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ECOLOGY OF THE RHINOCEROS IN MALAYA

by

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Of the five species of rhinoceros found in the world today, two are restricted to Southeast Asia. The Javan Rhinoceros, *Rhinoceros sondaicus* (Desmarest), is the rarer of these. It is now believed to be found only in the Udjung Kulong Reserve in Java, where with proper management it should continue to survive. Its former range included parts of Malaya, but there have been no confirmed records from the country since a specimen was shot for the British Museum (Natural History) near Telok Anson, Perak, in January of 1932 (Harper, 1945; Foenander, 1952).

The Sumatran Rhinoceros, *Didermoceros sumatrensis* (Fischer), enjoys a slightly larger range but no less precarious existence. It was formerly found throughout Borneo, Sumatra, Malaya, Thailand, Laos, Cambodia, Vietnam, Burma and even parts of India and Pakistan (Talbot, 1960). But over the past century, distribution and numbers have been drastically reduced, until now there remain small but significant populations only in Burma, Malaya, Sumatra, and perhaps Borneo. In Malaya, estimates of surviving population vary between 10 and 50 animals (Milton, 1963; Hislop, 1965).

Whether or not we are witnessing the natural extinction of these species is a question which is as yet unanswerable. However, much of the decline can be directly attributed to the activities of man. Hunting pressure has been very great in the past. Some specimens were shot as big game trophies, but a much larger proportion were sought for the profits to be made selling the spoils. The entire carcass, and especially the horn, is believed by many of the Asian peoples to possess strong medicinal qualities (Maxwell, 1960; Talbot, 1960), and thus a very lucrative market has provided the incentive for many hunts. The animal has long been protected by law, but even now under the Wild Animals and Birds Protection Ordinance (No. 2 of 1955) a fine of only M$1,000 or six months' imprisonment or both can be imposed upon anyone "shooting, killing, taking or wounding any rhinoceros for any purpose whatsoever" (Metcalfe, 1961). In view of the fact that the horn alone may be worth several times that amount, the penalty does not appear to be an efficient deterrent

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to poaching. There is evidence that fewer animals have been shot in recent years than formerly, but this may, at least in part, be attributed to the rhino's scarcity.

An equally important reason for the decline of the rhino population in Malaya is the rate at which rural development is taking place. The natural habitat of the rhino as well as many other animals is inevitably destroyed with man's extensive encroachment upon the wilderness. In Malaya the priority given to agricultural and industrial development schemes will probably continue to provide a constant threat to many animals for years to come.

In 1960 Oliver B. Milton began a survey to determine the status of the rhino in Southeast Asia. He began his study in Burma, and later moved into Malaya, under the sponsorship of the World Wildlife Fund and the New York Zoological Society and with the support of the Malayan Nature Society. Following his recommendation, a tract of land in Selangor was set aside as a reserve and sanctuary primarily for the rhinoceros. That area is now called the Sungei Dusun Game Reserve. However, at that stage very little indeed was known about the ecology of the rhino, and it remained to be discovered whether or not the Sungei Dusun Game Reserve was of an adequate size or in the proper locality. Much needed to be discovered about the animal and its environmental requirements in order to assure an efficient conservation effort.

A project for ecological study of the Sumatran Rhinoceros, intended to be based primarily on the Sungei Dusun population, was drawn up jointly by the Malayan Nature Society and the Zoology Department of the University of Malaya. Funds to initiate the project were finally made available in the form of a grant from the United States Government (Fulbright-Hays) to support an American graduate student in Malaya. I applied for and received that grant, as well as additional support from the World Wildlife Fund and the Conservation Foundation in Washington, D.C. My work began in September of 1965 and continued until my ten-month Fulbright grant expired in July of 1966.

METHODS

Many of the techniques that would normally be used in a study of this type were not applicable in the Malayan situation. The scarcity of the rhino is probably the most important of these. The time spent searching for rhinos or signs of them occupied the greater part of my efforts. Also, once they were found, nothing could be done

that might endanger them. In attempting to learn something about their food habits, it was impossible to kill specimens in order to examine stomach contents. The use of capture-guns to immobilize the animals for marking or examination was too risky, since not enough was known about them to prescribe the proper drugs or dosages. The habitat, namely dense tropical rain forest, increased the difficulties. It made aerial detection or surveys an impossibility and visual contact of any sort very difficult. The extreme complexity of the floral community prevented the identification of most of the material collected in faecal samples. Only the grossest structures, large seeds, etc., were of any use in determining what the animal had eaten. Radiotelemetry, given sufficient funds and manpower, might have been useful in discovering the range and rate of movement of the rhino, but was unfortunately beyond the scope of my project.

Thus my methods were slightly more primitive and laborious than might have been necessary under different circumstances. Most of my data were obtained by following the tracks of the elusive rhino, mapping its movements and collecting samples of plants upon which it fed.

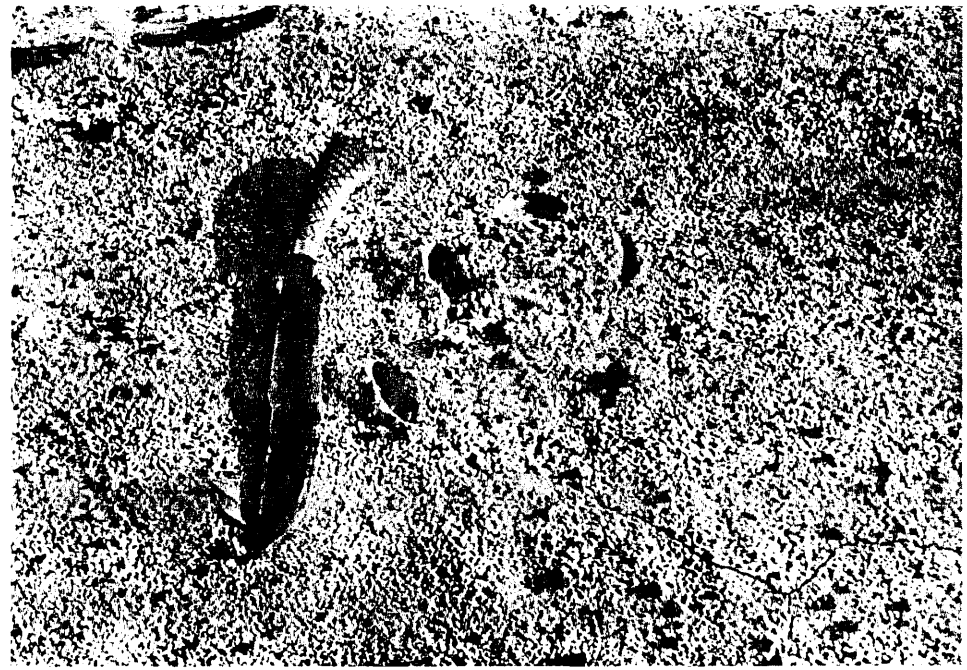
I made a number of brief surveys throughout much of Malaya, but because of the difficulty involved in familiarizing myself with an area sufficiently to map animal movements through it, I chose to set up one primary study area which would serve as the main source of my data. The Sungei Dusun Game Reserve was my first choice for a number of reasons. First, that area had long been a known habitat of *Didermoceros sumatrensis*, and the animal had been identified there in recent years (Metcalfe, 1961). It is also one of the areas in which *Rhinoceros sondaicus* had existed. Milton had already reported that there were still two, possibly three rhinos (species unidentified) there in 1962. Secondly, the area is relatively accessible. There is a dirt road into the northwest corner of the reserve, and during the dry season the journey can be made in an ordinary car. Since I was without a four-wheel-drive vehicle, this was important. Thirdly, the area had already been designated a reserve, primarily for the preservation of the rhinoceros, and it was one of my objectives to evaluate it as such.

In tracking the rhinos I had the assistance, at various times, of many game rangers, a few aborigines, and Mr. David Labang. Their help was invaluable, especially in the beginning, and over the months I too became a fairly adept tracker. However, the method had serious limitations. Although the Malayan Tapir, *Tapirus indicus*, is the only

animal in Malaya with tracks sufficiently similar to those of the rhinoceros to be confused with them, this fact presented me with unending difficulties. Generally tapir tracks are smaller, but the overlap between a large tapir and a small rhino is sufficient to cause concern. The tapir, while having four toes on the front foot and three on the rear (as compared to the rhino which has only three toes on all its feet), often leaves only a three-toed track. The reason for this is that the extra outer toe of the fore foot is a bit smaller and placed higher on the foot than the three others, so that only a very clear imprint of the foot on soft soil will reveal its existence. Rarely, however, does one find even a clear three-toed track, for both animals generally leave a print of the hind foot superimposed upon the front foot. Thus a clear imprint of seven toes indicates tapir, and this was used as the primary means of distinguishing between the animals (Pl I). A clear four-toed track does not necessarily indicate a tapir, for the superimposed front and rear foot of the rhino can result in such a configuration (Pl. II), as I learned from following the tracks of an animal that had been positively identified as rhino.

I have attempted to use the size of an animal's track to distinguish it from others in determining individual ranges, population size, etc. The only measurement I could obtain consistently was the width of the track at its widest point (from edge of outer toe to edge of inner toe). The size of an animal's track, however, varies considerably with the type of soil it is walking upon. For example, while following an animal with a track size of approximately 17 cm. in width, I found a difference of almost 2 cm. between tracks left in soft mud and those left in hard sand. There is also a slight difference between the front and hind foot, the front being slightly larger. Because of this variability I had to be extremely cautious in taking my measurements. Where possible the type of soil in which the track was measured was standardized, or in some cases an average of several measurements was taken. But neither of these precautions were completely satisfactory nor always possible. I therefore had to allow loose tolerances in identifying an animal from its track size, and this led to a conservative estimate of the number of rhinos in any given area.

While tracking various rhinos, I collected a number of plant species upon which they had fed. When possible I collected a sample of the fruit (or flower) and wood as well as the foliage. Most of the material was preserved in the field by means of a simple plant



Rhino tracks, front and rear feet.

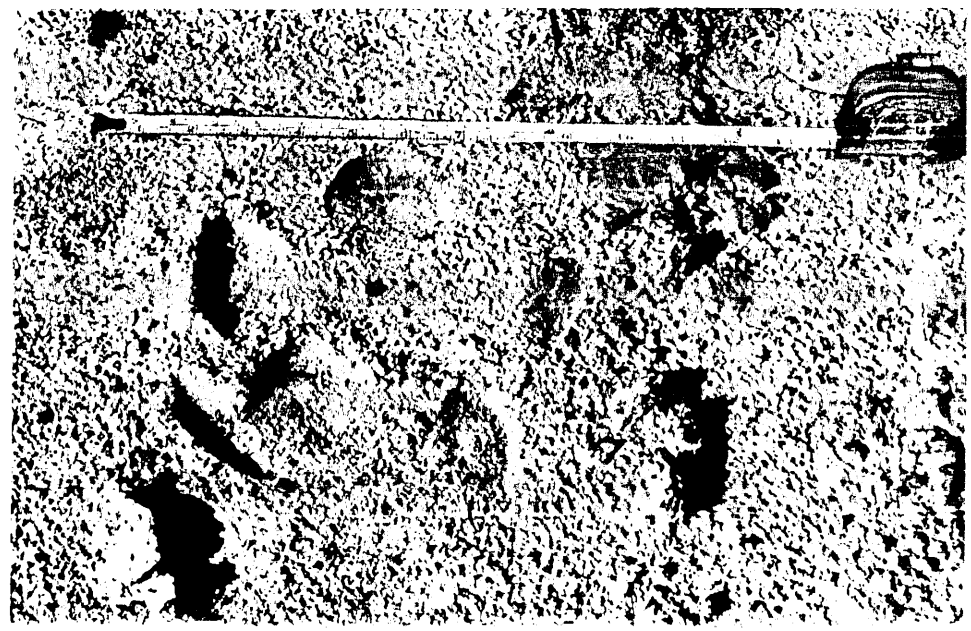
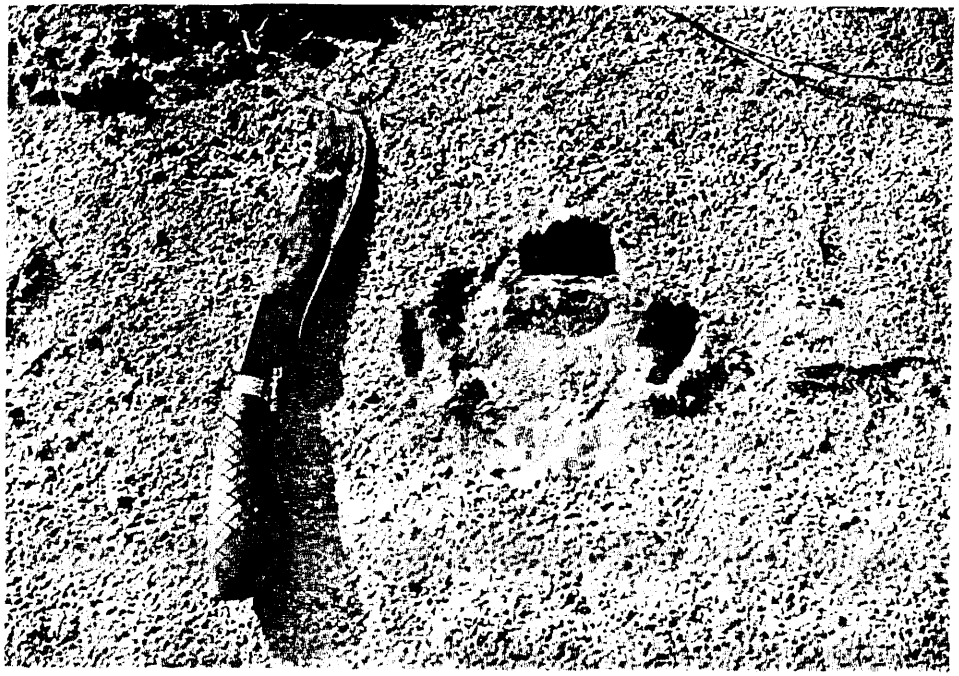


PLATE II



Rhino tracks—rear foot superimposed upon front foot to give a four toed track.

In addition to tracking, I also attempted to use hides of various sorts to gather information. These were situated near a salt lick, mud wallow or similar spot which attracted the animals. In the case of Sungei Dusun, I constructed a tree platform over what had been a mud wallow, and I baited the location with salt. Around this artificial salt lick I repeatedly set out a camera and flash on a trip-line in an effort to get pictures, but due to mishaps and malfunctionings this method was never successful despite repeated visits made by the rhinos.

I began my work at Sungei Dusun in November with the aid of the Game Rangers under Mr. Dara Singh, Regional Game Warden for the States of Malacca, Negri Sembilan and Selangor. November is the height of the rainy season for that area, and access to the reserve is therefore difficult. Unfortunately, Dara Singh's rangers could not afford to spend much time on the project, and as a consequence I made only a few relatively short visits to the reserve during the two months that followed. The rains also made the work rather irksome when I did get into the reserve. Aside from the discomfort of being constantly wet, following the animals is difficult because the tracks do not last long in heavy rain. My data for this period is very limited.

In January the rains began to subside and I managed to set up a camp in the reserve on the 10th of that month, unaided by the Game Department. I worked in the reserve almost continuously until April and made periodic visits after that until my departure in July. In February, through the help of Inche Mohamed Khan and Mr. Bernard Thong, I began to receive the assistance of Game Ranger Badzri from Perak, and he, David Labang and myself formed the basic team, assisted at various times by other people, that carried out the project.

The Sungei Dusun Game Reserve

The Sungei Dusun Game Reserve lies in the north of Selangor just a few miles from the Perak border. It comprises almost 11,000 acres of lowland forest, much of which is secondary and characterized by such genera as *Fagraea, Macaranga, Ficus, Melastoma, Endospermum, Hornstedtia, Madhuca,* and *Melanorrhoea.* The western boundary of the reserve is formed by a canal which runs south off the Sungei Bernam to feed the rice growing area around Tanjong Karang. The northern boundary is formed by the Sungei Dusun, the southern boundary by the Sungei Tengi, and the eastern boundary by the Bukit Belata Forest Reserve. The highest point in the reserve is 829 feet.

There are two main ridges running northwest to southeast in the northeastern portion. The northwestern section is also relatively high ground, the average height being about 50 feet. The rest of the reserve is primarily swamp forest which continues west from the reserve to the coast. In the drier areas and on the hills there are large stands of Bertam Palm, *Eugeissona triste*. Evidence of past logging can be seen in the form of old, overgrown logging tracks, especially in the northwest. Other trails were also cut by the tappers of the Jelutong tree, *Dyera costulata*, but these too have long been unused except by the game. In addition to these and the various game trails, I cut many miles of new tracks in and around the reserve to facilitate my research.

RESULTS

a. *Total Ranges of Rhinoceroses*

During the course of my survey at Sungei Dusun I found tracks which measured at many intervals from 16 cm. to 23 cm. However, due to the loose tolerances which must be allowed when associating an animal with a track measurement, I can confirm the existence of only three individuals in the reserve at present. As I have pointed out this is a conservative figure. At times it appeared that there may have been as many as five animals, but this was not proven.

The tracks of the animals thus analyzed measured 16–18 cm, 19–21 cm and 21–23 cm. The first two animals I have followed extensively, but the third one's tracks were found only occasionally. From information gathered in this manner I have attempted to determine the approximate range of individual rhinos. The ranges of all these animals overlap considerably (Fig. 1). The region where all three ranges overlap has obviously been used for many years by rhinos. The trails are very old and well worn, and the animals seldom deviate from them. There are a number of what appear to be regular feeding areas within this overlap. Young trees have been bitten off, regenerated and been bitten off again repeatedly. There are also a number of mud wallows which are presently in use, a few that have dried up and a number of potential sites for them (the major ones presently in use are marked as large dots on the map). This area also contains two "Lanjut" trees, *Mangifera lagenifera*, (a type of wild, sour mango) which attract a great deal of attention when fruiting. This appears to be a favourite fruit of the rhinos. The seeds were often found in freshly deposited dung, and in a few cases young seedlings of this tree were found sprouting from very

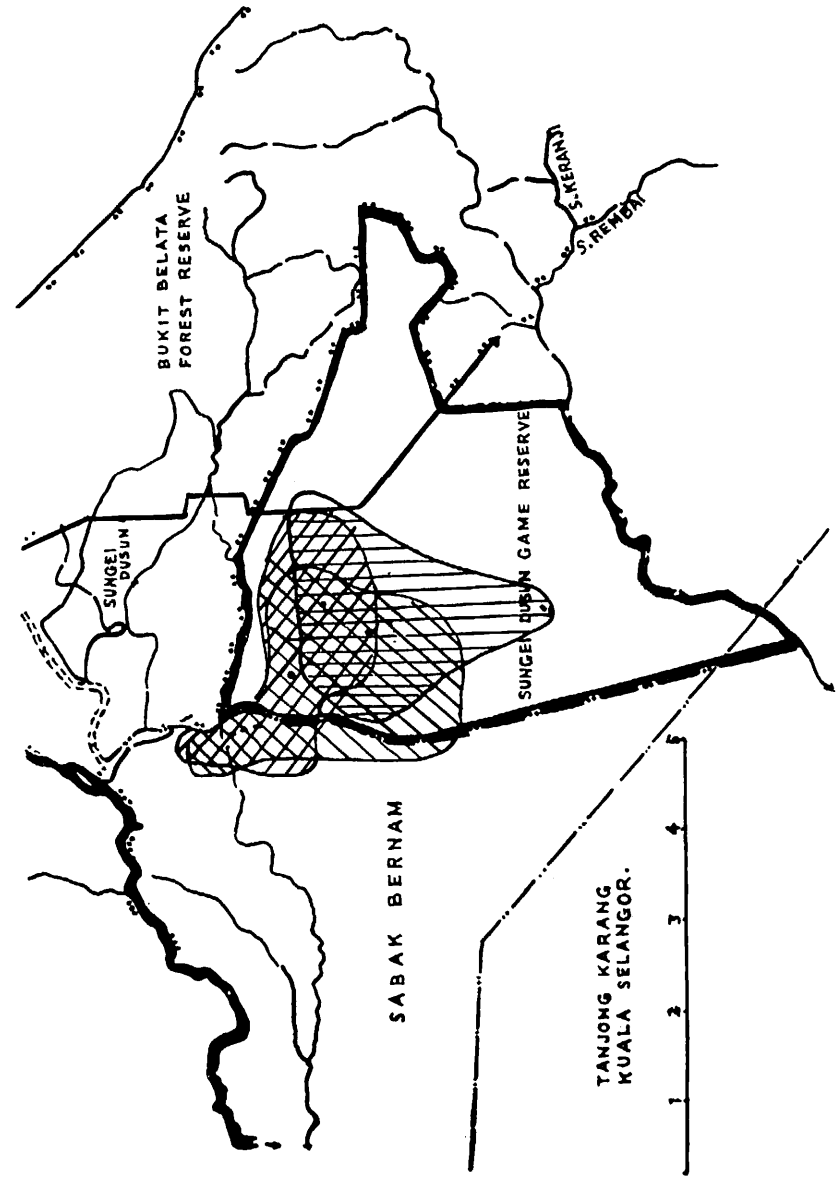


Fig. 1. Sungei Dusun Game Reserve showing the determined ranges of the three rhinocereroses as follows:
Left—right diagonals — — 17 cm foot measurement
Right—left diagonals — — 20 cm foot measurement
Vertical lines — — 22 cm foot measurement
Black dots indicate the location of major wallow areas. (Scale line in miles).

old deposits. However, the rhinos are not the only animals feeding upon this fruit. Pigs and monkeys also seem to enjoy it.

The ranges of the two larger animals average about four square miles, and that of the smaller animal slightly less. However, it must be emphasised that the areas shown on the map are minimum ranges in which positive evidence of the animal was found. A more accurate method (*e.g.* radiotelemetry) might reveal larger ranges, for I have followed even the smallest animal over three linear miles in a 24-hour period in which the animal was undisturbed, at least by humans. When disturbed, it covered considerably more ground. But during my study, I found no tracks or signs of rhinoceros outside these designated areas, and accounts given by the aborigines across the Sungei Bernam in Perak indicated that rhinos are no longer found in that area.

It is interesting to note the type of terrain contained in and surrounding these mapped ranges. The area where all the ranges overlap appears to be the most favourable, that is the animals spend the most time there. It is for the most part old, secondary lowland forest on low rolling hills. The highest ground in the reserve is still further east, and swamp lies to the south, west and north. All of these animals included within their range some swamp forest, but, they spent very little of their time in the swamp. There was only sparse evidence of feeding within the swamp; there were a few wallows, but they were far outnumbered by those on the hillsides. Most often the swamp functioned merely as a path from one bit of high ground to another.

Only on one occasion did anyone working on the project actually see a rhinoceros, and the circumstances surrounding the event were unfortunate. Whenever possible one man remained at the base camp. On the 9th of February, at about three o'clock in the afternoon, a rhino crossed the canal adjacent to the camp and in full view of the one man remaining there. But the fact that he was an untrained observer and apparently very much upset by his encounter with the animal made his description almost useless in identifying it to species. However, the tracks it had left along the canal left no doubt that it was a rhino.

Although the problem of positively identifying these animals to species is still unsolved, it seems to me unlikely that *R. sondiacus* still exists at Sungei Dusun. In the course of following them it was often possible to get an estimate of their size. When they leave a wallow, mud is deposited on the plants along the trail; and the under-

side of Bertam Palm branches, which often lie horizontally over the trails, scrape mud from the animals' backs as they pass. This served as a fairly accurate size index, but nowhere was mud found deposited over a height of 1.15 metres. Metcalfe lists the height of *R. sondiacus* as 1.65 m. (about 5½ feet) maximum at the shoulders and *D. sumatrensis* as 1.35 m. (about 4½ feet). The measurements I made indicate *D. sumatrensis*. It is possible that all of the measurements I took were from young animals, but it is unlikely.

b. *Daily Ranges of Movement and Intraspecific Reactions*

After a few months of tracking these animals, some interesting behavioural patterns began to appear. The smallest animal (16–18 cm. tracks) often wandered off the main trails. Indeed, it spent much of its time in areas with few or no well-established trails, areas where other tracks were found only rarely. Also, the tracks of this animal were sometimes found together with those of the intermediate animal (19–21 cm. tracks), especially in areas of heavy feeding. On three occasions the tracks of these two animals were found to be very closely associated. One of these occasions was at a wallow that had been baited with salt. The others were in well-established feeding areas. Often, however, the trails of these two individuals would cross but not converge. The smallest individual may be a young animal presently establishing its range, and there may be a calf/cow relationship between it and the intermediate.

On one other occasion, while working in Ulu Selama, Perak, I found the tracks of three different rhinos all converging upon one salt lick. It was difficult to determine whether or not they were all present at the same time, but the tracks did not indicate a clear temporal differentiation. However, most of the tracks found during this study were those of solitary rhinos.

As I have indicated, these rhinos are capable of covering many miles in a day; however, on more than one occasion signs at mud wallows, salt licks, feeding and resting areas indicated that less than a half mile had been covered in a 24-hour period.

From the data obtained in this study it is difficult to determine at what hours the rhino is most active. Only twice was I able to record the time at which a rhino was moving. The fore-mentioned sighting of a rhino in mid-afternoon is the first instance, and the second was while tracking an animal during the midmorning hours on February 10th. There was very wet mud on the foliage along its trail, and this combined with the condition of its tracks in a boggy

stream bed indicated that the animal was on the move at about 9.00 a.m. However, my presence in the area may have been an influencing factor in this particular instance.

Milton reported coming upon a rhino in a wallow at 11.00 a.m., and others have stated that rhinos spend much of the day in wallows and feed primarily at night (Metcalfe, 1961). No evidence was found in this study that would disprove that theory.

c. *Interspecific Reactions with other large mammals*

It has been suggested that the rhinoceros may be incompatible with some of the other large mammals in Malaya, and with the elephant, *Elephas maximus*, in particular. However, I have found them to exist in the same areas, sharing them at least spatially if not temporally. The exact proximity of these two species could not be determined, and I doubt that they enjoy each other's immediate company. But it is unlikely that they occupy competitive niches or are intolerant of one another. In one instance in Ulu Selama, Perak, I even found them using the same wallow. Tapir, tiger, pig, and many of the deer also appear to share the rhino's habitat.

d. *Feeding*

The feeding habits of the rhino are distinctive enough to have allowed me to collect what I feel is probably the majority of the species fed upon by them. Young saplings appear to provide the largest portion of their diet, and these are invariably damaged extensively during feeding. In some cases the trees are merely bent over or partially broken, but more frequently they are completely snapped off and the young foliage is eaten (Pl. II). Trees up to 6 and 7cm. in diameter were found broken off at anywhere from a few centimetres to two metres from the ground. The smaller trees were probably bitten off, but the larger ones were broken by first bending them over and then stepping on them. In some cases the trees are uprooted in the bending process, and yet they are still stepped on and broken into smaller units. The presence of fresh rhino tracks and plants fed upon in this manner inevitably prompted me to collect specimens for identification.

The only other forest animal that does damage of a similar nature is the Common Wild Pig, *Sus scrofa*. But the plants broken off are generally smaller, of a more uniform size, all broken at approximately the same height, and there appears to be little regard given to the selection of species. Also, the pig does this in order to build a nest, the presence of which immediately distinguishes the area.

I collected over forty species of plants upon which the rhinoceroses had fed. Unfortunately, it was not always possible to identify a specimen to species, and in a few cases no useful identification could be made. This was due, in part, to the fact that often I could find only a small portion of half eaten leaves and a bit of immature wood from a plant that had been virtually devastated by the rhino. With no fruit, flower, mature wood or even mature whole leaves, identification becomes very difficult. But over thirty of the specimens were identified to genus and many of these to species (Table 1, p. 16).

Most of the plants on this list are common lowland forest species. Five of the genera have already been listed by Metcalfe as food plants of *D. sumatrensis*, and one has been named by Foenander. Over half of the plants listed are characteristic of secondary forest or fringe areas (*i.e.* the edge of clearings, land slips, stream and river banks, wind falls, etc.). Although much of the Sungei Dusun Game Reserve is secondary forest, many of the 'primary' plant species can still be found and are relatively untouched by the rhino. Moreover, there is a definite pattern of preference in the rhinos' feeding habits. The species most frequently fed upon were *Endospermum malaccense*, *Macaranga triloba*, and *Xylopia ferruginea*—all notably secondary or 'belukar' species. Even outside Sungei Dusun there appeared to be a preference for these and other secondary species. In Ulu Selama, in relatively undisturbed forest, the fringe species were again most heavily eaten, adding to the list such plants as *Clerodendron* sp. and *Grewia tomentosa*. In every case, with the exception of the mango, *Mangifera lagenifera*, it was the young leaves of the plants that were eaten. Most of these plants were young trees or shrubs from one to five metres in height, except for such things as *Forrestia griffithii*, *Luvunga* sp., etc. A surprising plant on the list is *Melanorrhoea*. This is one of a number of species known as 'Rengas' in Malay. The latex of this plant causes a serious rash or blistering upon contact with human skin and in cases of extreme exposure, a high fever and even death may result (Corner, 1952).

Many of the young trees that had been eaten had small bits of the bark scraped off about a metre from the ground. In a few cases I found trees that had been scraped in this manner but had not been eaten. I suspect this is one of the ways in which the rhino distinguishes the plants it prefers.

In many respects I did not find the rhino to be as methodical a beast as some authors have made it out to be. Many of their trails were very well worn and had obviously been used for many

years, but nowhere did I find large dung heaps (Metcalfe, 1961) indicating repeated visits to the same spot to defaecate. In a few cases I found large deposits of tapir dung, which is similar; but nothing in the order of magnitude that would be accumulated over a period of years. Although the rhinos do frequent such spots as wallows, salt licks, etc., I could not discover with any accuracy a periodicity in this activity. By baiting one of the wallows with salt I was able to note increased activity, *i.e.* more frequent visits by the rhinos, but it still appeared sporadic. Their feeding habits also appear to be somewhat irregular. As stated previously, there were certain areas in which the rhinos had fed extensively on a variety of plants. Some of these showed signs of being repeatedly visited, others only once. At times only an occasional plant along the path of a rhino would be eaten, long distances would be travelled passing by plants of the same species and then another plant would be singled out, sometimes off the main trail, and eaten.

CONCLUSIONS

It was suggested to me by Dr. Lee Talbot before I started this project that the rhinoceros in Malaya, like the elephant, might be more properly considered a marginal animal than a true forest animal. The rhinos' strong preference for characteristically secondary and fringe plant species gives some support to this theory, although in fact the rhino does not appear to be as closely associated with these marginal areas as is the elephant. One obvious explanation for this is that any rhino which did occur in what is conventionally considered a marginal area, *i.e.* between forest and clearing for human endeavour, because of its tremendous economic value, would be in grave danger of being shot, much more so than the elephant or any other such animal. This is probably what happened to the majority of the rhinos in Malaya. If it were not for the hunting pressure brought about by this economic factor and possible conflicts with agricultural interests, such as exist with the elephant, clearing of the forest on a moderate scale would probably greatly benefit the rhinoceros. However, assuming this 'marginal' theory to be correct, even untouched primary forest will provide an adequate habitat for a limited number of these animals around land slips, wind falls, and along river banks, etc. Unfortunately the economic value of the rhino's carcass is still said to exist in Malaya, although I know of no one who has tested this supposition recently; and even though there is still a lot of forest left, it is being cleared very rapidly and not on a 'moderate scale'. The only sensible way to assure protection of the rhinoceros is to secure and maintain efficient game and forest reserves.

The Sungei Dusun Reserve is a step in the right direction. The size appears to be adequate and the boundaries properly placed with the exception of the northwest corner which could well be extended a half mile to the north and a half mile to the west. This would compound the difficulty of patrolling the reserve, but it would afford protection to a number of animals which frequent this area, including the rhino, elephant, tiger, and tapir. I am convinced that, should the time come when such a project is made possible, rhinos from immediately threatened areas in the country could be translocated into this reserve. I am confident that the area would support at least three more animals, and experimentation may prove that several times that number could be accommodated.

However, there are two things lacking in the Sungei Dusun Reserve. The first can, and someday may, be remedied. It results from the fact that the reserve is not properly managed. Indeed, it is hardy managed at all. This may be attributed in part to the lack of manpower in the Game Department. There is no one stationed at the reserve, and as a consequence patrolling is virtually nonexistent. There is an occasional party of rangers sent into the reserve to check on the situation there, but they seldom venture far from the base camp in the northwest corner. Most of them have never been more than a mile or two from this spot and have no idea where most of the boundaries lie. And even while in the area they hunt and fish freely, and apparently consider themselves to be exempt from the very laws they are supposed to be enforcing.

Proper management would of course be a prerequisite to measuring the efficiency of this reserve. It has been demonstrated that salt baiting can serve to attract the rhino to specific locations. The creation of artificial licks, wallows, and feeding areas could well function as a relatively inexpensive means of containment. The controlled felling of trees to encourage secondary growth at desirable locations could provide safe feeding areas. Peripheral wallows could be drained or filled in and possibly new ones created more centrally in the reserve. It has been shown that baiting even old wallows with salt causes increased activity, and the wallow is enlarged as a consequence. But along with this sort of management must come a certain amount of patrolling. Three rangers stationed at the Sungei Dusun Reserve would be a good start, although their job would still be difficult.

The second thing lacking is less serious, except where revenue is concerned. The Sungei Dusun Reserve does not have the makings

of a potential tourist attraction. Like most other places in Malaya, the game animals are rarely seen; but where some areas offer the scenic grandeur of large rivers and the beauty of virgin rain forest as consolation, Sungei Dusun Reserve has only a dirty canal, old secondary forest penetrated by overgrown logging tracks, vast stands of Bertam Palm, and miles of swamp that would appeal only to the most dedicated naturalist.

In this last respect other areas in Malaya may have more to offer. I surveyed one location in Ulu Selama, Perak, that had also long been a known habitat of rhinos, and there too I was able to confirm the existence of at least three animals. Sira Harimau formed the nucleus of this area which is only a few hours walk from Kampong Seputeh along the Sungei Selama. This is one of the most attractive areas that I visited in Malaya, and the presence of the rhinoceros should make it a prime consideration when new game reserves are being set up. The area presently lies within the boundaries of a forest reserve which does afford the animals some protection, but making it a game reserve as well would greatly serve the interests of conservationists. Unfortunately, I was not able to spend enough time at Sira Harimau to suggest functional boundaries for such a reserve, but the interest and enthusiasm of the Game Department in the State of Perak already exists and could be of great help in making recommendations.

When I undertook this project, with the naivety of someone new to the tropics, I had planned to make a census of all rhinoceroses in Malaya. I soon learned that one does not merely go out and count rhinos in the rain forest. Nor can one gather much accurate information interviewing the people who reside in various suspected or even reported habitats of the animal. Only a very small number of people have ever seen a rhinoceros in Malaya. More often than not tapirs and even pigs are reported as rhinos. On the other hand, I believe that there are probably areas in Malaya where rhinos exist unknown to anyone, or at least in larger numbers than suspected. In the past men with vast experience in dealing with the game animals of Malaya have ventured estimates of population size for rhino, but even these I fear are only crude guesses. Nevertheless, the number of rhinos is small, and the fact remains that man is posing an ever increasing threat to this animal's existence. The responsibility for this lies with all of us, but the burden for remedying the situation lies primarily with the Malaysian Government and the Game Department.

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REFERENCES

CORNER, E. J. H., 1952. *Wayside Trees of Malaya*, Vol. I & II, Second edition. Government Printing Office, Singapore.

FOENANDER, E. C., 1952. *Big Game of Malaya, their Types, Distribution and Habits*. The Batchworth Press, London.

HARPER, F., 1945. *Extinct and Vanishing Mammals of the Old World.* Spec. Publ. Comm. International Wild Life Protection, No. 12.

HISLOP, J. A., 1965. Paper presented to the I.U.C.N. Conference in Bangkok on Conservation in Tropical Southeast Asia.

MAXWELL, SIR GEORGE, 1960. *In Malay Forests.* Eastern Universities Press, Ltd., Singapore.

METCALFE, G. T. C., 1961. Rhinoceros in Malaya and Their Future. *Nature Conservation in Western Malaysia:* 183–191.

MILTON, OLIVER B., 1963. *Field Notes on Wildlife Conservation in Malaya.* Special Publication No. 16, American Committee for International Wild Life Protection.

TALBOT, LEE M., 1960. A Look at Threatened Species. *Oryx 5:* 169–215.

TABLE 1

Food plants of D. sumatraensis

Scientific Name	Common Name[1]	Vernacular Name[1]
Apama corymbosa	Shrubby apama	Akar julong bukit
**Atrocarpus* sp.	—	—
Bhesa paniculata	—	Aha tung, Bintan, Madang bura
Campnosperma montane	—	Terentang
Canthium sp.	Green coffee	Kahwa utan, Kopi utan
Clerodendron sp.	—	Panggil panggil, Bunga panggil
Cryptocarya sp.	—	—
Dehaasia sp.	—	Medang tandok
Endiandre sp.	—	—
**Endospermum malaccense*	Moon tree	Bulan bulan, Bebulan, Membulan, Sendok sendok Sesendok.
Fagraea fragrans	Common tembusu	Tembusu, Temusu, Tmensu, Temesu, Semesu
**Ficus* sp.	—	—
**Ficus* sp.	—	—
Forrestia griffithii	Griffith's forrestia	—
Grevia tomentosa	—	Chenderai
Gymnacranthera sp.	—	—
Knema kunstleri	Wild nutmeg	Pemaraham
Luvunga sp.	—	—
**Macaranga triloba*	Common mahang	Mahang, Mesepat, Melokan, Kubin
Madhuca sp.	—	Nystoh
Mangifera lagenifera	—	Lanjut
Melanorrhoea sp.	Scaly rengas	Rengas, Kerbau jalang
Melastoma sp.	Tiger-flower	Sendudok, Kedudok, Sedudok
Memecylon garcinioides	—	Nipis kulit, Mangas, Delek
Pavetta indica	White pavetta	Bunga jarum, Jarum jarum, Nyarum2, Gading2.
Polyosma sp.	—	—
†*Pternandre coerulescens*	Cursed shade	Sisal menshun, Lidah katak
Randia scortechinii	Wild randa	Randa utan, Tinjau belukar, Ulai ulai
Rubiaceae	—	—
Scaphium macropodum	—	Kembang sa-mangkok
Ternstroemia sp.	—	Medang bungalawang
Urophyllum glabrum	Common urophyllum	—
Xylopia ferruginea	Stilted antoi	Antoi jangkang

* Also listed by Metcalfe, 1961.

† Also listed by Foenander, 1952.

[1] Taken from Corner, 1952.