESCRIPTION

This is the smallest of the living rhinoceros. Height at the shoulder may be from 4 to 4½ feet; length from snout to root of tail, 8 to 9 feet. There are two horns, the anterior one generally under a foot long (there is one 19 inches long from Sarawak and a 32½ inch one in the British Museum of Natural History), the posterior 2 to 4 inches. The posterior horn is often quite small, especially in females, and from a distance it may appear to be missing entirely. This probably gives rise to the numerous reports of "one-horned rhinos" from areas outside the present range of either the Indian or the Javan rhinoceros. Unlike the Javan and Indian rhinos, whose skin appears to be made of armor plates, the Sumatran rhino's hide appears relatively smooth, with a conspicuous fold just behind the shoulder. On closer examination, the surface of the skin is seen to be quite rough and, in young animals at least, is thinly covered with short hair. The color and density of this hair varies with the geographic locality, Indonesian specimens being generally grayer and less densely covered with hair than those from the mainland. Judging from the few pictures of Sumatran rhinos that exist, their hair covering is not very conspicuous.

II. ECONOMIC VALUE OF THE RHINOCEROS

(This section applies equally to all three Asian rhinoceroses.)

Belief in the medicinal, religious or magical value of the various parts and products of the rhinoceros is common to all peoples of south and east Asia, with the possible exception of a few hill tribes. Every part of the body is highly prized, from hide, hair and toenails to the blood and visceral organs. In

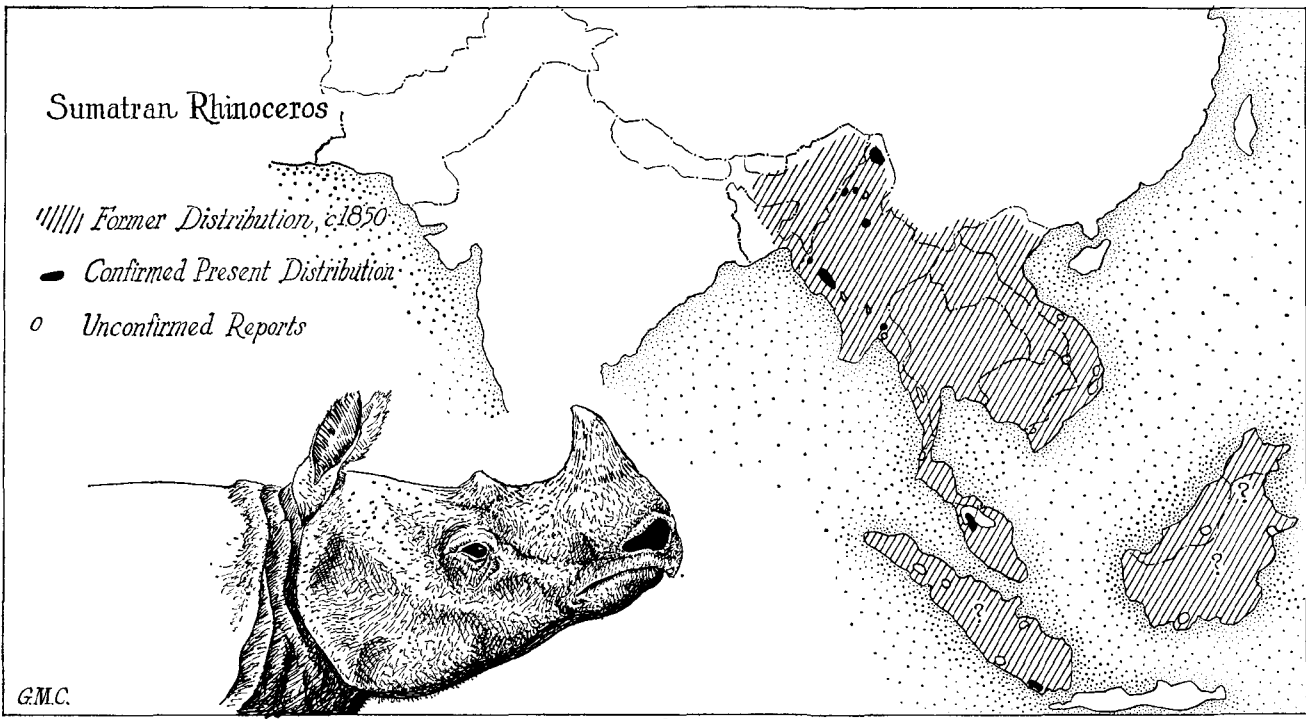
many cases the belief extends even to the urine and faeces of the animal. In 1955 tiny bamboo vials of urine, presumably from zoo rhinos, sold in Calcutta for 12 annas (about 15 cents).

The most valuable single part is the horn. In the past, rhino horn has been an important part of the export trade of all the south and south-east Asian countries. The greatest market was China. Even in Borneo, rhino horn was considered one of the three most important wild products in the trade with China (Harrisson, 1956).

Rhino horns were carved by the Chinese and others into a number of highly prized articles from buttons, belt-plaques and scabbards to knife handles, but probably the greater number ended up as cups. Most of these were libation cups, important in certain religious ceremonies. Others were kept, especially by rulers, because of the belief that they protected the user from poison. Such cups have been used in Asia up to recent times, but they also have been used by some British and European monarchs and popes.

As a protection against poison, the use of rhino horn varies by locality. In Sumatra, it should be drunk as a purgative if one feels the first signs of poisoning. In Burma, a belief exists that when one puts rhino horn shavings into a cup containing poison, they will bubble and smoke. In Nepal and parts of India, the belief is that if poison is placed in a rhino horn cup the poison will bubble, discolor or become harmless, or else the cup will slowly disintegrate or shatter. Interestingly enough, there may be some basis for this latter belief. Many of the old poisons were strong alkaloids, and the horn is what amounts to an agglutination of hair, closer in structure to toenails than to cattle horns or deer antlers. Such a structure would indeed be affected by a strong alkaloid, although the shattering and other dramatic behaviour is probably an embellishment. Because of their size, horns of the great Indian rhino are probably more used for cups than the smaller horns of Javan or Sumatran rhinos.

To-day, the greatest demand for rhino horn is based on its supposed value as an aphrodisiac and this widespread belief accounts for the greater part of its market value. China still provides the biggest market, with Singapore acting as the main collection point for horns, whether they come from Africa, India or South-East Asia. In each country, the local horn is regarded as the best, but any rhino horn is good. It seems to be somewhat a question of proximity, horns coming from Africa



being the least valuable. The place of origin is said to be easy to determine on close examination of the horn.

Sumatrans call the front horn of the Sumatran rhino the "true horn" and the rear one the "false horn". The front horn is the more valuable, and it is also usually the larger. Indonesians also recognize three kinds of local rhino horn—red, white and black. Black horns are the most common and the least valuable, white next, and red most prized, the white being about three-fifths the value of the red. I could find no explanation for the difference in horns; no size differentiation was reported. If there is truly such a difference, it would be most interesting to know if it were one of condition, age, sex or species. It may be the last, in part at least. In 1933 Hazewinkel noted that in Sumatra the horn and hide of the Javan rhinoceros brought ten times that of the Sumatran rhino.

Usually the horn is ground to a powder and mixed with water or coconut oil. Among the cures this mixture is supposed to effect are the following: to remove a thorn from the palm of a hand, apply the horn oil to the back and the thorn will work right out; to ease childbirth, the expectant mother should drink some of the mixture just before the baby is born; to shrink lumps, stop infections, close cuts, sooth irritations or cause broken bones to heal properly, just apply the mixture to the nearby skin surface and rub well.

The horn may be sold in small pieces, in powder, in a coconut oil or other solution, or in combination with other parts of the rhino. In the latter case, a mixture is made of rhino horn, toenail, rib, foreleg and occasionally other parts of the rhino body, all mixed in coconut oil. This is placed in small bamboo vials and is sold by itinerant "medical men". I saw a mimeographed paper giving the proportions of rhino in one mixture being sold by such a travelling druggist. The sheet described the parts of rhino included and the various ailments they were good for. I saw similar charts, along with large drawings of rhinos, in druggist shops in some of the larger cities of Indonesia.

When a travelling medical man arrives in an outlying village with some rhino medicine to sell, the word goes out and the village rhino experts assemble, along with most of the populace. The experts pass judgment on the man's products, and if they judge them *bona fide* the villagers buy. This judgment may consist of some test, such as rubbing nettles on an arm, then applying the alleged rhino horn potion and observing the results. These experts may be very highly esteemed in the village.

Even in an area where cash is not an important part of the economy, the medicinal value of rhino is great. The Kachin State Ministry (Burma) estimated that the value of a whole dead rhino to a northern hill tribe is the equivalent of \$900.

As an item of export trade, rhinoceros horn has an official market value in some places, such as Kenya and India. As it becomes more and more difficult to meet the demand (due to the increasing rarity of the animals themselves and in some areas more effective protection of the few survivors) the value rises. In Saigon, traders told me they could get 100,000 piastres for a large horn. That was then the equivalent of \$2,000. In Palembang a Chinese merchant was offering a new American car for a whole dead rhino. In Telukbetung, Sumatra, a Chinese trading group had a standing offer of 100,000 rupiah, then \$2,500, for a large horn. I heard of this particular offer from a number of sources. These may be the exceptions, extraordinarily high prices offered by wealthy Chinese who considered their need desperate, although the Telukbetung offer was said to be for horns for export to Singapore. These present-day prices seem more reasonable when we consider past values. A horn brought half its weight in gold at Calcutta in 1935 (Shebbeare, 1935); its weight in gold in Siam in 1937 (Loch, 1937); "thousands of dollars", at 3.2 Sarawak dollars to 1 U.S. dollar in Borneo "in historic times" (Harrison, 1956); and nearly 500 pounds sterling, \$1,400 U.S. in Sumatra in 1933 (Hazewinkel, 1933). Apparently a rhino horn is worth about what the seller can get for it above the market price. As the supply becomes shorter the poaching pressure on the surviving rhinos in both Asia and Africa grows steadily greater. When a local merchant, villager or tribesman knows the whereabouts of a rhino, he is likely to keep the information to himself in the hopes of cashing in on it.

For the most part, the known Indian and Javan rhinos are well protected, so that in Asia most rhino hunting is Sumatra rhino hunting. In Sumatra itself even with the full support of an Indonesian government expedition in the best known rhino habitat, I never saw the animal, although on five occasions I did find fresh tracks, varying from a few minutes to two hours old.

One result of the increasing economic value of rhino products has been to make it extremely difficult to gather, in the field, any facts at all about the surviving Sumatran rhinoceros. More important, as the market value of the rhinos climbs higher and

higher, the difficulty of conserving them becomes greater and greater.

III. DISTRIBUTION AND STATUS

India and East Pakistan

Former.—Within the last century the Sumatran rhinoceros was found in parts of the former Bengal (Chittagong Hills and Tippera, now East Pakistan) and Assam (Lushai Hills, Manipur Hills, Cachar and the valley of the Brahmaputra). It was considered rare in Assam in 1900 and by 1936 was presumed extinct or on the verge of extinction.

Present.—I received no verified reports from India of the Sumatran rhino's occurrence since the war. Mr. E. P. Gee believes that if any exist, they are probably in the Tirap Frontier Tract, along the Dihung River. There are occasional reports of rhinos from the adjoining area in Burma. As these reports sometimes specify large, one-horned animals the rhinos to which they refer may not be Sumatran.

There is also some possibility of isolated survivors in the Chittagong Hill Tracts, partially in the Indian Lushai Hills and partially in East Pakistan.

Burma

Former.—In previous centuries the Sumatran rhinoceros was apparently the most common rhino in Burma. It was reported from one end of the country to the other.

Present.—The present reported range does not differ much from the former range in total area, but it does differ considerably in distribution within that range. The animals are reported from Putao in the extreme north to Victoria Point, Burma's southernmost tip.

I had no time to visit the rhino habitats in Burma, but in order that I could get first-hand accounts of the animals, U Tun Yin, Burma's foremost spokesman for wild life, arranged for me to meet forestry officers from every part of the country. I also got in touch with other possible sources of such information: Government officers, agricultural technicians, soldiers, hunters and traders. U Tun Yin himself had visited some of the areas and since his retirement from government service had devoted most of his energies to gathering information on Burma's wildlife and furthering its conservation. The estimated number

of the Sumatran rhinoceros in Burma as a result of this inquiry was :—

	<i>Area.</i>	<i>Min.</i>	<i>Max.</i>
*Kachin State, near Tirap Border		4	6
Pegu Yoma		6	8
Uyu upper		3	3
Uyu lower		7	8
Arakan upper		4	6
Arakan lower		3	5
Kahilu		2	3
Tenasserim		2	2
Shwe-u-duang		4	5
TOTAL		35	46

* In October, 1955, a reliable report of about 30 Sumatran rhinoceroses in the Kamaing Sub-Division of Kachin State was received from the Assistant Resident Kamaing. U Tun Yin. *Journal B.N.H.S.*, Vol. 53, No. 4, August, 1956.

An occasional one-horned rhino is reported in Kachin State which might be the Great Indian Rhinoceros wandering in from Assam. These rhinos are said to be forced into the lowlands near Putao in the winter, if there is a particularly heavy snow-fall in the surrounding hills. Forest and game laws in the Union of Burma do not apply in the Kachin State, but U Shan Lone, Secretary, Kachin State Ministry, has issued official warnings to the people that the rhinos are to be totally protected.

During the war rhinos were reported just west of Prome. A road was recently completed through that area and the rhinos, according to the engineer in charge, have retreated to an area "five days' march" to the north. As another road is contemplated through that way, the rhinos will gradually be forced farther and farther back into the Arakan Hills.

Two one-horned rhino are reported near the Kaletha Sanctuary. A Buddhist priest at the nearby Kyaitiyo Pagoda apparently has established himself as their protector. As described above, the posterior horn of *D. sumatrensis* may be so little developed that it appears absent except on close examination. Such specimens may account for some of these one-horn observations.

At first one is apt to question the accuracy of estimates of individual rhinos in a land with the vast forested areas that exist in Burma. On closer examination several factors add to these estimates' credibility. Although the areas are vast and the people relatively few, the population is widely spread. The people are largely hill tribesmen or villagers who live on and

in the forest. The predominant agriculture of the hills is shifting cultivation, which means that a small human population may occupy a surprisingly large total land area.

The great value of a rhino has already been discussed. Although the live animal is protected by law in the Union of Burma, it is legal to sell rhino blood and other parts as medicine, and in recent years several rhinos have been killed on official permits by high Burmese officials "for medicinal purposes". A rhino is a much sought animal; as soon as the whereabouts of one is known the word spreads rapidly.

The Sumatran Rhinoceros is apparently a wanderer, occasionally travelling great distances. Being a large, conspicuous animal which leaves an easily identified trail, it is hard for one to escape detection. There are a number of records of rhinos whose location was known and recorded, day by day, for weeks or months until they were killed or had wandered off into some totally uninhabited country.

On the other hand, there is still some country that remains totally uninhabited. Not all Sumatran rhinos are great wanderers because some have been reported from the same locality for as much as three decades. Wandering may in fact be a response to disturbances by human activities and so it is possible that some rhinos may exist, undiscovered, in these out-of-the-way pockets. It has been my experience that in these countries estimates of wild animal populations tend to be lower rather than higher than the true numbers and it seems to me that the estimates of the Burmese rhino population are, if anything, rather low. They may, however, be considered a very good general indication of the status of rhinos in Burma. The rhinos reported are mostly single animals with a very few pairs, very rarely three at a time. This would be expected from a widely ranging animal, but the fact that these individuals are so very widely separated would seem seriously to reduce their chances of reproduction. With so few rhinos, harassed as they are, the odds on one even encountering another would seem quite slight. The chances of this encounter coinciding with the biological period for mating for both animals concerned are even more slight. Evidence supporting this surmise is provided by the lack of observations of young rhinos, possibly two out of the rhinos reported were noted as being young animals.

If the rhinoceros is to be saved in Burma, several steps should be taken quickly.

1. The office of Game Warden, with the departmental machin-

ery that goes with it, should be reinstated. Without such a post there can be neither co-ordination nor activity in wildlife conservation. Although many men in the Forest Department are interested in wildlife, each has his own job and no one has the time or authority to carry on the necessary wildlife work in addition.

2. An enlarged and effective system of reserves for the rhinos must be enforced. Burma had a fine system of reserves established before the war. However, what with the insurgents and the lack of a full-time game warden, it has not been possible to bring their administration up to the pre-war standards. But regardless of the present state of the reserves, only two of them are believed to have resident rhinos, Kahilu and Shwe-u-duang. Reserves are needed to include the known, present range of the largest possible number of rhinos. This might mean reserves in the Arakan Yomas, Pegu Yomas and Kachin State, and in other areas as they become known. Without reserves in order to keep out roads, cultivation and poachers, the few remaining rhinos will be continually forced back into the rapidly shrinking wild areas, and it may not be many years before all but the last solitary individuals have been driven out, hunted down and shot. These reserves must be large enough to allow for reasonable wandering of the rhinos—they cannot, of course, enclose those which wander dozens of miles, but if they are large enough, there may be no need for the resident rhinos to leave them—and they must enclose ecological units. For instance, if the rhinos make a seasonal migration up and down mountains, this movement should be considered when setting up the boundaries, as should such questions as seasonally available water and types of vegetation.

3. The laws legalizing sale of rhino parts for medicinal uses should be abolished. They provide the most serious loophole in what are otherwise quite good wildlife conservation laws. With public sentiment as it is, with widespread belief in the curative powers of rhino preparations, it would not have been possible to pass the present laws had they excluded such sale. It still may not be possible to change the law without a widespread public education program. (And this, again, points out the necessity for a game warden and staff, as other forest officers have not time for this sort of thing.) Until the law is changed there will be a legal incentive for illegal rhino poaching.

4. There should be a revision of the Wild Life Acts to afford greater protection to the rhino. The rhino is a "completely protected animal" under Section 6 of the Act, but penalty

for infringement of the law is imprisonment for a term not more than six months and/or a fine of 500 kyats (roughly \$100). Even if all poachers were apprehended and the maximum fines were invariably imposed, rhino horn is so valuable that poaching would still be a very profitable business indeed. A much sterner penalty is surely indicated.

The Sumatran rhinoceros is an extremely rare animal in Burma. The widely dispersed survivors are being hunted down constantly, and unless effective measures can be taken soon, there may be no survivors in a few years' time. Small as Burma's rhino population is, it is still the largest known "concentration" of Sumatran rhinos left in any one country, which shows the extremely critical state of the Sumatran rhino throughout its range.

Thailand

Former.—In the last century Sumatran rhinos were found in most of the hill country of Thailand, with the possible exception of the north-western areas. By 1919 they were considered rare in the country.

Present.—Dr. Boonsong Lekagul reports that in 1958 three Sumatran rhinos were killed near the southern part of the Thai-Burma border and two more in 1959 on the border north-west of Karnchanaburi Province. One of these latter was undoubtedly *D. sumatrensis*, the species of the other is uncertain. No rhinos are known with certainty by the Thai authorities to survive in the country to-day. The Burmese, however, believe that an occasional individual wanders into the southern part of Tenasserim from the densely wooded, wild, Thai portion of the peninsula. If any rhinos do survive there, the population cannot be large, probably a few individuals at most. A few may also exist in the extreme southern part of Thailand, for I have received periodic reports of rhinos from the adjacent wild lands of Malaya and perhaps a few in mountainous areas of the Thai-Burma border. It is not clear from the reports whether some or all of the animals mentioned above (both from Burmese and Malayan sources) might not be *R. sondaicus* instead of *D. sumatrensis*.

It would be very useful to carry out a survey to determine what the status of rhinoceros actually is in Thailand, but it should be done in such a way as not to attract public attention to any animals that might be there, as this would probably hasten their end,

Cambodia, Laos and Viet Nam

Former.—It is difficult to be sure of the exact distribution records from early reports. All three asiatic rhinos, *D. sumatrensis*, *R. sondaicus* and *R. unicornis* were referred to and there seems to be considerable confusion in terminology. All, whatever their identity, have been subjected to severe hunting and poaching and have been virtually, if not completely, exterminated in the last 50 years. In the mid 1920s, the rhinos (*sondaicus* and *sumatrensis*) were abundant in the Mekong Valley and were hunted not far from Saigon. Apparently rhinos of one species or another were found throughout what are now the three nations. They were reported almost everywhere, from the marshy plains near Saigon to the high mountains.

Present.—Reports indicate that possibly one to three dozen animals remain in isolated areas where hunters have not yet been able to get them. Foresters and hunters insist that both a small, two-horned and a larger, one-horned rhino still exist. The best documented locality is an old royal forest reserve near Dalat, north and east of Saigon, Viet Nam. The Director of Forest Research at the Centre National de Recherches Scientifiques et Techniques, Saigon, told me that he had seen tracks there a few months before my visit. These he thought were *R. sondaicus* though he says he is sure *D. sumatrensis* is found in Viet Nam also. Other areas where rhinos were reported were: "East Cochin China" (the Cambodia-Viet Nam border area); the mountains above Natrang (Viet Nam, east of Dalat); South of Dalat (Viet Nam); mountains south and west of Hue (Viet Nam); forested country of south-east Laos and adjoining Viet Nam (near the juncture of the Laos-Cambodia-Viet Nam borders). In August, 1955, a French hunter told me that within the previous month he had seen tracks of a rhino in the latter locality. It was a large rhino which had been wounded by local villagers.

I collected reports during visits to Cambodia, Viet Nam and neighboring areas, but I was unable to confirm them or to visit any of the rhino locations involved. According to the research centre, both the Dalat and the Hue areas are particularly rich florally. If they should be found to contain rhinos also, every effort should be made to protect the area's fauna and flora with park or reserve status. In Viet Nam, initially, this activity would probably come under the Forest Department and the Research Centre at Saigon.

Malaya

Former.—The range of the Sumatran Rhinoceros extended throughout the country from Johore to the Thai border.

Present.—Rhinos still exist in northern Malaya, but neither numbers nor species are known for certain. Both *R. sondaicus* and *D. sumatrensis* were previously found in Malaya. Both from reports I was given on the spot and these received through 1957, and considering the combination of the rather dense human population and the military activities of the last two decades, I believe rhinos may be considered exterminated in southern Malaya, except perhaps in Johore. In the north and west, however, there are extensive wild, wooded tracts where there are still few humans and from which occasional reports of rhino are received. Such a report from Slim River, Perak, appeared in *The Times* (London) of 1st April, 1957, with a photograph. The animal was called a *R. sondaicus* but in my judgment it is almost certainly *D. sumatrensis* with a much reduced rear horn. The Game Warden's office has reports of "a few" rhino from the north and west areas but exact information on numbers or location is not available. The policy of the Game Department has been to discourage publicity on rhino reports. They felt that the less local attention drawn to the rhinos, the less poaching effort would be expended on them. Considering the difficult and unsettled conditions in Malaya, especially during the "Emergency", it seems that this is a wise policy.

Reports gathered from the mainland of South-East Asia point to a very few, more or less isolated rhinos or groups of rhinos, scattered over a vast area. The protection afforded these survivors varies, but all are subject to hunting or poaching, and their numbers are being progressively thinned. It will probably be only a matter of months or years before most of these remnants have been hunted down. Some of the rhinos reported may be a one-horned variety, probably *R. sondaicus* and every possible effort should be made to protect them.

RECOMMENDATION

In view of the foregoing, I recommended that a survey be undertaken to determine, as far as possible, the numbers, locations and species of the surviving rhinoceroses in Malaya, Thailand, Cambodia, Viet Nam, Laos, Burma (such information is already available), India (Lushai Hills and Tirup Frontier Tract) and East Pakistan (Chittagong Hills). The survey

should include government personnel, both to locate and visit rhino areas and to work out protection programs based on their findings. Properly handled, public information about the survey could be very helpful, but locations of individual rhinos should not be publicized.

INDONESIA

Sumatra

Former.—Throughout the whole island.

Present.—On a foot expedition in the totally uninhabited mountains of the South Sumatran Nature Reserve “*Sumatera-Selatan*” I only found fresh tracks at five places. Older signs in the form of trails, wallows and droppings were plentiful, but this may not be significant, for these rhinos seem to be wide-ranging. Although I visited only a relatively small portion of the wild area of south Sumatra it was of course the area where rhinos had been reported in recent years. However, it would be reasonable to assume that there are more rhinos in this area than those whose tracks I actually saw. In 1938 Buitenzorg estimated the rhino population of the South Sumatra Reserve at a maximum of 30.

In addition to my own observations, I collected reports of rhinos in Sumatra from all available sources in both Sumatra and Java. Besides villagers living near the wild areas visited, only three persons were found who had actually seen the rhinos in recent times. One of these was Mr. Kushnadi, Director of the new Department of Nature Protection of the Indonesian Forest Service. Most of the rhino reports were of tracks, wallows or droppings. In sifting and evaluating the reports I considered a number of factors, including the experience of the reporters. For instance, in many cases I found that tracks of the tapir “*tenuk*” were mistaken for those of the rhino “*badak*”.

The most reliable reports point to rhinos occurring in at least five widely separated areas on the island: the Losei Reserve in the north and locations in the Tapanuli, Djambi, Bankuku and Lampung Districts. My experience was in the last area. I consider the Djambi section to be most likely of the other areas as three recent sightings are reported there. The northern situation is unknown as the area involved is in the Atjeh country and I could find no one who had been there in recent years, but fairly continuous word-of-mouth reports of “*badak*” from Atjeh have reached the forestry people in central Sumatra during the past several years. In any case, the rhino is very rare

in Sumatra, but in my judgment not so rare as recent estimates would indicate (Shebbeare, 1953).

The magnificent series of reserves established by the Dutch seem quite adequate to protect the rhinos if they could be carefully patrolled. However, the Indonesian game laws only apply in Java ; in other areas, including Sumatra, game matters are controlled by the local government or the military. This plus the unsettled conditions and the number of men that would be required to protect even the reserves now accessible indicates that it may be a considerable time before adequate protection for the whole system can be established. The rhino population may not survive that long.

It seems to me that two steps should be taken as soon as possible :—

1. Intensify the legal protection of the rhinos. This should be done through local governments, by acquainting them with the critical situation, where necessary increasing the penalties so that rhino poaching ceases to be a profitable occupation even if the poacher is apprehended, and by intensifying the enforcement of anti-poaching and reserve protection laws. In some cases, the army might be directed to enforce the wildlife laws. The sale or possession of rhino parts for medicinal or any other uses should be strictly controlled, although this may be a long term proposition.

2. An ecological survey of the rhinos in Sumatra and Borneo should be undertaken to determine, as far as possible, the location and numbers of the remaining rhinos. It should also determine as much as possible of the ecology and life history of the rhinos, to provide a basis for effective management. If this were undertaken by foreign personnel working with the local authorities, it could serve to emphasize the international importance attached to the rhinos and to threatened species in general. Although publicity for the project is very desirable, it would not be wise to publicize the location of any rhinos found.

BORNEO (Kalimantan, Sarawak and North Borneo)

Former.—The rhino was reported to be widespread both in British and Dutch Borneo. It apparently ranged from the lowlands to much higher ground, being common, for instance, in the mountains above the 3,500-foot Plain of Bario.

Present.—Tom Harrisson, Curator of the Sarawak Museum, reports : “ I am perhaps the last non-Bornean to have crossed the fresh tracks of the Two-horned Rhino. In October 1945, at about 3,000 feet in the uninhabited Indonesian area between the

headwaters of the Bahau and upper Batang Kayan rivers. . . .”

I was unable to visit Borneo myself, and I could find no recent confirmed reports of living animals, except those of Harrison. His estimate for the population of Sumatran rhinos in 1956 was “almost certainly not more than two living in Sarawak There may possibly be a few more in the Iwan-Bahau tract of Indonesian Borneo. . . .” And for North Borneo, “There are a few left there, mostly on the east side.”

Traders I met in Singapore reported that rhino horn was still smuggled in from Borneo. This indicates that rhinos still survive, though how much longer they will continue to do so is a question. Reports in possession of the Indonesian Nature Protection authorities state that there are rhino in Kalimantan (Indonesian Borneo) but that there are “more in Sumatra”. The Bornean Dyak’s only market is China—two sets of horns have been confiscated by Government (Sarawak and North Borneo) since 1955—but unsettled conditions, sparse human habitation and an extensive shoreline make it impossible to patrol against smugglers and poachers. Even if smuggling could be curtailed, it might not much reduce the ready Chinese market that hunters find for rhino horns. For the time being the only effective protection for these rhinos is their remote and difficult habitat. Their only hope for the future lies in carefully guarded reserves.

ECOLOGICAL NOTES

It is difficult to separate the rhino’s preferred habitat from his enforced one. Cultivation and intensive hunting have rendered impracticable for a rhino’s occupation most lowlands and savannas of south-eastern Asia.

This leaves densely forested and mountainous areas unfrequented by man, and here is where the rhinos are and have been reported. In Viet Nam, the Dalat area is a high plateau covered with rather dense, semi-coniferous forests. Most rhino areas reported in Burma are densely forested, though they range from sea level to over 6,000 feet in altitude. The Sumatran areas are the most varied. In the north, the Loser Reserve area is a country of grass plains (cogonalls, 4 to 5 feet high) interspersed with groves of pines (*Pinus merkusii*). Coming south, the rhino is also found in coastal swamps and in the mountainous areas in extremely dense, steep, monsoonal rain forest country. In short, the Sumatran rhino seems to frequent any habitat not occupied by man, from sea level to over 6,000 feet, from grassland and swamp to jungle and open pine forests. Freedom from

human persecution is the one common factor and given that, the animal seems able to adapt itself to any available non-arid situation throughout his geographical range.

Under excellent arrangements made by the Nature Protection Department of the Botanic Gardens of the Indonesian Government, I was able to take a two-week expedition on foot through the Sumatran rhinoceros habitat in the Sumatera-Selatan Reserve (formerly the Wildreservaat Zuid-Sumatera I). The reserve was established by the Dutch in 1934 to conserve "a typical and complete south Sumatra flora and fauna", and, more particularly, to protect the rhino and elephant which occurred there. Except for the Loser Reserve in northern Sumatra the Sumatera-Selatan Reserve is the largest known remaining Sumatran rhino habitat in Indonesia. It is a strip of land with an area of some 1,400 sq. miles extending for over 150 miles parallel to the southwest coast of Sumatra and 4 or 5 miles inland. Much of the land is mountainous and extremely steep, uninhabited and unfrequented by humans. Not once during the period that two Indonesian forest officers and I with our four porters climbed through that country did we see any sign of another human. Inland from the partially cultivated belt of land along the seashore, which is out of the reserve, the mountains rise abruptly to nearly 6,000 feet. Streams are swift following rocky courses deep in steep-sided gorges. Except on the more level ridge tops, vegetation is extremely dense, and a parang (a sort of narrow-bladed machete) is needed to cut a way through it. Slopes are so steep that it is often necessary to cling to vines and branches in order to climb them. The time of my visit was "normally the dry season" but it rained, off and on, every day; and at the ground level, far below the highest leaf canopy, it maintained a steady drizzle virtually 24 hours a day. Judging by the soil and vegetation, this was not an abnormal condition. This was the habitat of the Sumatran rhino.

The first fresh rhino tracks we found were about 11 miles up river from the coast. Other tracks were found from time to time during several days' travel up the mountains, and at equivalent altitude and isolation further south in the range.

Usually when rhinos are spoken of, they are associated with wallows. I had expected to find wallows in lowlands or at least in flat lands, and so they are when such land is available. But here I found wallows on the steepest slopes. The local belief is that the rhinos dig the whole wallow themselves. It appeared to me that they merely enlarged some natural depression, such as a rotted-out stump, mud backed up by a fallen tree trunk, or

the hole left by an uprooted tree. When pigs occur, rhinos may take over pig wallows. Mr. Hoogerwerf who was then director of wild-life research in Indonesia, believes that they do not use their feet in digging, but make wallows by rolling, just as the Javan rhinoceros does.

Some wallows gave the appearance of being much and long used, while others appeared to have been used only briefly or have been long unused. A wallow was usually on a hillside, 6 to 10 or 12 feet long and 3 to 5 feet wide. Several old wallows found on flat areas beside streams covered an area more than 15 feet across, although it was often difficult to determine the exact dimensions of former wallows.

Reports given me in Burma, Malaya and Indonesia stated that a Sumatran rhino may return to the same wallow for long periods of time, unless disturbed by man. In Burma they are reported to feed early and late in the day, and occasionally at night, spending much of the day in the wallow. The fresh tracks I saw in Sumatra had been made at all times of day, although in two cases the rhinos may have been moving near midday because of our presence, rather than for their own undisturbed purposes. Perhaps one reason for the rhinos' use of wallows even in such difficult places, is the prevalence of ectoparasites. If rhinos attract these pests as much as humans do, they are bedeviled creatures indeed. Land leeches were everywhere extremely common, particularly so along game trails and in the more flat areas frequented by various animals. Along the major game trails the leeches were joined by rather small, insisently biting, gnatlike insects and by others much like a very large gray horsefly.

The rhino droppings were most commonly found in the vicinity of wallows, though not in them, but were also found rather indiscriminately throughout the forest floor. Reports from Burma (Editorial Board—*Burmese Forester*, 1955) and other areas say that this rhino, when undisturbed, returns to the same spot to drop its dung, thus collecting piles measuring as much as 2 feet high by some 4 feet across. The Indian rhino has this habit, also, raising small hills several times that size. But apparently in Sumatra the rhinos are less topographically regular in their habits.

Even while following its tracks, it was difficult to believe that an animal the size of a rhino could get through such rough and steep country. Undisturbed rhinos had wandered through rivers—not only calm, gravel-bottomed rivers but extremely swift ones, up to 4 or 5 feet deep, with slippery rounded rocks

for a bottom. The Sumatran rhino seems to be a strong swimmer. In 1954 U Tun Yin referred to one seen swimming off the Burmese shore "near High Island which is a good 20 miles from the mainland although there are islands in sight all round". Rhinos which I followed had scrambled over large logs lodged crossways at water level, rather than swim under them even in deep water. From the tracks and other signs the most frequented rhino paths were stream beds. Next came game trails, ruts in the mud up to 3 feet deep with roots and logs worn smooth by elephant and rhino. They also just wandered cross-country. Judging by the tracks, muddy, vine-covered slopes too steep for men to climb straight up, were ascended with ease by the wandering rhinos. On more level terrain an undisturbed rhino track would zigzag from tree to bamboo clump to thorn patch with no apparent set direction.

The Sumatrans say that the rhino eats a number of kinds of trees and bushes, and that he is a browser, breaking down or twisting down saplings. This agrees with the animal's reputation on the mainland. It would be interesting to know what it eats in the grass country in the north.

The Sumatran rhino's sight is reputedly quite poor and his senses of smell and hearing very good. It seems a much more wary creature than either the Javan or Indian rhino. This may explain why the Javan rhino was apparently exterminated from Sumatra while the Sumatran one survived. The Sumatran rhino is also widely feared as being potentially quite aggressive. I found its reputation more sinister even than that of the much more impressive Indian Rhinoceros.

Apparently the Sumatran rhino need fear no predators except man. A tiger could doubtless kill a juvenile rhino, but people in each area where they occur state quite positively that a full grown Sumatran rhinoceros has no wild enemies. However, his two-footed enemies are proving quite enough. Whenever we discussed getting porters for our expedition with nearby villagers, they expressed their willingness to accompany us, even to the rough and reserved area where we did go later, only if they thought the expedition was going to hunt rhino. They had no interest in a journey to see or to protect rhinos. So that even though the rhino occupy what is probably Sumatra's least accessible habitats, without adequate protection it will be only a matter of time until the last of them is hunted down.



THE GREAT INDIAN RHINOCEROS

[*Photo: E. P. Gee*]

GREAT INDIAN RHINOCEROS; INDIAN
RHINOCEROS;
GREAT ONE-HORNED RHINOCEROS

Rhinoceros unicornis Linnaeus

I. DESCRIPTION

Largest of the Asiatic rhinoceroses, this great animal reaches a height of over 6 feet at the shoulder and a length of more than 14 feet. The weight of a large adult may be as much as 2 tons. There is a single horn, thick at the base and often quite blunt, probably averaging 8 to 9 inches in length; specimens with horns up to 2 feet long have been taken. The thick hide hangs in great folds at the neck, shoulders and hindquarters, giving the appearance of armor plate. A fold in front of the shoulder does not continue all the way across the back of the neck, as it does in the slightly smaller Javan rhinoceros. Like the Javan, there are folds continuing across the back behind the shoulder, in front of and across the thigh and around the neck. The legs emerge from beneath other folds, looking far too slight for the weight they must carry. The legs, the flanks and occasionally the sides of the body, are studded with large, round, rivet-like tubercles which further add to the armored appearance. The skin is hairless, except for a fringe of hairs on the ear tips and tail. As with other rhinoceros, the color usually is determined by the mud of its most recent wallow. The unusual individual that happens to be clean, perhaps just having swum a river, is brownish gray with a very slightly pink or reddish tinge to the edges of skin folds, ear and nostrils.

The only animal with which the Indian Rhinoceros could be confused is the Javan rhinoceros, as both of the African species and the other Asian one (*Didermocerus sumatrensis*) have two horns and a relatively smooth hide. The Javan rhino is a little smaller than the Indian, has usually a shorter and slighter horn, and has the transverse fold of skin in front of the shoulders extending all the way across the back of the neck. The Indian rhino appears the more massive animal, partly due to its great depth of body. Although the two single-horned rhinos once occupied overlapping ranges, at present the only known Javan rhinos are found in Java's Ujung Kulon Reserve, some 2,000 miles south-east of the last known surviving Indian rhinos.

II. DISTRIBUTION AND STATUS

Cambodia, Laos and Viet Nam

Former.—There is some question about the Indian rhinos' occurrence in what was French Indo-China. Some authors include it, but others assume that the rhinos referred to in this area by earlier writers are either *R. sondaicus* or *D. sumatrensis*. Blyth, in 1862, believed *R. unicornis* to be limited to the Terai region of the Himalayas and the valley of the Brahmaputra. He thought that the animal referred to as *R. unicornis* (or *R. indicus*) by previous writers was really *R. sondaicus*. Harper states that "The older works do not include this country in the range of the species, and the recent reports probably require verification". Rightly or wrongly, the species has been recorded from virtually the whole area, from Cochin China in the south to Tonkin in the north, and north-westwards of them.

Present.—Unconfirmed reports of a very few one-horned rhinoceros larger than *D. sumatrensis* were received. If these reports are true, they probably refer to *R. sondaicus*.

Thailand

Former.—"Its occurrence in this country is doubtful." (Harper, p. 380).

Present.—The existence of any kind of rhino in Thailand today is doubtful.

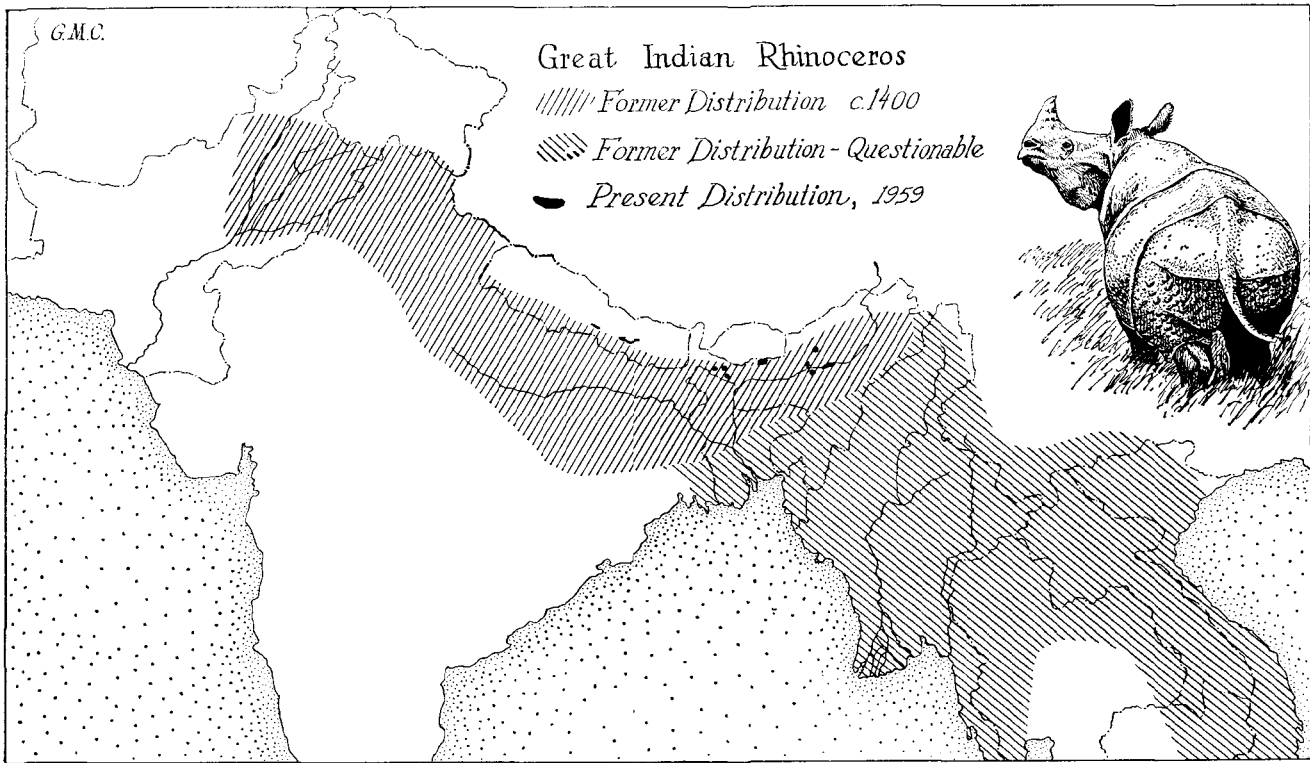
Burma

Former.—If the Great Indian Rhinoceros ever inhabited Burma, its range by the late 1800's was probably limited to the areas adjoining Assam and Bengal.

Present.—Consistent, but unverified, reports of large, single-horned rhinos in upper Burma in the areas adjoining the Tirup Frontier Tract may indicate a few survivors there. More likely, the animals reported have wandered east from Assam. There is also the possibility that they may be *R. sondaicus*. In any event, there is no confirmed resident individual or population.

India and Nepal

Former.—Five hundred years ago the Indian rhino ranged over a large part of northern India and Nepal. The westerly boundaries of its range were the foothills of the Hindu Kush west of Peshawar and the bush country south along the Indus River; the northern limit was the frontier of Kashmir. The boundary presumably then went south-eastward along the foothills of the Himalayas, through the Terai to the Burmese border. The



southerly limit is uncertain, although arid conditions presumably limited its southern extension in much of India. The rhino was said to be quite common in much of its former range. Two principal factors brought nearly to extinction the numerous population which once roamed a large part of the Indian sub-continent if not of South-East Asia—hunting and habitat encroachment.

Hunting was doubtless important, and may well have been a sort of *coup de grâce* to a population already in rather desperate straits, but instrumental in reducing the rhino population to the point where hunting became critical was man's modification of the rhino's habitat. As the human population of India increased so did the land area put under cultivation or grazing. One expression of this increased pressure on the land has been the growing area covered by desert in west and north-western India, where it is largely a result of man's land abuse.

As the fertile lowlands were taken over by agriculture, the rhinos retreated to hill areas. They were followed there by different forms of agriculture, largely paddy and tea. The change of land ownership from hill tribes to more sedentary agriculturalists often brought an end to the fires traditionally set by tribesmen, which had had the effect of keeping large areas open or in savannah. As a result of the protection from fire, tree cover, initially *Sal*, *Shorea robusta*, took over areas formerly covered with dense grasses, probably predominantly *Imperata cylindrica*, with *Microstegium ciliatum* in the hill areas and *Saccharum spontaneum* and *Phragmites karka* in the flood plain along the major rivers. So that rhinos even where they were not actually displaced by agriculture, were deprived of cover and became easier targets for poachers.

By the early 1900's the rhino population was so far reduced that the British authorities became alarmed. About 1910 they prohibited all hunting of the rhino in Assam and Bengal. Starting with Kaziranga and Manas, a series of sanctuaries and reserves were established in the upper valley of the Brahmaputra and nearby Bengal, to protect the last concentration of the rhinos together with some of their habitat. Protecting the animals in the reserves sometimes required strenuous measures, including the intervention of troops of the Assam Rifles, for by 1930 rhino horn had become so valuable that poaching was growing into a highly organized activity. This protection resulted in greatly slowing down rhino poaching and in more or less maintaining the position, at least within the reserves.

The intensity of poaching pressure, probably slackened

during the war, and the rhinos both in and out of reserves got several years' rest. Following the war, but especially following Indian independence, there was a renewed interest in the wildlife conservation in Assam, sparked largely by Mr. P. D. Stracey, then Conservator of Forests of Assam, under whose jurisdiction wildlife matters were carried out, and Mr. E. P. Gee, long time tea planter in Assam and member of the Indian Board for Wild Life.

Present.—The present range of the Indian rhino consists of eight reserves or sanctuaries in India, and the Rapti Valley region of the Nepal Terai. Occasionally individual rhinos are reported outside the reserves, some of them presumably stragglers from the Indian reserves or the Nepalese Rapti Valley area. In the latter category are those occasionally reported from Northern Champaran District of Bihar State which adjoins Nepal. Other reported individuals may indicate small isolated populations, such as the few animals consistently reported from an area a little way up the Brahmaputra river from the Kaziranga Sanctuary in Assam. E. P. Gee estimates this group at about ten animals.

The occasional but unverified rhino reports from the Tirup Frontier Tract in Assam may indicate the presence of a few survivors in that area.

Nepal.—Although an estimate made in the late 1940's placed the number of Indian rhino in Nepal at 48 (Gee, 1953 ; Shebbeare 1953), there is abundant evidence that the population was much larger. The Rapti Valley and other areas where the animals may be found are quite isolated ; indeed until recently there was not even a motorable road into the Rapti Valley area. Very few westerners have ever been to these places and it is extremely difficult to get any accurate information about animal life in them.

According to the Nepalese Department, of Defense, under whose jurisdiction protection of the rhinos comes, 72 rhinos were poached in 1954. During the same period several rhinos were reported to have been washed down rivers into India during floods. All told, I received reports of the deaths of almost 100 rhinos during 1954.

Under the previous government, the rulers maintained a careful guard over the Rapti Valley as it was a royal hunting area, the Chitawan Game Reserve, and poaching the rhinoceros

was almost a capital offense. However, none of the Nepalese consulted considered the reported poaching toll for 1954 unusually high for recent years. No limited population of an animal reproducing as slowly as the rhino, whose gestation period is estimated at 18 months and with whom single young are the rule, can long sustain any such rate of attrition.

In September 1958, an apparently reliable report was received by the International Union for Conservation of Nature, then assembled at Athens, that during 1957 a band of Indian poachers had entered the Rapti Valley and slaughtered all the rhinos they could find. Estimates of the kill were as high as 500 animals.

Thereupon the Survival Service Commission of the Union, with the active co-operation of the Government of Nepal arranged for Mr. E. P. Gee to visit the Rapti Valley.

He was to report upon the situation and to make recommendations for the preservation of the rhinoceros.

Mr. Gee's most interesting report which the Fauna Preservation Society published in *Oryx* in August 1959 gives the number of rhinos in Nepal in April 1959, as about 300 and shows their distribution.

Mr. Gee's recommendations include: an extension of the Mahendra National Park to include the rhinoceros migration routes; the establishment of other protected areas in the valleys of the Narayani, Rapti, and Reu rivers; the re-introduction of the rhinoceros into a new sanctuary in the Morang District of south-east Nepal; that a Nepal Board for Wild Life be constituted with full authority for wild life preservation.

The International Union for the Conservation of Nature has adopted Mr. Gee's report and has recommended it to the Government of Nepal.

India.—The great authority on the Great Indian Rhinoceros, E. P. Gee, estimates that there are about 400 rhinos in India. He himself deserves a great deal of the credit for this encouraging position, for he has long been one of the most active and effective proponents of sound wildlife conservation and the planning of national parks in the country. Besides his other activities, he has through his prolific and popular writing, greatly encouraged interest in conservation among the people of India. Mr. Gee gives the following approximate distribution of the rhinoceros in India at the end of 1959.

State of Bihar	.	.	.	.	.	.	.	.	2
State of Bengal	Jaldapara Reserve	.	.	.	.	.	.	.	45
	Garu Mara	.	.	.	.	.	.	.	3
State of Assam	North Kamrup Sanctuary (162 square miles)	.	.	.	.	.	.	.	25
	Kaziranga Sanctuary (166 square miles)	.	.	.	.	.	.	.	260
	Orang (24 square miles)	.	.	.	.	.	.	.	15
	Sona Rupa (85 square miles)	.	.	.	.	.	.	.	5
	Laokhowa Reserve (27 square miles)	.	.	.	.	.	.	.	25
	Outside reserves	.	.	.	.	.	.	.	20
Total	.	.	.	.	.	.	.	.	400

Compared with Nepal, the rhinoceros areas in India are quite accessible. But due to the nature of the vegetation and terrain, it is extremely difficult to determine exactly the rhino population and no regular census has been attempted, except at Kaziranga. There counting from an airplane was tried, but the elephant grass cover was so dense that most of the animals were not visible. It is believed that because of the efficient protection they now receive, the number of rhinos is increasing. A few rhinos are sold alive to responsible zoos. The rhinos are trapped in pits, stockaded, crated and shipped; 16 were disposed of in this manner in the eight years up to 1959. The operation is carried out by the Forest Department and all applications for live animals must be approved by the Forest Minister for Assam.

Through the kind arrangements of E. P. Gee, the Indian Board for Wild Life, and facilities extended by the Government of Assam, I was able to spend two weeks in Kaziranga. Much of this was on elephant back, observing flora and fauna in the sanctuary.

The sanctuary covers 166 square miles, roughly 25 miles long by as much as eight miles wide. It is bounded to the north by a curve of the Brahmaputra River. This is a rather mobile boundary, because the river's course is continually shifting. The southern boundary runs more or less parallel to the Assam trunk road. The actual boundary winds about, partly following the Hora Diffeu stream and partly following surveyed lines.

The government has provided well for visitors. There is transport to the nearest airport, Jorhat, 55 miles away. Near the sanctuary there is a fine guest house and riding elephants are provided for viewing the animals. A resident staff of about 40 men patrols and protects the area, and supervises improvements such as building roads and observation towers. The opportunity afforded there to view Indian rhinos in some numbers and at close range is unique.

The main threat to the rhinos at Kaziranga is by domestic stock within the sanctuary boundaries. Officially, grazing is only

allowed on an area one mile deep and 3 miles long inside the edge of the sanctuary. But since the permitted area is unfenced and unmarked and the herds of buffalo and cattle are generally grazed free without supervision, it is extremely difficult to enforce those limits. From time to time deaths of rhinoceros and other wildlife have been tentatively traced to disease spread by these domestic stock. Anthrax and rinderpest are believed to be the worst offenders.

As most Indian wildlife are forest animals or edge dwellers, they do not lend themselves to tourist viewing in the manner that the plains game of East Africa does. Nevertheless, with a somewhat different approach to tourism, the Indian wildlife gives promise as a resource to be developed. This is illustrated well at Kaziranga. In spite of its status as a sanctuary and not a park, and with virtually no publicity, the number of visitors there in the season, December to April, is very large indeed. The Kaziranga Sanctuary is a magnificent example of what can be done to conserve Asian wildlife.

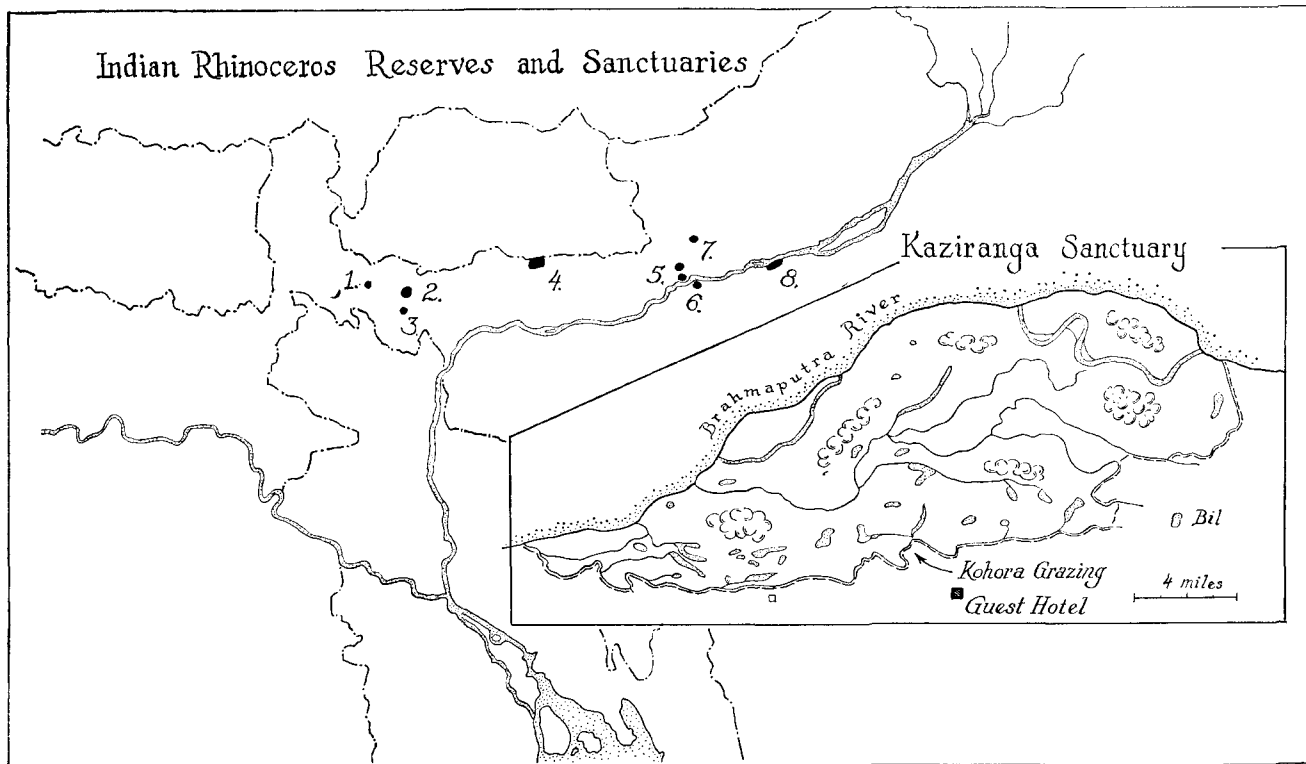
III ECOLOGICAL NOTES

Habitat.—Traditionally, the Indian rhinoceros has been considered an animal of inflexible habitat requirements, the usual explanation for its present distribution being that it requires a swampy area, or at least one with dense stands of tall grass and abundant water. As this habitat was taken over either by agriculture or tree growth, the animals supposedly died out because they could exist under no other conditions.

It is true that the area where the rhino may most readily be seen, the Kaziranga Sanctuary in Assam, fits the accepted habitat description perfectly. On the other hand, analysis of some of the other habitats still occupied by rhino tells quite a different story :

Dense moist forest, some steep slopes, some grassland.—Outside India all the world's Indian rhinos live in the Nepal Terai. The known habitat is the Rapti Valley, the southern part of which I was able to visit thanks to the kindness of Mr. Raymond Sheppard and the Nepalese authorities. Before 1956 the valley was extremely isolated, during any but the driest season the only access was on foot or by elephant. This isolation probably secured the survival of rhinos in the valley.

The area inhabited by rhinos includes a strip some 30 to 40 miles long, starting several miles north of Hataura, a village on the Katmandu-Amlekhganj trail, now a dry-weather road. At its south end the valley floor is less than a mile wide and the



1. Garu Mara. 2. Jaldapara. 3. Cooch Behar. 4. North Kamrup.
 5. Orang. 6. Loakhowa. 7. Sona Rupa. 8. Kaziranga.

side slopes rather steep. As it drops gradually to the north-west the floor widens to about 8 miles, with correspondingly wider hill slopes, east and west.

A transect taken in rhino habitat some 6 miles down stream from Hautaura, shows the following: Central in the valley floor is the main river bed, shallow boulder strewn, 100 to 200 feet wide. Side channels and tributaries make a mile-wide lace-work through the valley floor, cutting off islands up to half a mile wide. These islands are littered with boulders and flood debris but are crossed at intervals by game trails used by rhinos. The extreme width of river flow is marked by a bank some 20 feet high, cut by tributary streams and well-worn game trails. Extending back from this for a quarter to half a mile is a terrace-like alluvial plain covered with a dense low forest composed largely of *Shorea robusta*, *Terminalia* sp. and *Lagerstroemia flos-reginae*. No grass is evident, although a water-cress-like growth fills the tributary streams. Farther downstream this terrace widens to three or four miles. In places, the dense forest gives way to agriculture or where burned, to savannah areas, apparently dominated by *Imperata* sp.

Next up the hill comes a quarter mile wide band of grass, including *Imperata* sp. and *Themeda* sp. Following this is a slightly steeper rise, 100 to 200 feet in half a mile, again tree covered. Dominants here again seem to be *Shorea robusta* and *Terminalia* sp. Then between here and the densely forested ridge top is a savannah area, varying from a few hundred yards to 5 miles in width. Here are scattered trees in grass stands 8 to 12 feet high. Farther downstream both the river beds and terraces widen. The slope varies from a gentle rise to quite steep pitches; occasionally tree cover is continuous from the river bank to the ridge tops. Rhinos wander all through these areas, in the forestlands as well as the savannah or open grasslands.

Drier, mixed forest and bush, hills.—In the North Kamrup hills of Assam adjacent to Bhutan, about 25 rhinos live in the North Kamrup Wild Life Sanctuary. It is mostly flat, fairly dry in places, containing a mixture of heavily and lightly forested country with open stretches of grassland. Some of the prominent trees are *Dillenia pentragyna*, *Terminalia* sp., *Sterculia* sp., *Acacia* sp., *Lagerstroemia parviflora* and *Eugenia jambolana*. Grasses where present, include *Themeda arundinacea*, *Cymbopogon nardus* and *Imperata cylindrica*. The Manas and Biki rivers

where they come through the Sanctuary are fairly broad, edged in places by wide beaches. Extensive tall grass jungles predominate in this sanctuary.

Tall, dense, elephant grass jungle on flood plain.—This habitat is exemplified in Kaziranga Wild Life Sanctuary which is an almost flat expanse of tall grass. This grass sea is cut by several ridges, about 8 feet high, a series of interconnecting streams and a number of small, usually permanent lakes called "bils". These areas flood, becoming open water during the rainy season. Some are 10 or more feet deep but most are rather shallow. During the dry season, until the grass burns they provide the only open areas to be found in the sanctuary. The climate is monsoonal with rains usually from May to October. By December the ground and grass are getting fairly dry and in January, February and March part of the grass (between one-fifth and one-third each year) is burned off. During this period, and for the next two or three months, while it is still young, the grass provides fine food and is low enough for the animals to be seen. Enough unburned grass remains, however, to provide ample cover for the animals. The "elephant grass" here is made up of several species of grasses and reeds. In areas more or less continually wet, *Phragmites karka* is the dominant. Areas flooded during the rains but later dry, are mostly covered by *Saccharum* spp. and *Erianthus elephantinus*. Slightly drier areas (ridge tops and surrounding higher land) are dominated by *Imperata cylindrica* with a number of other andropogonous grasses. Apparently with regular burning and heavy grazing pressure, even in fairly low parts of the sanctuary favours the andropogonous types and these probably provide the best year-long food for wildlife and domestic stock. *Phragmites* and *Saccharum* are regarded as favorite rhino foods, but rhinos, as well as the other animals, probably get the most nutrition from them when new growth starts following burning. By late summer elephant grass grows to a height of 15 feet or more. Rhinos and other animals literally tunnel through it, and as long as it stands they can remain completely hidden. If unburned, the dead grass may remain more or less upright, creating after several seasons, a mass so dense that even elephants can barely force their way through. In this form it is useful only for shelter, and the periodical burnings are apparently necessary to encourage and expose the new growth. There are scattered stands of trees at both ends of the sanctuary and denser groups clustered on the ridges. Dominants are "simul" (*Bombax malabaricum*),

“ ajar ” (*Lagerstroemia flos-reginae*), and the leguminous “ koroï ” (*Albizia procera*). *Terminalia* sp. is also present.

In considering the Indian rhino habitats described above, I am impressed—not by a uniformity of conditions but rather by the wide diversity displayed. The one obvious factor common to all is freedom from human persecution. In Nepal, rhinos were protected as Royal Game by the former rulers. Although such effective protection no longer exists, the inaccessibility of the habitat effectively carried on that protection until recently. In India the rhino habitat, once isolated, is now easily accessible and much of it surrounded by cultivation ; but nearly all of it is located within reserves and sanctuaries. For over 50 years the increasingly effective protection afforded these areas has accomplished the protection that the terrain no longer affords. In my judgment, the evidence does not point to an animal of inflexible habitat requirements, gradually being exterminated along with its one suitable type of habitat. Instead, it points to an animal which retreated before human pressure to some of the most remote lowlands of the Indian sub-continent ; it survived because it was able to adapt itself to the wide variety of habitat conditions which they presented.

Relationship with other animals.—Probably the most common large mammal in the Kaziranga Sanctuary is the Indian buffalo (*Bubalus bubalus* Linnaeus). Solitary buffalo may be seen, but more commonly herds of from a dozen to about 100 are reported. The wild population is estimated at 400, but there are also a number of semi-wild “ buffs ”. This is because domestic water buffalo are grazed within the sanctuary boundaries and there is some intermingling between them and the wild stock. The rhino and buffalo often appear together ; I saw them grazing within 10 to 20 yards of one another in open bils and immersed in adjacent wallows 20 yards apart.

Gaur (*Bos gaurus* ssp.) are rare ; one herd of nine was reported and one skull was found in the sanctuary.

Indian elephants occur in herds of up to 60 animals. These presumably move back and forth between the Mikir Hills and the sanctuary. When in the sanctuary, they remain on the low ridges or in the tree areas unoccupied by the rhino. Both in Nepal and Assam, elephants were described as normally being afraid of rhino. At Kaziranga, the game staff said it required about a year and a half to train riding elephants to approach rhino. Once trained, some elephants apparently lose or overcome this fear, At least one elephant in Nepal was far famed for

actually chasing rhino and twice in Assam I saw elephants stand fast before charging rhino, apparently outbluffing them. Others apparently never lose their fear. One I was riding bolted several times when approached closely by rhino.

Indian rhino can do considerable damage to elephants or to each other with their lower incisors or tushes. Most rhino I observed were somewhat scarred, the scars apparently being inflicted with something sharper than the usually blunt horn. One rhino attacked the elephant on which I was riding, inflicting a cut some 18 inches long and from 1 to 2 inches deep on the elephant's flank. The rhino was a female with a young one. When we came upon her in a clearing in the 15 foot grass, she snorted and plunged back and forth several times. Then she charged my elephant, who coiled his trunk high, wheeled about and crashed off through the grass and water, trumpeting shrilly. The rhino, snorting continually, caught up with the elephant with apparent ease, then ran along behind for some 100 yards with her mouth open, tossing her head, apparently trying to gouge the elephant's rear. Failing in this, she pulled up along the left side of the elephant and with a toss of her head, made the gash. The elephant veered off to one side and the rhino continued in a straight line for some yards farther, then turned off into the grass and disappeared. Examined later, the top of the gash measured 7 feet from the ground, which height is explained both by the Indian rhino's considerable stature and its neck articulation. The Indian rhino can throw its head up and back considerably farther than the African rhino, and this would greatly increase the effectiveness of its tushes as weapons. I never saw a rhino use its horn as an offensive weapon during my two weeks observations. I am not sure how effective the horn would be in real combat, for it is often quite blunt and may be somewhat loosely attached to the skull. In the zoo at Katmandu, a keeper could grasp the horn of one of his two Indian rhinos and visibly wobble it.

Tiger (*Panthera t. tigris* Linnaeus) are fairly common in Kaziranga and both their tracks and buffalo kills were in evidence. I was given one report of a young rhino mauled by a tiger, but the general belief is that tigers are afraid of rhino, or at least leave them alone. An adult Indian rhino has probably no predator to fear except man.

Deer are well represented in the Kaziranga area. Hog deer (*Axis p. porcinus* Zimmermann) are common, especially in the shorter grass area outside the dense elephant grass jungles or in

bils in the interior. Both sambar (*Cervus unicolor niger* Blainville) and swamp deer or barasingha (*Cervus d. duvauceli* Cuvier) may be seen grazing in bils in the interior, occasionally within a few yards of rhino.

Wild boar (*Sus scrofa cristatus* Wagner) seems to be more tolerant of the rhino than any other animal. Both the jungle myna and the cattle egret were observed riding on the backs of rhino. The ubiquitous egret was so often an associate that it served as an easy means of locating rhino where the grass was too high to see the rhino itself. Both birds apparently serve as a warning device, the rhino usually bolting when the birds fly in alarm.

Crocodiles are reported from the sanctuary's many streams during the summer. They could conceivably be a menace, at least to young rhinos. Rhinos so often swim the streams that their points of entry and exit from the water are wide and hard packed.

Fire, Flood.—There are no reports on rhino behaviour during the annual fires, probably because such a large amount of the grass area remains unburned that a rhino can retreat to and through it without being noticed. The grass jungles of the Brahmaputra valley are probably caused by fire and are certainly maintained by it (Bor, 1938), so that fire is probably an integral part of the rhino habitat in that area.

Some degree of flooding is a regular and expected thing in the valley of the Brahmaputra. The great earthquake of 1950 loosened a vast amount of silt which washed into the headwaters of the Brahmaputra and has since been slowly moving downstream. It has made a sort of moving dam which has caused floods far in excess of the historical normal. (Gee, 1952). The flood of 1955 inundated almost all the sanctuary except the tops of some ridges. At time of flood some rhinos have usually moved up into the Mikir Hills, where they are apt to fall prey to poachers. In addition, as a result of floods some rhinos are always reported dispersed, swimming or wandering into other areas. To date, most of the rhino conservation effort has gone into the Kaziranga population, but as long as this area is vulnerable to the catastrophe of flooding, it is extremely important to assure also the safety of the other known rhino concentrations.

Another by-product of the floods is the spreading of waterhyacinth (*Eichhornia crassipes*). In recent years it has invaded the sanctuary, choking the streams and bils. Floods serve to

clear these temporarily, but they also spread the ubiquitous plant over formerly clear areas. As it is, navigation through much of the sanctuary by canoe or elephant has become difficult or impossible. What the effect of this will be on the ecology of the area is not known. Rhinos are not now found in the areas of greatest hyacinth concentration, but whether this represents cause and effect or coincidence is not known.

Man.—Rhino poaching seems well under control, at least in the vicinity of reserves and sanctuaries. When rhinos wander out into the surrounding territory, especially into districts of the hill tribes, very little control can be exercised. If there are any rhino poachers at Kaziranga they probably enter the area from the Brahmaputra side.

As far as other animals go, some poaching takes place in areas remote from sanctuary activities, patrols, road building, visitors. This might be inferred from the behaviour of wildlife, especially chital and barasingha. Near areas of sanctuary activity these animals are relatively fearless, while in outlying places all one sees of them is a movement in the grass. Part of this behaviour may be tolerance acquired through almost a decade of harmless visits by people on elephants.

In the case of the rhinos, the tolerance is striking. Those seen in remote parts of the sanctuary seem to become nervous, though not particularly frightened, at the sight of a riding elephant. If the elephant in the open where he can be seen approaches to within 40 or 50 yards, these rhinos sometimes become aggressive. The place where rhinos are easiest to observe is the Kohora grazing ground, a field of medium to low grass at the sanctuary edge near the hotel. Here, where they are accustomed to humans, it is often possible to ride up to within 30 yards of the rhinos without much disturbing them. Mothers with young are the aggressive exception.

An occasional old rhino, usually assumed to be a bull driven out of the sanctuary by other rhinos, takes up residence outside the sanctuary near the paddy fields to the south. Instead of becoming dangerous rogues, these individuals have become extremely docile, paying little attention to livestock or to the native life which goes on nearby. There have been several such rhinos at Kaziranga, the most celebrated living in that docile state for more than 14 years. There are a very few cases where rhinos have run amok, causing injury or destruction. These may have been driven from the sanctuary by floods and then wounded by poachers.

Rhinos from the sanctuary do raid the rice fields nearby, especially when the rice shoots are first put out. The villagers have built little shelters on high towers, and from these fairly safe vantage points they try to drive off the rhinos. So far nothing very effective has been devised to protect the crops.

Life History.—The best accounts of what little is known of rhino life history at Kaziranga are in the writings of E. P. Gee. The rhinos feed, off and on, both day and night. They spend considerable time in mud wallows, most of the day during hot weather. This may serve to allay the clouds of insects which inhabit the swamps; for in spite of its armor plated appearance the rhinos hide is quite sensitive and a comparatively slight scratch will draw blood. Rhinos usually drop their dung in large piles but whether or not a rhino is truly territorial, always using the same pile or piles as markers, is unknown. From my brief observations, I should think that at the season of my visit the rhinos were not strongly territorial. Some identifiable ones appeared each day in about the same area, but wallows were shared by as many as five rhino at the same time. Other rhinos wandered through the areas at will, and use of the dung-hills seemed to be a matter of chance, determined by which hill they were nearest at the time. Several rhinos used more than one hill while I watched them. These dung hills are quite considerable structures, some of them measuring over 15 feet long and up to 4 feet high.

From the numbers of young in evidence, the rhino population at Kaziranga would seem to be vigorous and healthy.

IV. RECOMMENDATIONS

As my work in connection with the Indian rhino in India was mainly concerned with the largest known concentration of the animals, i.e. those in the Kaziranga Sanctuary, the following recommendations refer primarily to that area.

1. Livestock grazing, at present allowed in parts of the sanctuary presents a considerable threat to the rhinos and other wildlife. Even though most of the livestock may be inoculated for rinderpest, the disease suspected of doing the worst damage is anthrax, and the animals cannot be inoculated for that. In addition, large numbers of domestic stock compete directly with the wildlife for the available forage, and the greater grazing pressure resulting, may alter the vegetation makeup, possibly reducing the carrying capacity of the area. Consequently, I would urge further consideration by the authorities of the resolution passed in 1954 by the International Union for the

Conservation of Nature indicating the desirability of recommending that all domestic livestock should be excluded from the sanctuary.

2. It is impossible to eradicate the water-hyacinth because of the annual floods. However, from the dual standpoints of ecological stability and ease of access for tourism and patrolling, it may prove necessary to effect some annual control of the plant. To this end, knowledge is needed on the ecological impact of hyacinth in Kaziranga, and on economical means of control (for instance, spraying). This might be handled by the forestry personnel in the sanctuary.

3. The Kohora grazing field should be included in the sanctuary because of its large and accessible resident rhino population.

4. More protection should be given to wild life in the Mikir Hills which are adjacent to the sanctuary. Animals move there during the flood season.

5. Through effective and timely protection of the rhino and its habitat, the Indian government has shown at Kaziranga what can be done to prevent a seriously endangered species from becoming a "fossil of tomorrow". Conditions (floods, disease, firearms, etc.) in that part of India are changing so rapidly that implementation of the above recommendations would, I believe, help to strengthen the fine work already accomplished. The only way to provide for effective management of a wild animal in the face of continually altering conditions is to have a sound knowledge of the animal's ecology; yet at present extremely little is known of the ecology of the Indian rhino. The Kaziranga Sanctuary affords a magnificent opportunity for the study of the rhino in its natural habitat. In my judgment, ecological study of the Great Indian rhino should be undertaken as quickly as possible.

JAVAN RHINOCEROS; LESSER ONE-HORNED RHINOCEROS

Rhinoceros sondaicus Desmarest

I. DESCRIPTION

The Javan Rhinoceros looks much like a slightly smaller edition of the Great Indian Rhinoceros. Males may be 5 feet 10 inches high at the shoulder and females 5 feet 6 inches—approximately 6 inches lower than the Great Indian Rhinoceros. The Javan is said to be of slighter build than its Indian relative, but from personal observations at close range of both animals in the wild, I find it difficult to detect much difference between them in size, although the Javan rhino appears to have a slightly less deep body than the Indian.

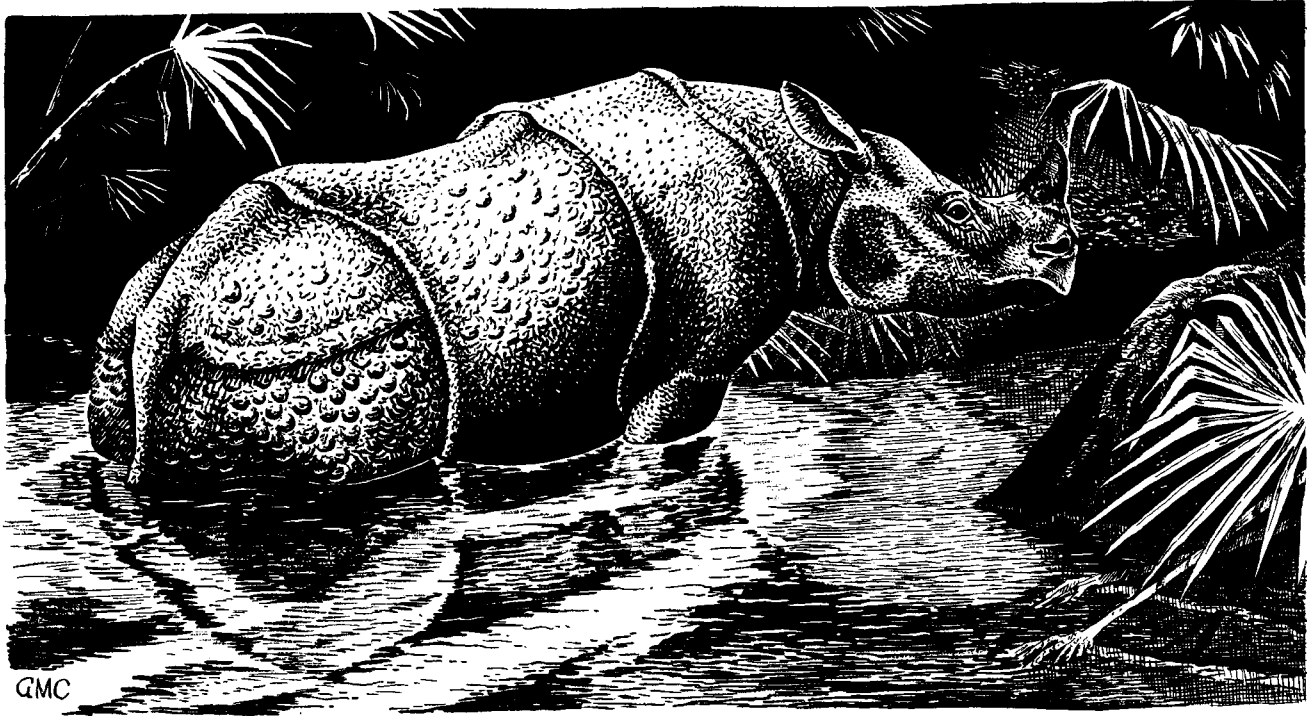
The obvious points of distinction between the two rhinos are the horn and the body folds. While the Indian rhino has a prominent horn which attains a length of 2 feet, and both sexes are conspicuously horned, the male Javan rhino's horn may be only slightly over 10 inches in length; the female's horn is very slight or totally lacking.

Both Indian and Javan rhinos have prominent folds in the hide across the back, over the withers, and behind the shoulder. In addition to these, the Javan rhino has a similar fold just in front of the shoulder. Reports state that the skin is broken into a scaly mosaic by small cracks (the Malay name, "badak tenggiling", means scaly rhino) but these were not evident on the wild specimens I saw even at 5-6 yards range.

II. DISTRIBUTION AND STATUS

India, Sikkim, East Pakistan

Former.—The most westerly range recorded by Harper is "in the forests of Orissa and about the delta of the Mahanadi River, in the Bay of Bengal". But he notes that there is considerable question about the validity of that report. In 1950 the range included the Sikkim Terai, the valley of the Brahmaputra River in Assam and Bengal, the Sunderbans,



GMC

THE JAVAN RHINOCEROS

along the Torsa River, the Jalpairugi and Chittagong Forest tracts, Manipur, and the Lushai Hills.

Present.—Probably extinct throughout the above range.

Burma, Thailand, Cambodia, Laos and Viet Nam, Malaya

The literature and reports bearing on distribution of rhinos in these areas often are not clear as to whether the animals involved are *Rhinoceros sondaicus*, *Didermocerus sumatrensis*, or even *R. unicornis*. For a discussion of distribution and status of the Javan rhinoceros in these areas, see the chapter on "Sumatran Rhinoceros".

China

Former.—*R. Sondaicus* was definitely reported as far north as Tonkin. Other reports indicate that it may have been found over the Chinese border, particularly up the Song Koi and Mekong Rivers.

Present.—Probably extinct.

Sumatra

Former.—Apparently the Javan Rhino was found throughout the entire island.

Present.—It has been presumed extinct in Sumatra for at least two decades. I have found no evidence to the contrary.

Java

Former.—The Javan rhino may once have roamed over most of the island, although some sources quoted by Harper limit the range to the west and central parts. In the last century with the tremendous population growth in Java¹ the rhinos would have been excluded from most of the island by agriculture, even if they had not been hunted to death for their horns. By the mid-1930's the last known Javan rhinos were in the Udjung Kulon game reserve on the western tip of the island. From 1934 to 1937 at least 15 rhinos were known to have been killed. Three more were poached about 1939, and one at the start of the Japanese occupation. No further rhinos were reported killed until the period following the Japanese occupation, when firearms again became available and conditions were quite

¹ The population of Java in 1800 was estimated at 3-4 million; in 1850, 11 million; in 1900, 28 million; and 1930, 41 million; in 1958, 57 million.

unsettled. Between the end of the war and 1955 an estimated 10 animals were poached, at least two of which had wandered out of the reserve into the mountains to the east.

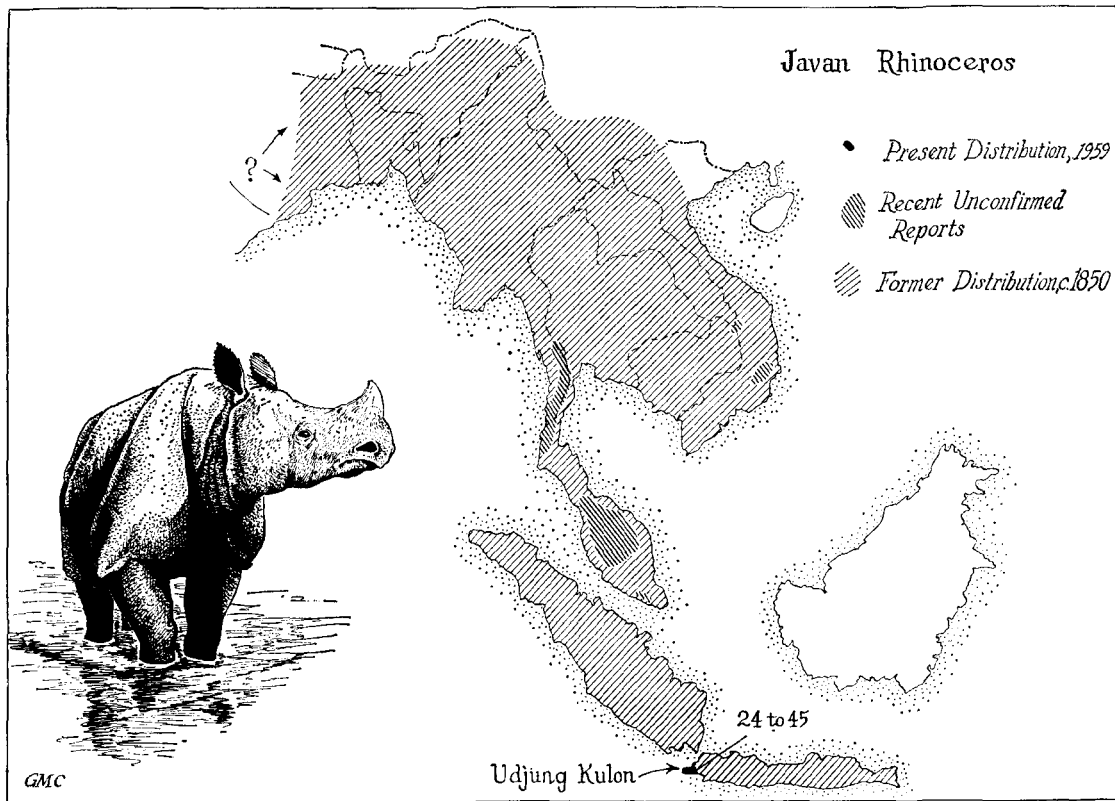
Present.—The last known population of Javan rhinos is estimated at from two dozen to four dozen animals. These live in the Udjung Kulon Reserve, although occasionally an animal wanders out into the mountains immediately to the east. The Nature Protection and Wildlife Management authorities of the Indonesian Government very carefully protect the rhinos from interference by man. The greatest threat to the rhinos at present may be biological. In the population of a few dozen animals, only one or two young are known to exist, and perhaps the population has reached such a low level that adequate reproduction may not occur.

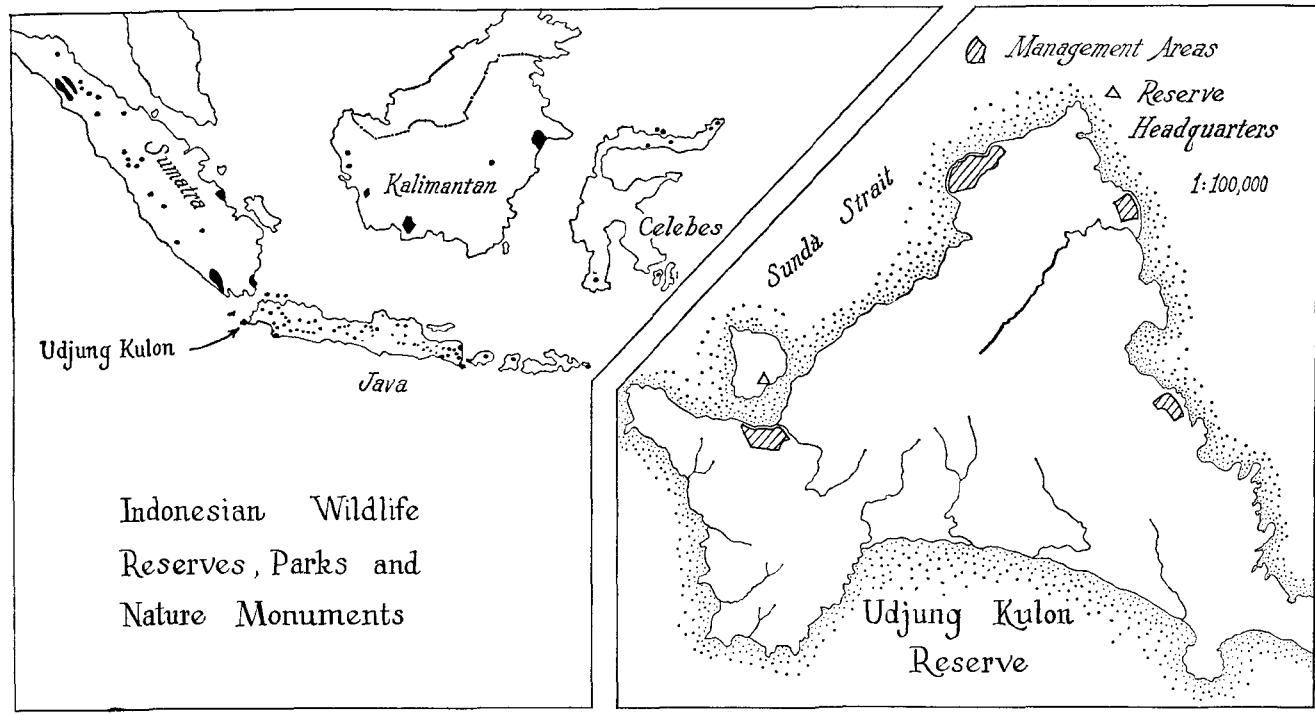
III. ECOLOGICAL NOTES

Habitat.—*The Udjung Kulon Game Reserve.* In the last century when the Javan rhino's range included much of South-East Asia, it was reported to be generally a creature of the lowlands, while the Sumatran rhino was found at all elevations. The Udjung Kulon is lowland and as such may be representative of the rhino's habitat of choice. Today, however, it must be considered primarily a habitat by necessity for it is the only place where these rhinos have received enough protection to survive.

Thanks to the courtesy and fine arrangements of the Indonesian Government, I was able to carry out a two-week ecological reconnaissance of the Reserve. Both this and the Sumatra expedition were made possible by Professor Kusnoto, Director of the Indonesian Government Botanical Gardens; by Mr. Andries Hoogerwerf, then head of the Botanic Gardens' Department of Nature Protection and Wildlife Management, who made all the advance arrangements; and by Mr. Kusnadi, head of the Nature Protection Department of the Forest Service, who provided personnel and boat transport.

Location, Topography, Weather.—The Udjung Kulon Reserve is the westernmost point of Java, a bulbous peninsula jutting out for 13 miles into the Sunda Straits. At its junction with the mainland, the peninsula is only .6 of a mile wide, but it widens rapidly reaching a maximum width of 7 miles. The area of the reserve is 117 square miles. The highest land is on the western tip where a several hundred foot high ridge with one higher peak rises above the fairly uniform level of the rest of the





to preserve the Javan rhino, the Banteng (*Bos sondaica*) and the Javan tiger (*Felis tigris sondaica*), all of which were threatened with extinction. Human habitation has been excluded since that time, and although one can still find traces of villages, the general impression is that of a primeval forest.

In the early 1930's the status of the area was changed from that of a Nature Monument to a Game Reserve. This allowed the nature protection authorities to carry out a certain amount of management, which has taken the form of opening, or re-opening, pasture land along the north coast to augment the limited existing pasture. In 1951 the current habitat management program started under the instigation and direction of Mr. Hoogerwerf. There are now four large management areas. By maintaining these areas as open pastures of alang alang grass, the habitat for the Banteng and the Javan deer (*Rusa timorensis*) is greatly improved. The deer, for instance, have increased from estimated population of 75 to something over 250. The reserve is administered by the Nature Protection Department of the Forestry Service. No residence is allowed on the peninsula and the headquarters and homes of the reserve personnel are on nearby islands or the mainland. The permanent staff number about 50, including one chief warden, and one supervisor, each with three assistants, four rangers with police powers, and the rest wardens. The area is constantly checked by foot patrols of four wardens and an armed ranger. Patrol paths have been cut along the perimeter of the reserve; patrol huts have been constructed at strategic points about a day's march apart along the paths. Dugout proas, are available on the larger rivers for checking the interior of the peninsula. When the weather permits (from April to November) patrol boats keep watch over the coastline. The principal area occupied by the rhino lies in the centre and south of the peninsula, so the management activities on the north coast, and along patrol paths should not affect them at all.

The Rhinos.—The estimates I was given of the number of rhinos in Udjung Kulon varied from two dozen to around eighty. Mr. Hoogerwerf, who has a more thorough knowledge of the area and its fauna than anyone else, favors a low estimate and from my brief observations I should agree. The animals wander considerable distances, zig zagging back and forth. So what at first appear to be tracks of numbers of rhinos turn out, on investigation, to be due to the meanderings of a single animal. Most estimates are based on tracks; for the rhinos hide so well

and the forest is so dense that the animals themselves are rarely seen. It seems to me that a safe estimate of the rhino population is between two dozen and four dozen.

The Javan rhinos are so rare and secretive that even less is known of their habits than of those of the Sumatran rhino. They have wallows which Mr. Hoogerwerf states they may use for from several days to a month, before moving on to another. These wallows appear much like those of the Sumatran rhino, some even being located on hillsides, although never in as steep a situation as some of the Sumatran examples. I found one fresh one on a hillside in dense jungle. It measured 12 feet by 6 feet. Along the well-worn path to it was a tree, about 4 inches in diameter, with its bark worn smooth to a height of 5 feet. Apparently it was used as a rubbing post. Mr. Hoogerwerf states that these rhinos do not use their feet for digging wallows and he believes that they may enlarge pig wallows or natural depressions. He thinks that the animals are territorial to some extent, at least to the degree that they have established centers of activity, though they roam considerably through other rhino's areas. There are well established rhino paths leading into streams and rivers, smooth sided trenches several feet deep in places. But like the Sumatran, the Javan rhinos show considerable agility in scrambling up steep banks and over or through obstacles.

The rhinos occupy the parts of the peninsula least accessible to man: the low central jungle-clad plateau and the southern coastal area. They may travel through the pasture lands of the north coast or the highland forests of the western tip, but none apparently live there or are reported to have lived there in the past.

As with the other species of rhino, the Javan's eyesight seems rather poor, while the sense of smell and hearing are acute. None of the six animals I closely approached seemed to recognize me as a human being by sight, and I was within 5 meters of one female with a baby! When disturbed from the down wind side, the rhinos snorted and made short dashes cross wind through the jungle growth, possibly in an attempt to pick up my scent. When this failed, they would rush off directly up wind.

My very good fortune in seeing the rhinos was due to the efforts of Mr. Amin Soekardi, the director of the reserve, who kindly accompanied me during the expedition. Through his knowledge of the animals' locations and his energy in finding them, we came to within a few yards of six animals and had good observations of four of them.

In the case of the female and baby, we had been following their tracks when we caught sight of the baby disappearing into the jungle some yards ahead. The carriers and trackers promptly and prudently took to the trees as they always did when we came to a rhino. Mr. Soekardi and I pushed ahead and crawling around a clump of rattan, we unexpectedly came upon the little rhino at a distance of about 5 meters. It was chewing tepus, a favorite food of the rhino. Soon it lay down, first folding its hind legs and sitting with its front legs stiff, looking around. Then it folded its front legs also and laid its head down on the ground. This jungle is so dense that even at that range our view was not very clear, for although it was early afternoon the jungle floor was very dark. Suddenly the mother rhino stepped from behind a rattan clump and stood beside the baby looking at us. She stared for a long while, blinking her black eyes, swinging her head, sniffing with flaring nostrils, and flicking her ears. We were down wind, exactly 5 meters from her tracks. She suddenly jumped back about two steps, turned, and began calmly feeding. Shortly thereafter the baby got up and the two moved away.

For forage the rhino seems to choose tepus (*Nicolaia* sp.) young bamboo of various types. *Donax arundinastrum*, *Ficus septica*; leaves of *Ardisia humilis*, *Desmodium umbellatum*, other *Ficus* spp., *Terminalia* spp., *Spondias* spp.; and some fruits. Mr. Kushnadi reported seeing the rhinos knee deep in the sea and he believed they ate the intertidal *Rhizophora*. To get at the leaves, twigs, and possibly fruits of some trees the rhinos merely pushed them over. Judging by the tracks they accomplish this by leaning a shoulder on the tree, and then, as it starts to give way, they walk up over it forcing it down between their front legs. In this manner they had pushed down trees up to 6 inches in diameter and over 20 feet high.

Other Animals.—It is estimated that between three and four hundred banteng live in the reserve. Most of these are around the open areas along the north coast, but a few are found near the smaller clearings along the southern coast, where they keep the grass in the open spaces so closely grazed that the appearance is of a well kept park. Few, if any, banteng live yearlong in the dense interior; during the dry eastern monsoon they tend to concentrate in the pasture areas, and are then easier to observe than during the wet west monsoon.

The Javan deer or rusa is even more a creature of the pastures than the banteng; in fact these graceful animals with their long hair and fine antlers are probably never found in the interior.

Wild boar (*Sus vittatus*) are quite common both in the pasture lands and along paths in the deep forest. They are found scattered here and there throughout the interior of the reserve also.

The lesser mouse deer or kanchil (*Tragulus javanicus*) and the barking deer or kidang (*Muntiacus muntjak*) are widespread throughout the forested areas. Three species of monkey can be seen: the common Javan mojet (*Macaca irus*), the black lutung (*Presbytis cristatus*), and the rarer surili (*P. aygula*). Other occupants of the forest which may occasionally be seen include a squirrel (*Callosciurus notatus* ssp.), a mongoose, the gungaragan (*Herpestes javanicus*), and the Malayan giant squirrel or jelerang (*Ratufa bicolor*).

Flying foxes (*Pteropus vampyrus*) can be seen each evening. They fly out over the peninsula or to the off-shore islands, returning to their roost trees at dawn. The numbers of these bats at each roost are incredible. One evening I counted one sector of a sky full of bats. In 11 minutes 6,000 came by, and they continued in undiminished numbers for half an hour more until dark.

The largest predator is the Javan Tiger (*Felis tigris sondaica*). Mr. Hoogerwerf considers it the most threatened animal in Java. There are an estimated 10 to 12 in Ujung Kulon, with a possible 20-25 in all of Java. From the rhino's standpoint, the tiger is a very useful citizen. The human residents of this part of Java believe that the tigers are the souls of their departed ancestors, so they will not aid poachers in killing them. The tiger has a rather fearsome reputation. During the Japanese occupation when guns were not allowed, several persons were killed by tigers and Mr. Kushnadi told me that two of his men had been attacked by a tiger a month before my visit. There is a story that after the last war poachers planned to try to kill all the Ujung Kulon rhinos for their horns. When they entered the peninsula one poacher was killed by a tiger, and since they could not get any help from the nearby villagers in combating the tigers, the poachers gave up. It is an interesting situation where one of the world's rarest herbivores may have been saved from extermination by an even rarer predator. Signs of tiger was widespread throughout the reserve although fresh tracks were not common. I found pig hairs defecated by tigers, and probably their primary sources of food are pigs, deer and banteng. Management of the pasture land aids the tigers by increasing their food supply.

Leopard or panther tracks are also widespread throughout the

peninsula. Javan wild dogs (*Cuon alpinus javanicus*), although I saw no signs of them, have been reported periodically from the pasture areas in the north and are considered to be very destructive to deer and banteng.

Bird life in the reserve is abundant and gorgeous. The Green peafowl (*Pavo muticus*), two species of junglefowl (*Gallus* sp.) and the hornbills are the most conspicuous birds.

The commonest big reptile seemed to be the water monitor (*Varanus* sp.) which reaches lengths of more than 3 feet. It or its tracks are commonly seen along the beaches where it has been searching and digging for turtle eggs. Crocodiles were also seen near the mouths of two rivers. Several smaller lizards were in evidence, skinks and geckos were conspicuous around all the patrol cabins. Snakes are less commonly seen although I saw a dozen small water snakes along one river.

The rhinos live somewhat apart from the rest of the large wildlife of the area and probably do not come into direct contact with them or into competition with them for either food or space. A tiger could possibly kill a very young rhino, but to do so it would have to face the formidable mother. Where there is such an abundant supply of alternative less dangerous prey there would seem to be little danger to the rhinos from tigers.

RECOMMENDATIONS

The Government of Indonesia deserves great credit for the fine condition of the Udjung Kulon Game Reserve. Without its active and well-directed program the Javan rhino would probably be extinct.

Man remains the greatest immediate menace to the rhino's continued survival. The provisions of the Government for the reserve's protection were quite adequate in 1955. As conditions change, however, the policies of the reserve will have to be reassessed. A sound knowledge of the rhino's ecology is a necessity as a basis on which to build future plans both for habitat management and for possible tourism. This knowledge is also necessary to judge what actual danger exists from the effect of the low population level on potential breeding success. A start has already been made on this enquiry.

Mr. George C. Ruhle, Park Naturalist from the Hawaii National Park, went to Indonesia in June, 1959, to carry out a six months' study of the Indonesian National Parks to help that country to start a National Park Service. The project is under the direction of Mr. Harold Coolidge.

It is most important that no significant disturbances be made—trapping rhinos for zoos, for instance—until there is enough knowledge of the animals' ecology to predict the effects on the remaining rhinos with some certainty. Where so few individuals remain, even an apparently slight disturbance may mean the difference between survival and extinction.

ASIATIC LION; INDIAN LION

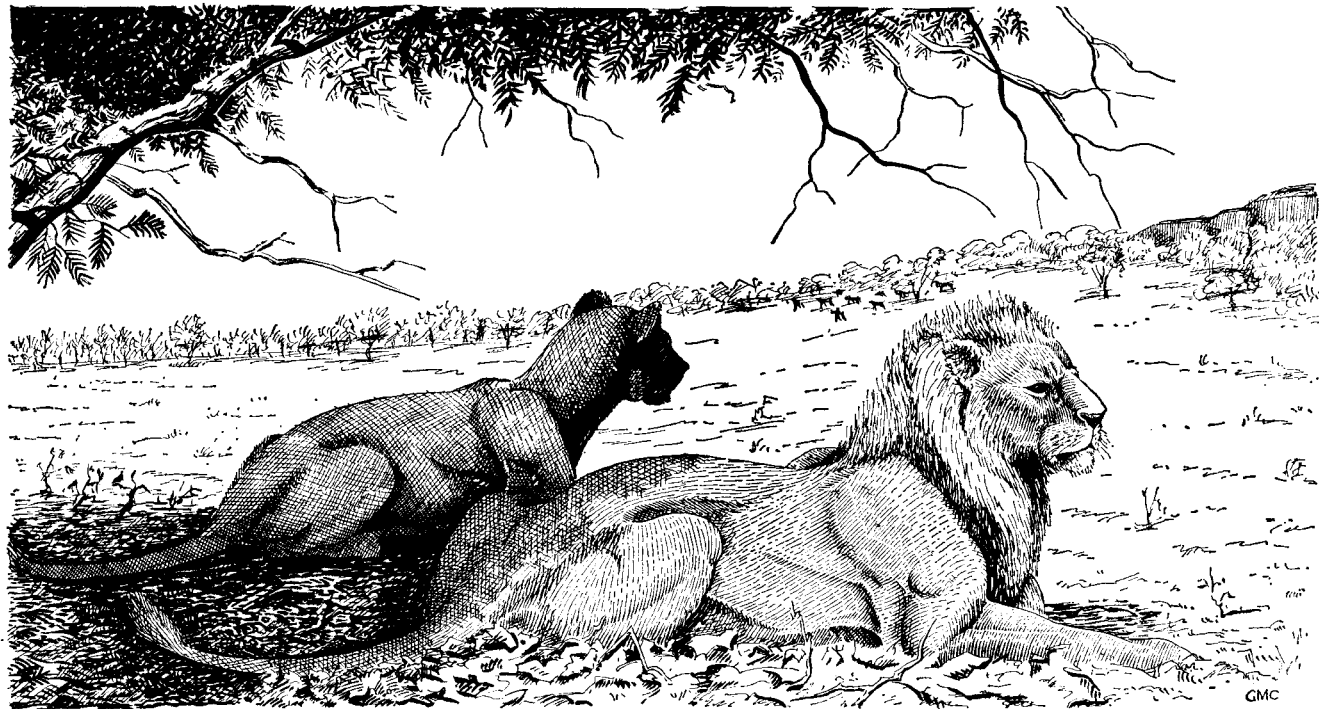
Panthera leo persica Meyer

I. DESCRIPTION

The Asiatic lion closely resembles its African counterpart, though it is commonly believed that the African animals differ in size and appearance from the Asiatic. In literature the Asiatic lion is variously described as being both lighter and darker in color than the African; of longer and of shorter mane; with more and with less body hair; and of equal as well as of considerably smaller size. A careful review of available descriptions fails to show consistent differences between the two lions in these characteristics (Harper, 1945; Cadell, 1935; Dharmakumarsinhji, 1951; Gee, 1956; Pocock, 1930; Roosevelt and Heller, 1914; Rowland Ward, 1914 and 1928; Smee, 1834; Wynter-Blyth, 1949, 1950, 1951).

The descriptions of African lions are based on thousands of lions killed and observed, many by biologists. Descriptions of the Indian lions, on the other hand, are based on a very few specimens killed or observed, and few of these by trained biologists. Consequently, the available descriptions of the Indian lions may be much less representative of the race as a whole than those of the African animals. There seems to be little difference in average total body length between Indian and African lions. The average weights of both are probably between 400 and 500 pounds. There seems to be wide individual variation within both species with regard to the length and color of the hair on mane and body including tail tassel, elbow tufts, and belly fringe. The available data do not appear to warrant distinguishing between African and Asian lions on the basis of those characteristics.

It appears to me that this paucity of specimens is the reason for the widespread belief that the Asiatic lion differs considerably from the African lion, for by the time western investigators started describing the Asiatic lion, it was almost extinct. Indeed, they were so little known in the wild that zoo specimens were used to describe them. According to Pocock (1930) the first description of the Asiatic lion was by Griffiths, who wrote about one displayed in Calcutta. In 1827 a pair from Persia in the London zoo were described by Temminck as the "Persian Lion" and were subsequently named *Felis leo persicus* (Fischer).



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THE INDIAN LION

The same year Bennett described and named (variety *bengalensis*) a pair of Indian lions displayed at the Tower of London. In 1834 Jardin described two zoo specimens in London, naming them *Felis leo asiaticus*. These were presumably the same animals Temminck had described, now grown adult. So the same two zoo animals may have served as type specimens for two different races.

Apparently the first description based upon specimens collected in the wild was by Smee in 1833 and 1834. On the basis of eleven such specimens from India, he named the lion *Felis leo goojratensis* and published it under the name "The Maneless Lion of Gujerat". For the next century there followed very occasional accounts or descriptions of the Asiatic animals and even more infrequent specimens of the same. So rare were the specimens that in 1930 Pocock was unable to find more than one skin of "the Persian lion" and eleven skins of the Indian lion, five of which were collected within a year of his publication. At least two of the remaining six were from zoos, another "when unstuffed was found to contain a tiger's skull", and another was "merely cured, hot dressed and stretched, and is certainly dried and shrunken."

There was not a single complete wild-killed example of the lion in the British Museum of Natural History at that time, and five of the specimens Pocock studied were sent from overseas, Chicago and Bombay. With so little material for comparison, there has been a tendency to generalize on the basis of a very few specimens, some of them apparently quite atypical (such as maneless or melanistic ones) and others modified by life in a zoo.¹

The foregoing discussion points out the lack of reliable information on the Asiatic lion, for the considerable but often conflicting literature is based on a minimum of valid zoological material. The situation has changed little since 1930 when Pocock wrote regretfully of "the tolerably copious literature and deplorably scanty material. . . ." One partial solution will be to make sure that any Asiatic lions, shot in the future are carefully described and recorded by suitable people and, where possible, the specimens supplied to museums. Few animals are likely to become available in this way, and I certainly would not recommend any wholesale collecting of a rare species; but a considerable number of specimens must adorn the floors, walls

¹ The effect of captivity on lions' morphology may be quite significant; the mane may become considerably enlarged, skins darker, musculature and bone structure somewhat modified. (Pocock, 1930).

and trunks of present and former officers of the Indian government, Indian royalty and big game hunters. These trophies are usually in the form of tanned skins with or without heads; or mounted heads, often with the skull inside the mount. With whatever records accompany them, they provide an untapped source of zoological materials. If this were studied together with specimens in museums and with data from subsequent specimens, it might yield the information needed properly to describe and classify the Asiatic lion and give an insight into any morphological changes, which may be taking place within the Gir population.

II. DISTRIBUTION

Europe

Probably the last lions in Europe were those in Greece. Aristotle and Herodotus wrote of the lions of Thessaly attacking baggage animals attached to Xerxes' army in 480 B.C. but by 100 A.D. these lions were considered extinct. Whether the Greek lions were a separate race from the Asiatic lion is not definitely known. It is generally assumed they were, but the ranges of the two were adjacent at the Straits of the Bosphorus. No specimens from Europe have been found (Harper, 1945).

Asia Minor

Former.—Harper quotes one record from the upper Euphrates in Turkey, and Murray (1866) says "It is . . . not rare in Asia Minor."

Present.—Extinct.

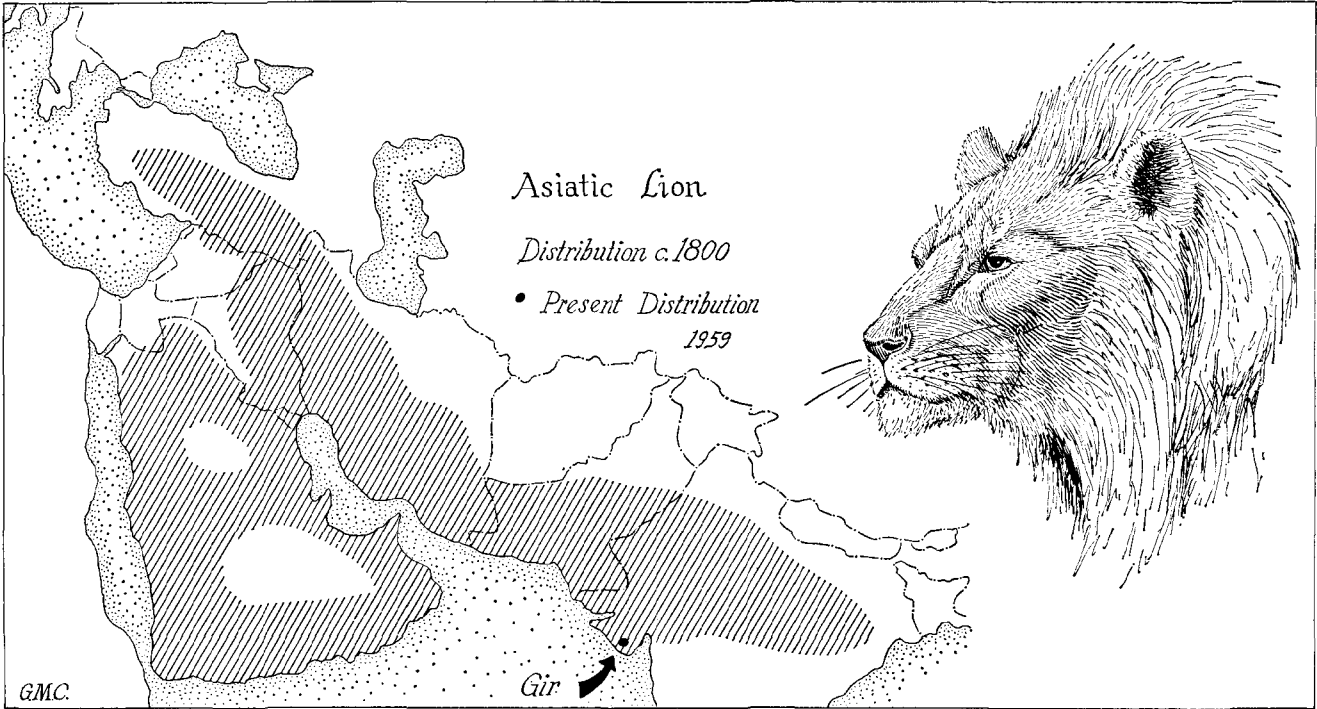
Syria, Palestine, Iraq and Arabia

Former.—At the time of Christ the lion was sufficiently common to be mentioned approximately 130 times in the Scriptures. Apparently it was exterminated in Palestine about the time of the Crusades, but a few survivors still existed into the present century in the wilder parts of non-desert Arabia, and in the dense vegetation along the less frequented parts of the Tigris and Euphrates.

Present.—Extinct.

Iran

Former.—Although probably once common over much of the country that was not actual desert, by 1900 lions were exterminated in most of their range, being common only in west Persia, especially in Khuzistan. There they remained until the



late 1920's though isolated reports from the south of Persia continued into the 1930's.

Present.—In Baghdad and Damascus, I was told that reports still come down occasionally of lions in southern or western Persia, and there were several references to lions seen in the Zagros mountains during the last war. As most such report stemmed originally from tribesmen in the area involved, I regard them as questionable. This is not because of any lack of trustworthiness on the part of the tribesmen, but rather because of the difficulties in translation. "Nim'r", or variations of it, can refer to lion, tiger, panther or wildcat, and I found this to be a source of considerable confusion while working on the cat family in the Middle East. Considering the possibility of semantic confusion, and the abundance of modern rifles, the existence of any lions west of India is highly unlikely.

Afghanistan

Apparently the lion did not inhabit Afghanistan, at least in recent times.

Pakistan

Former.—The lion probably once occurred all along the Indus and its tributaries. There are a few reports of lions in the Baluchistan mountains, one of the latest being 1935 from Bolan Pass, south of Quetta. The last known individual was killed at Kot Diji (in the southeast) in 1842 (Pocock, 1930).

Present.—Extinct along the Indus; probably extinct in the Baluchistan mountains.

India

Former.—The very early distribution may have included some of southern India, but in the last 200 years the range probably extended into India as far as a line running roughly from Hariana in the Punjab, south-east to south-central Bengal, then generally west to Baroda and the Kathiawar Peninsula. (Pocock, 1930). The last lion recorded outside Kathiawar was in 1884 in central India. (Wynter-Blyth, 1949).

Present.—Since 1884 the range of the Indian lion has been limited to the Gir Forest and its immediate environs. The forest, an area of about 500 square miles, is roughly 20 miles south of Junagadh, in the south-west of the Kathiawar Peninsula. Small population, wanderers from the Gir, are found year-long at Girnar and Mytiala, respectively 11 and 14 miles from the forest. An occasional individual may wander farther from the

forest's protection, but such animals are usually shot before they get very far.

III. ECOLOGICAL NOTES

History and causes of extermination.—In country after country, as the human population and occupation of the land increased, the lion retreated and this process accelerated as more efficient weapons became available; especially with the presence of foreign military forces. In Palestine, for instance, the lion disappeared about the time of the Crusades. In Persia and Iraq the increase in firearms during the first world war is blamed for the lion's extinction. In India the greatest lion kills were held by the military. For example “. . . during the Mutiny, Colonel George Acland Smith killed upwards of 300 Indian lions . . .” (Kinear, 1920, quoted by Harper, 1945.)

Lions were regarded as the symbols of strength, bravery and nobility and their sculptured and painted images appeared again and again in the palaces, forts and great cities of the ancient middle eastern world. Hunting the lion was the sport of nobility. As modern firearms reduced the risk and skill required, the ranks of the royal hunters were swelled by ever-increasing numbers of lesser government officials, military officers, influential visitors and travelling big game hunters, anxious to secure an ever-rarer trophy. But even without the trophy value attached to the lions, the interests of men and lions were bound to clash. Lions were a direct threat to human life and predators on domestic ungulates.¹

Lions can exist under a wide range of habitat conditions. It is not likely, in my opinion, that physical alteration alone (vegetation change, cultivation, etc., short of producing actual desert) was enough to drive the animals out of their habitat. Nor is it likely that the presence of human beings by itself had that effect. Lions live quite successfully in the Gir in the midst of considerable numbers of people. Conflict probably came through direct competition for food. Human occupation often affected the lions' wild supply of food, substituting for it or augmenting it by the more easily captured animals.

Tigers have often been accused of aiding the extermination of the lion where the two shared the same area. Unless there was

¹ The record of larger mammals exterminated throughout the world during the past 2,000 years shows that the larger predatory mammals as a group have sustained the greatest losses at the hand of man (26 forms of larger predators exterminated contrasted with only 18 forms of Bovidae, Equidae, and Cervidae. (Harper, 1945.) The lions of Asia merely followed the trend of the large predators and are more fortunate than many, even to have survived.

some striking increase in the tiger population and the spread of its range (neither of which is known to me) it seems highly unlikely that tigers played any role at all in the lions' retreat. Before the reduction of the lion's range, both tigers and lions shared parts of India, and that fact alone should settle the question. Long after lions had become virtually extinct in the tigerless portions of their range, they survived in some numbers in parts of India also occupied by tigers. In any event, it is doubtful if tigers and lions filled the same ecological niches in their adjoining habitats. Tigers like dense vegetation, while lions choose open land. Tigers also are much more difficult to approach than lions, which from the earliest records are noted as being comparatively fearless. Given these conditions plus gunpowder, selective extermination of the lions would certainly be expected.

By 1884 the last known lions in India were in the Kathiawar Peninsula, in the vicinity of the Gir Forest. Several factors combined to make this the lion's last refuge. The local people had religious scruples against killing animals, even stronger than those over most of India. The forest was isolated both by topography and by administration—the peninsula area being an assemblage of 202 small states, each with an absolute ruler in the form of a royal prince or maharajah.

By 1900, however, continual hunting by visiting officials and royalty had considerably reduced the lion population. One commonly accepted estimate is that in about 1900 less than a dozen lions existed in the forest. Many estimates have been published for the period from 1890 to 1913, most of which indicate two to three dozen animals remaining. On the other hand, E. P. Gee states that there were at least 100 lions in the central forests at that time. His reference is the Jam Sahib of Nawanagar, who informed him that the nawabs of Junagarh (the state in which most of the Gir Forest lies) let it be known officially that the number of lions was so low, in order to discourage over-hunting by "every British Viceroy, Commander-in-Chief, Governor of Bombay, Indian Prince, and others down to persons of less importance".

Whatever the number of lions surviving around 1900 actually was, the animals were then declared protected and have been so ever since. This protection allowed a few lions each year to be converted into trophies by important guests of the Nawab. This number was officially set at three per year for most of the period. The actual kill may have varied between three and twenty, but with that degree of protection the lions increased. Even in the very early 1900's a few lions straggled out into

adjoining states. It did not require straggling very far, for the forest area included or adjoined several small states. Virtually every lion found outside the Gir was killed, and some elaborate schemes were devised to lure or drive them over the boundary line. From sometime before 1920 up to 1947, an estimated ten to twelve lions were thus killed annually.

A census in 1936 showed 289 lions in the forest, but there is considerable question about the validity of that count (Wynter-Blyth, 1949). In 1950 Wynter-Blyth himself undertook a census based on measured foot prints, assuming that no two lions have the same foot measurements and that in a period of two days almost every lion will have moved enough to leave suitable foot prints. The result of this census was a count of 219 to 227 lions. From his research, Wynter-Blyth believed that there had been a decrease in lions between 1936 and 1950. In 1955 he conducted a second census in much the same manner as the first, counting a total of 290 lions. This, when the variables between the two censuses were worked out, gave him an increase of 25 per cent between 1950 and 1955. Between 1947 and 1950 no permits were given for hunting lions. A maximum of four permits a year was then publicized, but this policy was discontinued and since then few permits have been granted.

From 1950 to 1955 there were over 20 known kills, some to protect stock, some in alleged defense of life ; two were wounded animals that had to be destroyed. Several of the unauthorized kills were in the vicinity of villages where "home guard guns" had been issued. Such poaching is to be expected and will probably increase as long as there are so many lions living in such close contact with so many people. The significant thing is that even with this degree of killing, the number of lions should have increased 25 per cent.

Breeding and Rate of Increase.—Little is known regarding the rates of increase of wild Indian lions. A lion's biological potential is high. One Gir lioness in the Junagadh zoo produced a litter of three in August 1949, and another of five, six months later. Whether this would happen in the wild is not known. For that matter, the breeding age of a lioness is not known.

The lion population appears to be on the increase, judging both from the census figures and the proportion of young animals. Regardless of the absolute accuracy of a census method, if subsequent censuses are carried out in the same manner, they will give a valid picture of the relative numbers and population fluctuations. In 1950 Wynter-Blyth's figures gave 19 per cent

of the lion population as being young animals. In 1955 this percentage had dropped to 16·9 per cent, while the total population had increased by 25 per cent.

One factor that vitally affects the increase rate is the ratio of lions to lionesses. Local herdsmen and forest officers believe that lionesses predominate, citing as evidence both their own observations and the numbers of males killed for trophies. On the other hand, Wynter-Blyth firmly believes that males predominate. He gives a ratio of roughly 1·6 males to 1 female, and notes that the "belief in the preponderance of lionesses is due to the fact that all young males, being maneless, look like lionesses from a distance".

Wynter-Blyth's sex-ratio is based on lions shot or found dead from 1936 to 1947, and from the results of five censuses. Most of the latter figures are based on track measurements, about which he says—"It is difficult to say to what extent these figures are accurate, as the method of determining sex by the shape of the pugmark is far from infallible . . .". He had in 1949 noted the possibility that the 1936 census had been padded to attract hunters. If this were so, the padding would be expected to favor the males, and would probably indicate a lower per cent of lionesses than actually existed.

If males do predominate to the extent that Wynter-Blyth believes, up to half of the adult male lion population in the forest may play no part at all in reproduction, unless there is some unrecorded need for numbers of spare lions as a sort of breeding stimulus, a condition suggested in some bird and animal species. A considerable number of adult or sub-adult males could then be culled without adversely affecting the rate of increase. It must be remembered, however, that in Africa, lionesses apparently do most of the hunting, and there is no reason to suspect that Indian lions are different in that respect. Consequently lionesses are more likely than lions to run foul of humans and be killed. This is borne out by the high percentage of lionesses in the "in defense" kills in the Gir. This factor should be considered if culling is ever carried out in the forest.

Several writers have speculated on the possibility of inbreeding adversely affecting the Gir lions. The danger from this would depend on how low the population had dropped. If there actually were only a dozen or so lions in the forest around 1900, inbreeding might be a significant factor. However, if the minimum figure is nearer 100, which seems more reasonable to me, I should expect no difficulties from inbreeding. Selective downbreeding is another thing entirely. If, out of a small population, several

of the largest, trophy, males have been killed each year, for over a hundred years, the genetic effect could be significant.

Since breeding data are vital to effective management of the lions, this is a subject which merits early study. (See *Recommendations* section following).

Habitat.—*The Gir Forest.* Thanks to the efficient arrangements made by the Bombay Natural History Society and the facilities kindly provided by the government of Saurashtra, especially its Forest Department, I was able to visit the Gir forest during the second and third weeks of June, 1955.

During and immediately after the rains the forest must appear lush and green. When dry, with the leaves dead and the ground cover grazed off, its appearance is much less inviting.

Six years before my visit, Wynter-Blyth had written that "The Gir Forest has been so strictly preserved that for many years it has been a terra incognita except to the very few". In spite of his fine articles about the forest subsequently published in the *Journal* of the Bombay Natural History Society, the forest still remained little known and before my visit I received a remarkable variety of descriptions of it.

Location, weather, topography.—Lying in the south-west of the Kathiawar Peninsula at 21° N. the Gir Forest is at roughly the same latitude as Honolulu, central Cuba and southern Formosa. The climate is strongly monsoonal, with steady west-south-west winds off the Arabian Sea bringing wet weather, usually from June or July through to September or October. A dry cool season follows, extending to February or March, and this in turn is followed by the hot season with desiccating desert winds from the north east.

In general, the Kathiawar Peninsula is a low-lying, seasonally arid, scrub-desert land in which the Gir is the only large wooded area remaining. Its highlands are the source of several rivers, very important in the regional economy for the supply of irrigation water. Where such water is available, staple crops especially wheat are grown. These are the population centers. The rest of the land is thorn-scrub desert and is used for marginal grazing and a little dry farming.

The area covered by the forest is an irregular tract of about 480 square miles about 15 miles north and east of the sea and from 500 to 1,741 feet above sea level. Its maximum length is some 44 miles and the width varies from 5 to 24 miles. Narrow fingers of forest extend out into the surrounding country. The land is intersected by several low ridges, with the higher hills,

mostly of volcanic origin, basalt and trap, rising abruptly in the north and tailing off toward the south or south-east. The highest land is oriented along a north-west to south-east line. Five rivers rising there and flow generally south or south-east with one flowing off to the north-west. These larger watercourses with their numerous smaller tributaries have cut gulleys or "nalas" of varying depths through the forest. Soils show considerable variety. Fairly rich "black cotton soil" is found in some of the lower forest areas, along some of the large streams, and in part of the cultivated "revenue lands" adjacent to the forest. The people who farm these "revenue lands"—for which they pay rent to the Government—live in permanent villages of stone houses surrounded by fences made of stone or thorn and usually located just beyond the forest boundaries.

In some of the hills there is virtually no soil cover. Infertile, reddish soils are found especially in the north.

Vegetation.—The vegetation of the Gir Forest may best be considered as falling into three main formations: the central core is a dry mixed deciduous forest composed mainly of teak; surrounding this is a wide belt of thorn scrub; and both of these are intersected by long narrow ribbons of evergreen riverain vegetation.

Mixed deciduous forest—dry teak forest. The principal tree is teak (*Tectona grandis*) which covers roughly half of the forest area. The best merchantable timber has long since been harvested. What remains is mostly second growth or rejected scrub timber, contorted by indiscriminate branch cutting, grazing and burning, described by an Indian forest officer as "a forester's nightmare". Here and there in the almost pure stands of teak are groups of banyan trees (*Ficus* sp.) standing green and aloof on their many trunks. Other common trees are ebony (*Diospyros melanoxylon*), laurelwood (*Terminalia tomentosa*), flame of the forest (*Butea frondosa*) and karanj (*Pongamia glabra*). There is very little undergrowth. Except for the contorted aspect of the much misused teak, the appearance of the forest in the dry season is much like that of an open deciduous forest of northern Europe or north-eastern United States. Openings through the forest are common; in fact, the forest appears more open than closed. Where any grass remains, species of *Aristida* and *Heteropogon* are conspicuous.

Thornscrub.—Probably half the forest area is covered by thornscrub which varies from dense acacia thickets to almost bare ground. This formation surrounds the teak stands, except

where cultivation enters the former forest core. It is also found on the hills and here and there through the teak forest proper. Most conspicuous plants are the acacias, *Acacia arabica*, *A. catechu*, *A. suma*, *A. ferruginea*, and *A. leucophlaea*. The first, *A. arabica*, "babool", forms dense forests over 25 to 30 feet high. Candelabra (*Euphorbia* sp.) and *Sterculia urens* trees stand out above scrub brush. Ber (*Zizyphus jujuba*) is one of the more common bushes, often occurring as isolated clumps in otherwise bare ground. Other species found interspersed with the acacias are *Soymida febrifuga*, *Adina cordifolia*, *Boswellia serrata*, *Carissa* sp., *Emblica* sp., and *Garuga* sp.

Riverain.—The larger rivers are more or less permanent, and there is apparently permanent sub-surface water along some of the tributary streams. In the nala bottoms and extending for some yards on each side, the perennial moisture supports vegetation that is significantly different from the rest of the forest. Here the banyan, karanj and laurelwood trees are joined by jambudo (*Eugenia jambolana*), simul (*Bombax malabaricum*) and a variety of evergreen bushes and creepers. Where water is present, it is often edged with rushes. The result is an evergreen strip, often dense, cutting through both teak and scrub forest, which provides the only real cover for wildlife during the dry parts of the year.

Location of the Lions.—The whereabouts of the lions within the Gir seems dependent on the food supply—that is livestock—with the vegetation characteristics more or less incidental. The greatest concentrations are those found near the permanent revenue villages on the forest edge and outside it. Wynter-Blyth's surveys show movements of lions from time to time corresponding to movements of people with their livestock. Presumably, a lion requires an area that is fairly open, with at least enough cover provided by vegetation or terrain, both to stalk its prey and to lie up undisturbed. A handy water supply is also necessary. During the heat of the day the lions usually lie up in the nalas, but they are also reported to do so in the isolated *Zizyphus* or acacia clumps, when no nala is available. During the wet season there is probably no lack of cover within the forest, but at that time many lions are reported to leave the forest proper and to stay on hilltops or in open fields. The herders and foresters told me they believed the lions moved to escape the insects, especially the mosquitos, that accompany the annual flooding of the lower parts of the forest. The forest has widespread notoriety for malaria during the monsoon period,