ASPECTS OF THE ECOLOGY AND BEHAVIOR OF THE MALAYAN TAPIR (*TAPIRUS INDICUS* DESMAREST) IN THE NATIONAL PARK OF WEST MALAYSIA

By

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ABSTRACT

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Details of feeding, defecation, urination, movements and resting behaviors were obtained by following tracks and locating radio-collared tapirs in the world's most species-rich, tropical rainforest.

Tapirs broke and walked down saplings up to a height of 6 m. Understory Euphorbiaceae and Rubiaceae were the most significant plants in the diet, indicating that tapirs may be primary-forest, and not forest-fringe, adapted.

Percentages of available browse eaten from 46 plant species were estimated and 27 whose twigs and foliage were more than 75% browsed were listed as preferred forages.

The home range of one male was 12.75 km^2 and overlapped the home ranges of several other tapirs. Tapirs were not markedly associated with water. Three ticks, not previously listed for *T. indicus*, were collected. One 0.7 ml dose of the drug M-99 and acepromazine ("Immobilon") effectively immobilized several adult tapirs.

Recommendations for monitoring the condition and trend of tapir habitats were made.

Dedicated to Lillian Ellen Williams

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INTRODUCTION

Distribution and status

In the ancient past, tapirs were widespread throughout much of the Northern Hemisphere. Members of the only surviving genus, however, occur in southeast Asia and the tropical Americas. The genus *Tapirus* has been present in the Old World since the late Miocene (Walker, 1968). *Tapirus indicus* (Desmarest), the Malayan or Asiatic tapir, ranges from Thailand and Burma through West Malaysia to the island of Sumatra.

In Thailand it is thought to be fairly common in the provinces of Ranong, Krabi, Trang, Pattalung and Satum (McNeely, pers. com.) and as far north as Uthai Thani province (16°N). There, forests are basically deciduous with evergreen species fringing the streams. Though the species may still occur south of Tennasserim (17°N), the tapir's status in Burma is unknown. In Sumatra, tapirs occur in most unsettled areas south of the Asahan River. Even though this region contains a tapir reserve of 23,800 ha, the status of the species is uncertain there (Van der Zon, pers. com.).

Tapirs in West Malaysia occur in all states from the evergreen rainforests of the lowlands to the drier ridges at about 1200 m elevation. They are common in many localities including (Hislop, 1961; Khan, 1971) Taman Negara, literally "The National Park," an area which overlaps the borders of Pahang, Kelantan and Trengganu states.

Description

Tapirus indicus belongs to the order Perissodactyla and normally is black with a white blanket encircling the body except for the ventral surface. The ears are white-tipped. Two all-black specimens were captured near Palembung in Sumatra (Kuiper, 1926).

Tapirs are large-bodied animals with stocky legs. The front feet have four toes, the hind feet three. The height is 1.0-1.2 m at the shoulder. Though usually weighing 250-375 kg, one animal killed in Burma weighed 540 kg (Lekagul and McNeely, 1977).

The elongated nose forms a short, flexible proboscis which plays an essential role in feeding and is important as a touch organ (von Richter, 1966). Tapirs have excellent senses of smell and hearing but their eyesight seems poorly developed.

Based on the data of Seitz (1970), births occur in captives throughout the year. The gestation period is 390-403 days (Lekagul and McNeely, 1977; Seitz, 1970) and the single young weighs about 7 kg when newborn (Lekagul and McNeely, 1977).

The young one stays with the mother until the birth of the next offspring and sometimes longer (von Richter, 1966). Females attain sexual maturity at 2-3 years of age and produce young about every 1.6 years. Males reach sexual maturity at three years of age (Seitz, 1970).

Present human pressures on the tapir

The tapir is not highly regarded as food in Malaysia but is eaten occasionally by aborigines. The species offers no valued trophies to hunters and its hide is considered to be of poor quality. The Malayan tapir is a unique and interesting aspect of the local scene, however, and an attraction to wildlife observers and photographers.

Land clearing in Malaysia is a widespread and substantial practice. Since independence in 1957, the rate of deforestation has steadily increased. Under the Second Malaysia Plan (1971-1975), 48.9% of the forest in the Malay Peninsula has been cut or is earmarked for agricultural development (Khan, 1976). The destruction of their lowland primary-forest habitat appears to be a major factor which is rapidly reducing tapirs throughout the Malay Peninsula. The future status of the species must be carefully monitored.

Nature of the study

Large herbivores in the tropical rainforest ecosystem of southeast Asia have been little studied. Schenkel and Schenkel-Hulliger (1969) investigated the Javan rhinoceros, Strickland (1967) reported on the Sumatran rhinoceros, and Weigum (1972) observed the seladang (gaur). For T. indicus, Thom (1936), Sanborn and Watkins (1950), Foenander (1952) and Medway (1969) have made general field observations of its ecology and behavior. Medway (1974) noted the percentages of available plants browsed of 9 plant species along 600 m of forest road.

The present investigation was undertaken:

(1) to determine food preferences, habitat use and general behavior patterns of tapirs; and

(2) to identify problems related to the preservation and management of large herbivores and the unique rainforest of the West Malaysian National Park.

The study was started in November 1975 when the author was park naturalist at Taman Negara. Field work was carried on full-time between February and late October 1976.

THE RESEARCH AREA

Taman Negara is an area of 4334 km^2 in the north-central part of peninsular Malaya (Figure 1) which is administered by the Department of Wildlife and National

Figure 1. Taman Negara (The National Park) of West Malaysia. Adapted from Weigum (1972).

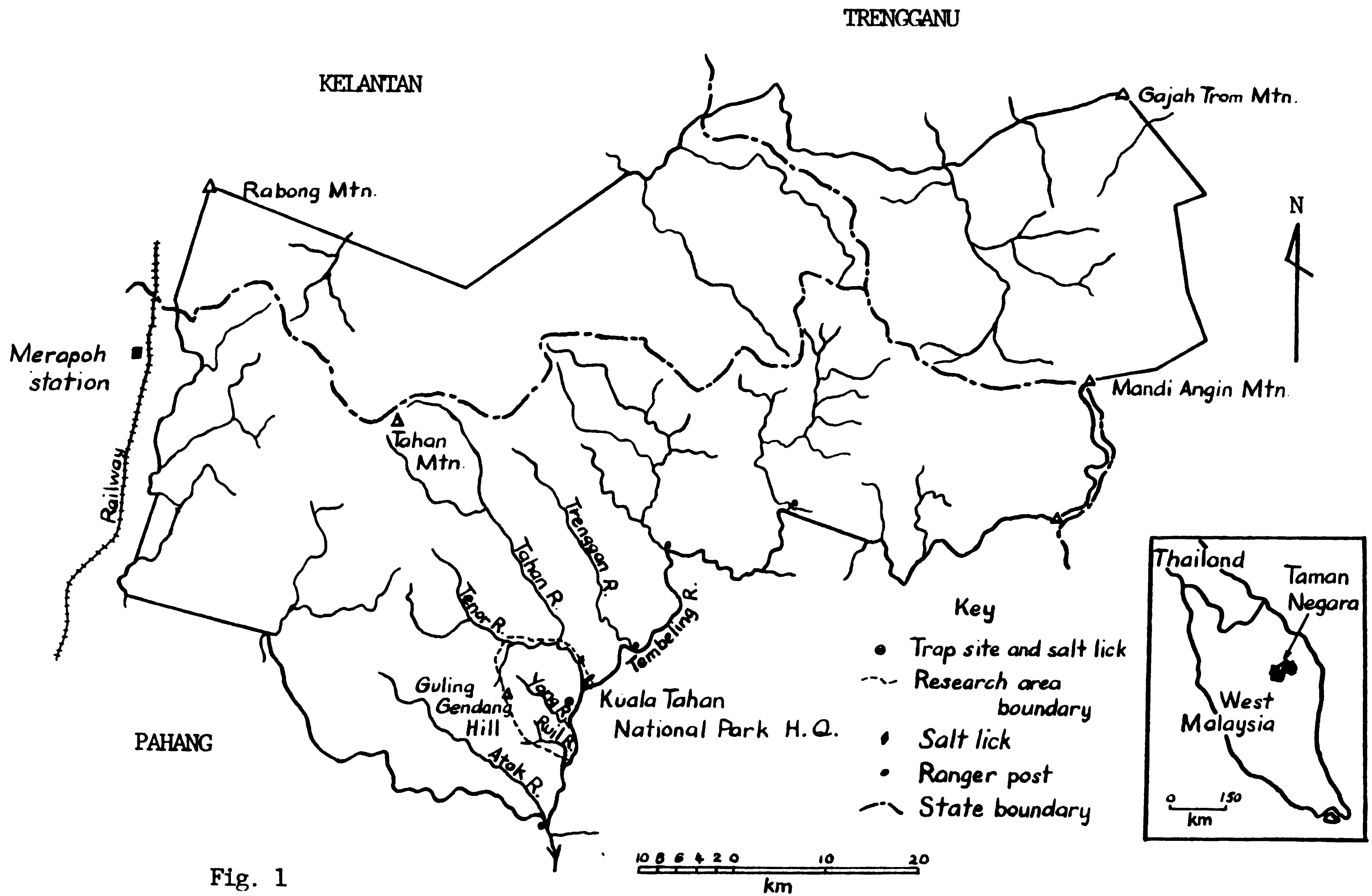

TRENGGANU
KELANTAN
PAHANG
Gajah Trom Mtn.
Rabong Mtn.
Mandi Angin Mtn.
N
Merapoh station
Railway
Tahan Mtn.
Trenggan R.
Tahan R.
Tenor R.
Tembeling R.
Yong R.
Ruil R.
Atok R.
Guling Gendang Hill
Kuala Tahan
National Park H.Q.
Key
Trap site and salt lick
Research area boundary
Salt lick
Ranger post
State boundary
10 8 6 4 2 0 10 20
km
Thailand
Taman Negara
West Malaysia
0 150
km

Fig. 1

Parks of West Malaysia. It is representative of the world's most species-diverse (but swiftly disappearing) rainforest. The number of seed plants in the Malay Peninsula and Singapore has been estimated at about 1500 genera containing 7900 species (Whitmore, 1973 in Whitmore, 1975). "Considering solely the trees, there is commonly a great number of species growing together and the number increases with increasing size of the sample area" (Whitmore, 1975: 5). The park is one of only two reasonably-secure nature reserves protecting this unique and fascinating plant formation and its animal inhabitants.

The topography of the research area varies from gentle undulations to steep hills. The rock base is principally sandstone but several small limestone outcrops occur. In the eastern half, between Kuala Tahan and Guling Gendang Hill, the soils are red and yellow latosols and red and yellow podsols. These change to lithosols and shallow latosols in the remainder of the area (Panton, 1964).

The research area, like most of the park, is covered with dense, primary forest dominated by large trees of the Family Dipterocarpaceae. An area of secondary forest, however, extended about 1.6 km upstream from the mouth of the Yong River (Figure 1) and occupied approximately 1.25 km^2.

The annual rainfall for Park Headquarters at Kuala Tahan averages 225.17 cm (Weather Bureau, Malaysia, pers. com.) and is heaviest during the northeast monsoon between

October and January. A dry period prevails in February and March but rains again become frequent in mid-year as the southwest monsoon is felt. Daily temperatures range from about 18.6°C to 37.2°C with an annual average of 29.4°C (Weigum, 1972).

The approximately 200 park-headquarters personnel living at Kuala Tahan have a significant local impact on park values, removing rattan, bamboo and small trees, clearing areas for gardens and playing fields, and maintaining exotic animals and plants inside the Park.

Aborigines live in the Park in low numbers. They follow a hunting and gathering existence and have developed extensive trail systems. While paths are occasionally widened for visitors by government staff, such use is minimal.

METHODS AND PROCEDURES

Following tapir tracks

With the assistance of aborigine trackers, tapir tracks up to two days old, as determined by the trackers, were followed. Fresh tracks (12 hours or less old) were ideal and such spoor was sometimes followed for up to three kilometers. Initially, all tapir tracks encountered were measured for the purpose of identifying individual animals. Differential toe-spreading occurred, however, in different terrain types. These differences, and the great variation in both fore and hind foot measurements led to the method being abandoned after three months.

Following tracks made possible a detailed study of browsing by tapirs. Samples of plant foods were collected, dried in a conventional field press and later identified. Observations of resting places, defecation and urination sites and associated behaviors were recorded.

Food preference study

Petrides (1975) indicated that through the recognition of preferred and neglected species the conditions and trend of an herbivore's range can be readily appraised.

In studying an animal population it is important to identify both the principal and preferred foods. The principal foods, according to Petrides, are those which are eaten in greatest quantity, while preferred forages ". . . are those which are proportionately more frequent in the diet than in the available environment." While a knowledge of the former group is essential to an understanding of an animal's basic environmental needs, an awareness of the latter species also contributes to the recognition of whether the range is in good condition or poor, is improving or degrading, and is under- or over-stocked.

Food preference values may be determined (Petrides, 1975) either by dividing the percentage of a food item in the diet by its percentage availability in the habitat, or by calculating the percentage of forage food materials removed by the herbivore. For tapirs, the latter type of data was collected by tracking the animals and observing their browsings. Within the series of browsed species, the calculation of percentage removed enabled food species to be ranked relative to each other with regard to tapir food choices and this was the principal aim.

While this method did not permit the precise calculation of which plant species were preferred or neglected, it was the only feasible technique to use in the extremely complex (Whitmore, 1975) rainforest studied. Under the conditions of study, the vast number of uneaten species tended to hide the browsed plants and would have made total availability tallies extremely time consuming and unproductive. Also tapirs commonly broke or pushed over shrubs and saplings, thus feeding on twigs and foliage which grew to a height of 6 m.

In the field, for each plant browsed by tapirs, the local, aboriginal name was listed and the plant's height was measured, as well as the diameter just above the buttress-like trunk-swell which is characteristic of many tropical, woody plants. The numbers of twigs and leaves available and the percentage eaten were recorded for each browsed plant.

All fecal deposits found were broken to determine if fruit parts were present. Samples from six such droppings were collected for plant fragment measurement.

Tapir trapping

No records were known to exist of the reaction of *T. indicus* to immobilizing drugs. It was decided, therefore, to trap them first to insure their safety and so that their response could be monitored. Using timber from the nearby forest, a trap (Figures 2 and 3) was built in a natural clearing 100 m from a salt lick frequently used by tapirs.

Posts 8-10 cm in diameter and 2.7 m in length were sunk to a depth of 45 cm. Fence rails 5-8 cm in diameter and 2.7 m in length were attached. After the first animal was trapped the fence was raised to a minimum height of 1.6 m. Two heavy, log-framed, woven-wire gates (Figure 3) were fitted, each 3.3 m wide and 1.5 m high. Each was hung from a cross-bar by three 10.2 cm steel hinges.

Two V-shaped guide-fences, or leads, one meter high and 10 m long, led to each gate. They were constructed in three sections, each made of three large-diameter bamboo rails 3.3 m long. Nylon trip-strings for each gate were suspended across the center of the trap, 30 cm apart at a height of 50 cm. The gate-release mechanism was a modified version based on that of Le Resche and Lynch's (1973) moose trap. The gate was held aloft by a rope attached to a trigger ("B" in Figure 4). The trip-string was tied around an upright log ("A"). When it was pulled, the log rotated on the bolt and released the trigger which fell with the gate.

Figure 2. Plan of the tapir trap.

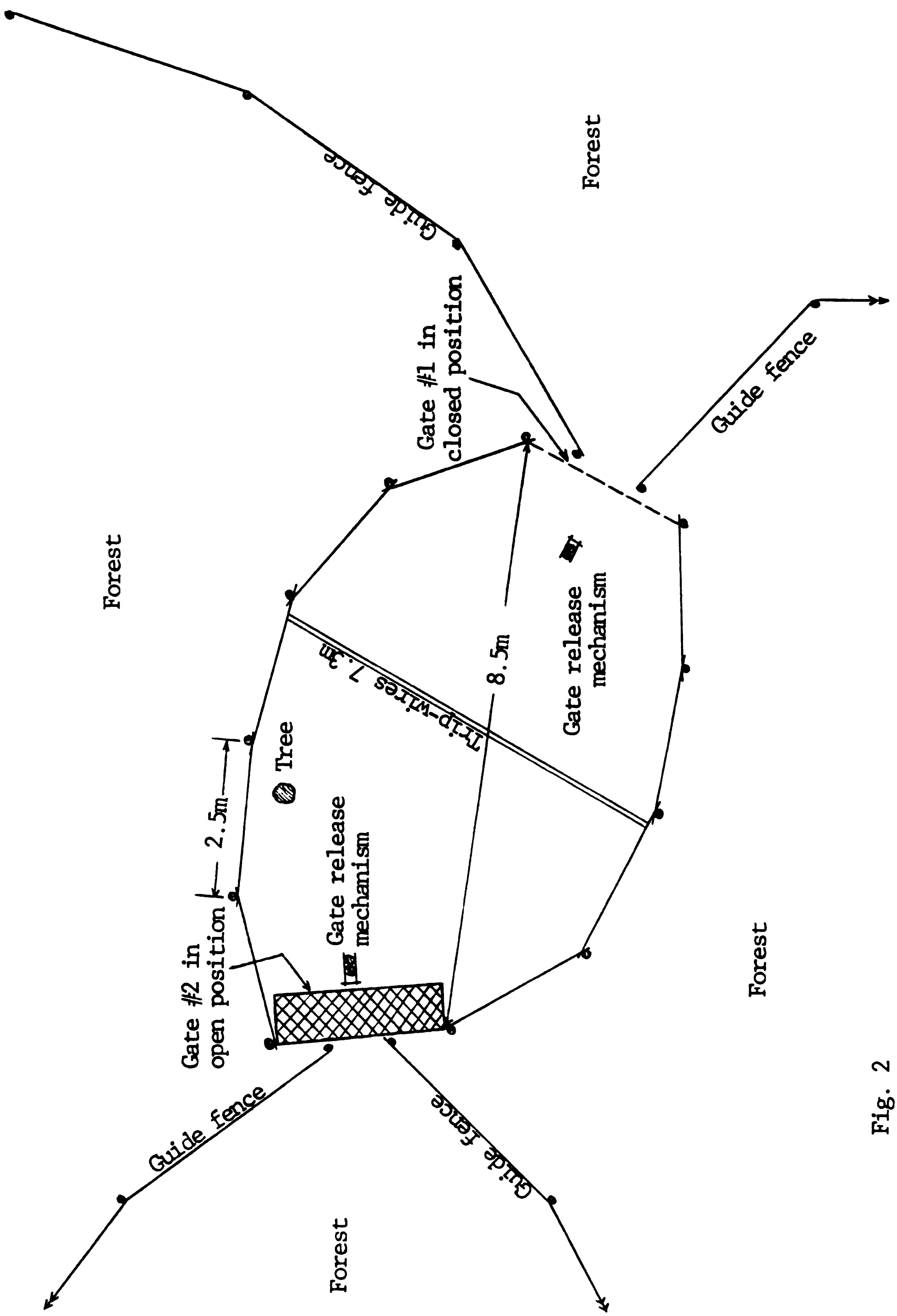

Guide fence
Forest
Gate #1 in
closed position
Guide fence
Forest
Gate release
mechanism
8.5m
Trip-wires 7.3m
Tree
2.5m
Gate release
mechanism
Gate #2 in
open position
Forest
Guide fence
Guide fence
Forest

Fig. 2

Fi

Figure 3. Tapir trap under construction.

Figure 4. Gate release mechanism.

After the capture of the first tapir, a salt block was placed inside the trap hopefully to increase its attractiveness. Two other tapirs were caught, possibly attracted by the additional salt.

Immobilization and radio-collaring

When an animal was trapped, doses of the neuroleptanalgesic etorphine hydrochloride (M-99, 2.44 mg ml^{-1}) and acepromazine ("Immobilon"), and its specific antagonist diprenorphine (M-285) ("Revivon"), were prepared. A modified 10 ml syringe (Figure 5) was loaded and the plunger attached to the end of a 3 m pole. Tapirs are poor-sighted and it was possible for the trap to be approached quietly and for the tapirs to be injected from outside the trap using the pole.

When immobilized, the tapir was fitted with a radio-transmitter collar (Figure 6). The head had to be held up when the collar was attached, otherwise the collar would slip off. The collar packages were supplied by the AVM Instrument Company, Champagne, Illinois, and had four mercury batteries set in dental acrylic. The signal wave-length was near 154 KHz. Fastened to a collar made of 5-ply belting 6.4 cm wide, the total package weighed approximately 0.9 kg. Before being released, ectoparasites were collected and the tapir was measured. During handling, the animal's body was wetted to prevent heat stress. For release, "Revivon" was injected into a vein at the back of the ear. The animals

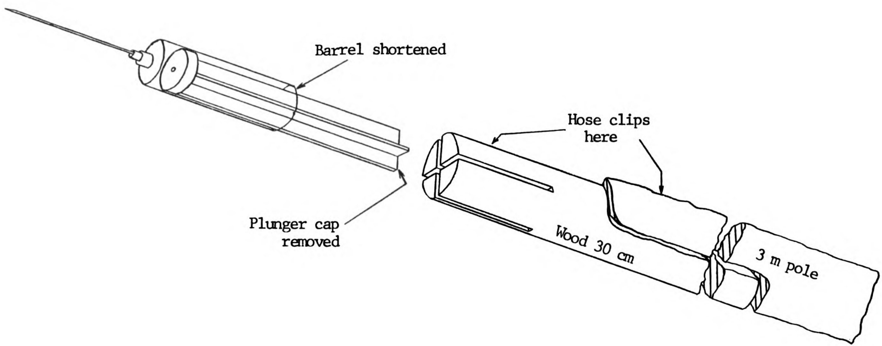


Fig. 5. Modified syringe and holder

Figure 6. Fastening the radio-transmitter collar.

were permitted to leave the trap when their gain and responses seemed normal.

Radio-tracking

Instrumented animals were tracked both from the air and the ground.

(a) From the air

Two yagi antennas (112 cm x 91 cm) were attached with galvanized iron-sheet clamps to the wing struts of a light airplane so that the antennas axes were at right angles to the long axis of the plane. It was then possible, by alternately isolating each receiving antenna, to fly over the search area and determine from what side of the plane the signal from an instrumented animal was coming.

The first flight over a search area was 667-823 m above the ground. When a signal was detected, the plane descended in a spiral, when possible to an elevation about 80 m above the tapir. At this stage, the instrumented animal was being tightly circled.

Aerial tracking presented terrain-related problems. Signal blocking, a "sheltering effect" by hills, ridges and spurs, usually made accurate locations difficult to ascertain. Also, it was often not possible to circle an instrumented animal at low altitudes because of narrow valleys. Thus a signal could be detected from only one direction. Signal strength then became critical as the locating factor.

After the tapir's location was determined, its position was plotted on a map scaled at 2 cm per 1.27 km. Because of dense foliage, however, in no case was a tapir seen from the air. Nevertheless, locations were considered to be accurate ± 0.16 km. Seventeen aerial locations were plotted for three tapirs during twelve flights. Indirect confirmation by later ground-tracking was obtained in several cases.

(b) From the ground

To receive a signal from a transmitter it was necessary to have a line-of-sight contact, i.e. no intervening hills, between the receiver and the transmitter. Even small rises were effective in blocking signals.

Forest vegetation also weakened radio reception. Jasik (1961, Chap. 33: 17 in Anderson and de Moor (1971)) stated that the attenuation experienced by vertically polarized waves is greater than that for horizontally polarized waves when passing through dense vegetation. Presumably, tree trunks and young saplings in the rainforest effectively blocked the vertical component of the signal and permitted only the weaker, horizontal component to pass through. In any case, the receiving antenna had to be held in the horizontal plane.

Not only did signal strength vary greatly with terrain and vegetation type, but dense growth made carrying the antennas difficult. To overcome the transport problem, the yagi antenna was collapsed after every location attempt.

To facilitate antenna-folding, the hexagonal nuts supplied for holding the elements were replaced with wing-nuts. When a signal was received, an effort was made to find the tapir by approaching it carefully, obtaining new bearings frequently. When sighted, observations of behavior and of the surrounding environment were noted. When close to instrumented animals, however, folding and unfolding the antenna quietly plus its large size (112 x 91 cm) made progress difficult.

To reduce the vegetation-density problem, the receiving system--the yagi antenna and a small, portable receiver--was set up on hills in areas where instrumented tapirs were believed present as based on previous aerial determinations. The hills were generally 100 m above the valley floors. This effectively reduced the quantity of vegetation through which the signal had to pass and lessened the sheltering effect of rises. The maximum distance from which a signal was received was 2.4 km in a situation where the receiving system was 168 m above a long valley. Usually the receiving system was carried to about 95 m above the valley floors. Though yielding an effective search distance of only 0.8 km or less, this was an improvement on attempts made at low elevations where signals could be received only at distances less than 0.3 km.

RESULTS

Food and feeding behavior

Over 115 species of 40 plant families and 70 genera were observed to have been browsed by Malayan tapirs (Appendix). The animals were found to be selective browsers, usually eating only the young leaves and growing twigs of a relatively few shrub and tree species. In addition, some herbaceous (*Curculigo latifolia*) and low-growing succulent (*Homalomena* spp. and *Phyllagathis rotundifolia*) plants were eaten.

Only the young leaves were eaten from *C. latifolia*. *P. rotundifolia*, even where plentiful, was consumed minimally. The aborigines reported that a club-moss, *Selaginella willdenonii*, also was eaten by tapirs. The vine *Ventilago oblongifolia* was eaten, but possibly only accidentally since the specimen recorded was climbing on a young, heavily-browsed *Baccaurea parviflora* sapling.

No browsings were seen in the secondary-forest area near the mouth of the Yong River.

Tapirs appeared to eat suitable leaves and fruits as they encountered them while wandering. Browsing activity did not seem to be concentrated in particular localities. If the twigs of saplings were out of reach, tapirs either snapped the plant stem or walked the trunk down to a more-or-less horizontal position.

Saplings characteristically when snapped, were broken with the teeth at heights of 0.8-1.2 m, occasionally to 1.4 m. Measurements of tooth marks as compared with the teeth in adult skulls indicated that saplings broken in this manner were grasped between the tapirs' premolars. Trunks of tooth-snapped plants varied in thickness, but were usually less than 2.7 cm in diameter. One sampling of a glaucous-stemmed Macaranga sp., however, was 3.8 cm at the point of break.

When samplings were pushed down, the animal placed a foot on the trunk about 50 cm above the base and proceeded to walk along the length of the tree to near its tip, if necessary, to lower it to browsing height. Saplings pushed down ranged in diameter from 2.0-6.5 cm. Saplings broken or walked down also were sometimes snapped or bent back at the upper end.

Among the more than 115 plants eaten by tapirs, relative food preference values were determined (Appendix) for 46 species. Over 75% of the available forage was consumed on twenty seven (58.7%) and these (Table 1) were considered to be the most highly preferred foodstuffs.

As evidenced by seeds and fruit parts found in all but one fecal deposit examined, fruits taken from the forest floor by tapirs also included many species. Determinations of scientific names was not possible in all cases because of the lack of reference materials. Fruits indirectly observed to be consumed (with Malay names) were "jaba,"

Table 1. Preferred food plants* of the Malayan tapir in the research area, Taman Negara, in 1976.

Scientific Name	Local Name
Lasianthus maingayi	kentul tampoi
L. griffithii	tenboh
#_Urophyllum glabrum_	cabal
Urophyllum sp.	narum
Psychotria sp.	pecang
Prismatomeris malayana	banran
Rubiaceae	pengemang
Rubiaceae	camakob
Macaranga denticulata	mahang hijau
#_M. hypoleuca_	mahang puteh
M. curtisii var. _glabra_	mahang hijau
Aporosa praineana	tembasa
A. stellifera	metkot
A. symplocoides	metkot
#_Baccaurea parviflora_	kemai
B. pyriformis	jentek
Homalomena deltoidea	kemoiyang hijau
Amorphallus sp.	sampah
Memecylon oligoneuron	klandis
Symplocos crassipes	nirat
Symplocos sp.	tenboh
Gomphandra quadrifida var. _ovalifolia_	ubat kera
#_Ficus semicordata_	gaboit
Garcinia nigrolineata	asam ketam
Saurauia leprosa	pahung
Curculigo latifolia	cateng
#_Helicia attenuata_	jering tupai

*Over 75% of available forage consumed.

#Also browsed by elephants (Olivier, pers. com.).

"tamun" (*Baccaurea parviflora*), "cangris," "perah" (*Elateriospermum tapos*), "kelat" and "perancah." These varied in diameter from about 1 cm ("tamun") to 6 cm ("cangris").

A comparison (Appendix) between tapir food plants and those listed for the elephant (*Elephas maximus*) and seladang (*Bos gaurus*) by Olivier (pers. com.) and Weigum (1972), respectively, indicates that interspecific competition for forages could occur in densely-occupied areas. No such dense populations, however, were observed.

Salt licks

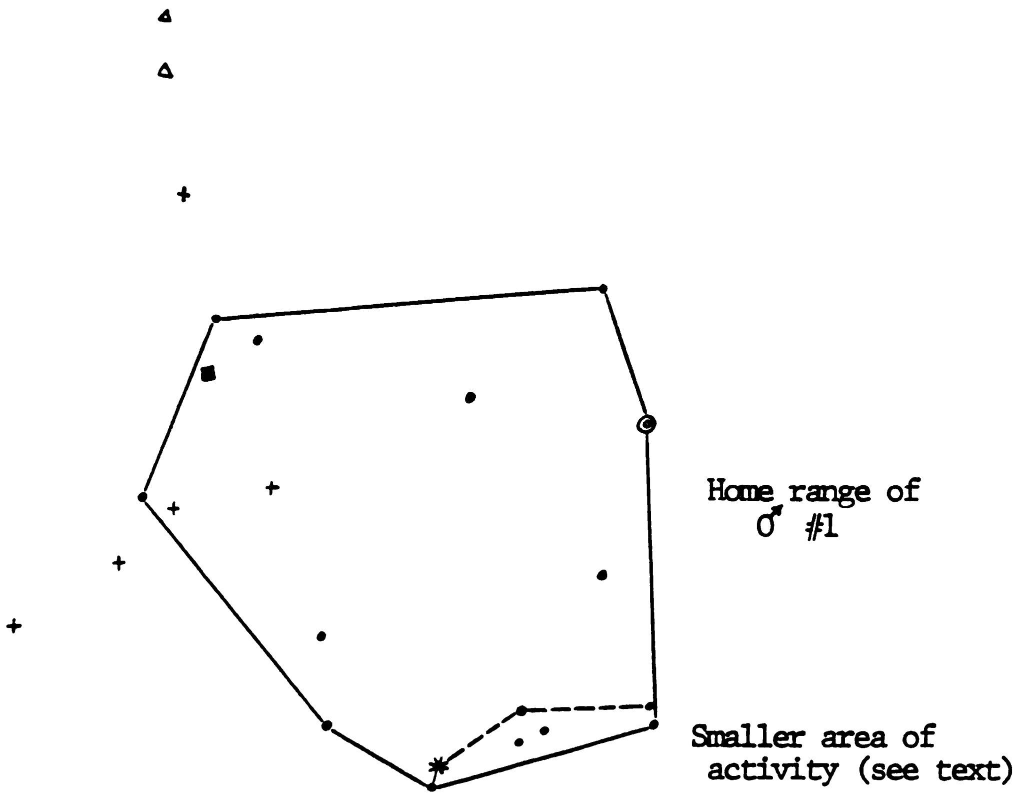
Within the research area, three salt licks were known (Figure 1), of which two (Figure 7) were natural. The existence of an additional natural lick near the Ruil River was reported by aborigines but not confirmed. Natural salt licks in Taman Negara were used frequently by tapirs and other ungulates. Tracking studies indicated that tapirs will walk up to 5.6 km to use a salt lick (Figure 8). Though Wharton (1957 *in* Weigum, 1972), working in Cambodia, suggested that if salt licks were not available, ungulates would have to migrate or perish, their essential values to tapirs in Taman Negara were not determined.

Preferred habitat types

Tapir signs (tracks, feces, urine spots, browsed twigs) were found in all rainforest environments visited.

Figure 7. The two natural salt licks in the research area excavated mainly by tapirs.

Figure 8. Radio-locations of the three tapirs.



N

Key

- • Radio-telemetry locations of first ♂ trapped
- + Radio-telemetry locations of ♀
- △ Radio-telemetry locations of second ♂ trapped
- ◉ Trap site and salt lick
- ▪ Site where collar of ♂ #1 found
- * Site where ♂ #1 was associated with a ♀ and her young

Figure 8.

Scale: 1 inch per 1 mile

Most tapir spoor occurred on the lower slopes and valley bottoms on mesic and hydric sites. Browsing was heavier in these places but whether this was due to the greater availability of plant foods or to other factors was not determined. Heaviest browsing was in mesic areas supporting medium-sized trees and many saplings.

Trail use

According to Medway (1969), tapirs wander long distances on regular trails. Yet Lekagul and McNeely (1977) say that these animals do not follow regular paths. The tapirs followed in this study wandered on and off man-made trails and did not make or use trails except at saddles between hills, gully crossings, rivers and river crossings, and in the vicinity of salt licks.

Tapirs often walk in and follow rivers for distances up to 100-150 m or more. One animal was tracked in a river bed and along a large submerged rock. The tracks entered a deep pool and left the river 100 m upstream. Raffles (1822) reported that a captive tapir frequently entered ponds and appeared to walk along the bottom while submerged, making no attempt to swim.

Defecation

A typical fresh tapir dropping consisted of about eight nearly-spherical, light-brown balls each about 5.0-5.5 cm in diameter and made up of coarsely-ground leaves and twigs. Many twig fragments 1.0-3.5 cm in length and pieces of leaves approximately 1 cm^2 were evident. Fruit parts and seeds also usually were present.

Tapirs deposited their dung both on the ground at the sides of their track and in the water. Deposition on the ground was associated with pawing movements of the hind feet. The feet did not contact the dung. Pawing of the ground, in the research area, resulted in the partial or complete covering of droppings with leaves and sticks. Von Richter (1966) studied captive tapirs and reported that pawing occurred both before and after defecation.

Captive tapirs have established defecation places (von Richter, 1966). Strickland (1967), in Sumatra, also found a few ". . . large deposits of tapir dung" and Thom (1936) advised that ". . . droppings are sometimes found in large heaps." In this study, no place was found where dung had been deposited more than once, but it is possible that defecation recurred at sites where earlier droppings had been covered or consumed by termites or dung beetles. Feces on the soil surface were seen to be disintegrated into loose, fibrous materials in one or two days where dung beetles were active. Old manure was often covered with soil due to termite activity.

Droppings found in water were usually in flowing streams at places where the depth was in excess of 20 cm. They did not accumulate there. In swampy areas, droppings were always in small pools and it appeared that tapirs may have sought out such pools in which to defecate. Von Richter (1966) believed that defecation was stimulated when the tapir came into contact with water.

Urination

Pawing of the ground with the hind feet also occurred in association with urination. Frequently signs of pawing were seen where urine was not present. Further along the animal's path in many such cases, however, evidence of urination was found and the initial pawing seemed likely to have been an associated feature. Urination frequently occurred along paths where the animal was feeding.

Urine was released to the side of the track; the animal evidently turning at an angle to its direction of travel. Observations of urine placements indicated that both males and females urinated in this manner. When urination occurred on plants it was considered possible sometimes to determine the sex of the animal since males urinate only at heights below 50 cm, spraying with the penis pointed backwards. Urination by males typically occurred in a series of 3-5 efforts, spaced 20-50 m apart. Urination by females occurred more frequently but was less concentrated. These observations agree with von Richter's (1966) report for captive tapirs.

Resting

Tapirs lay down in small hollows or on level ground. Resting areas were most often found near creeks or rivers but also near the tops of high ridges and spurs, well away from water. Sometimes an animal made use of an area many times, using different spots therein over a period of a week or more, leaving evident bedding spots. Areas of dense cover evidently were not required for resting, since tapirs often selected relatively open places in which to lie down.

Immobilizations and radio-collarings

Three tapirs (two males and one female) were trapped, immobilized and radio-collared. Details of each individual animal's reactions to the drugs were timed and recorded.

The dose of 0.8 ml of "Immobilon" used for the first tapir (a male) captured contained 2.0 mg of eterphine hydrochloride (M-99) with acepremazine. The dose selected was on the basis of Jones' (1972) report of 1.5-2.0 mg of M-99 being suitable for _T. terrestris_ with body weights of 120-160 kg. When applied, 0.8 ml was thought possibly to be an underdose for the much larger _T. indicus_ (250-375 kg), yet it proved to be close to an overdose. Dosages of "Immobilon" were reduced to 0.7 ml and the second and third tapirs were immobilized successfully.

Contrary to the usual reported reaction to eterphine, respiration was elevated in both the immobilized female and the second male. The respiration of the first male was initially lowered and did not become elevated at any stage. With the female, respiration was elevated to 80+ min^{-1} after about 30 minutes. Before release, the respiration rate had become lowered to 39 min^{-1}. The respiration of the second male was recorded at 47 min^{-1} ten minutes after the animal fell.

Social behavior

Tapirs are essentially solitary animals. Associations of individuals were few and thought to occur only between sexually-active adults and between a mother and her dependent young. One group of three animals, nevertheless, involved an instrumented male tapir located as it rested with two other animals. Although they could not be seen, the tracks and resting beds indicated that two adults and one young were together. The additional animals were presumed to be a female and her dependent young. Twenty-two days later this radio-equipped male was sighted alone.

Intraspecific tolerance was evidenced by the home range overlap of instrumented tapirs (Figure 8) and by the tracks of other tapirs being found in the areas used by instrumented animals. No evidence of conflicts was found.

Home ranges and utilization

Of the three tapirs radio-collared, only one could be tracked for a sufficient length of time to give information on home range size. This animal, a male trapped on May 26, was relocated on 16 occasions (Figure 8) prior to the collar being found on October 16 with the belting broken at a point of flexion.

This tapir ranged over 12.75 km^2 (Figure 8). The average straightline distance travelled per day by the male while instrumented was 0.32 km but the plot (Figure 8) of radio-locations indicated only a random pattern of movement. An area no larger than 0.52 km^2 was occupied for at least 27 days. It was in this smaller range that the instrumented male was located with two other tapirs, possibly a female and her young. This locality showed signs of both old and new browsing by tapirs.

The female tapir, trapped and radio-collared on August 29, was located five times over 51 days. The activity of this female also appeared to be random.

No useful information was gained from the second radio-collared male.

Parasites

Ticks collected from the three immobilized tapirs were identified as *Amblyomma testudinarium*, *Haemophysalis semermis*, *H. nadchatrami* and *Dermacentor astrosignatus*.

The two species of *Haemophysalis* and this species of *Dermacentor* had not previously been listed for *T. indicus* (Kohls, 1957). Both sexes were found in all tick species. Larvae of *H. semermis* and *A. testudinarium* were found with the adults of those species on the female tapir.

A. testudinarium were found also elsewhere on the tapir's body but with populations concentrated in the crotch and on the scrotum and udder. *H. semermis* and *H. nadchatrami* occurred inside the ear near its opening, and on the back of the ears. *D. astrosignatus* was in the crotch and on the scrotum and udder.

Though land leeches were ubiquitous in the research area, none was found on the immobilized animals.

Predation

Hislop (1950) reported a tiger attack on a tapir at the forest edge near the Ampang Reservoir just north of Kuala Lumpur. A similar attack on a tapir was reported near the research area during this study but the information was ten days late and no trace of the kill remained. Tapirs, especially young animals, presumably may be preyed upon also by leopards (*Panthera pardus*) and wild dogs (*Cuon alpinus*).

DISCUSSION AND RECOMENDATIONS

In most temperate-zone habitats, the effects of herbivore-feeding on vegetation usually are readily evident. In the rainforest, however, animal browsings tend to be masked by the vast number of scarcely-consumed and uneaten plants present. Selective browsing could be heavy there and still go undetected. The accuracy of assessments of tapir ranges which are made casually, therefore, are open to question.

The condition and trend of tapirs' understory-range can be estimated by observing the degree of use of the most preferred species in that range. The best method to appraise food preferences in the complex Malaysian environment was found to be by measuring the percentages of available browse removed.

Although the Dipterocarpaceae dominate the forest canopy (Soepadmo, 1971) and this family includes the largest and most economically-important species in this rainforest type, none occurred in the diet of the tapirs studied.

Most species of the two largest families of woody plants in the rainforest, the Euphorbiaceae and the Rubiaceae, occur as shrubs and small trees (Whitmore, 1975). A total of 41.7% of the species in the diet of the Taman Negara tapirs were of these two families.

Burkill (1919 in Richards, 1966: 381) found that the vegetative composition of a 30 year old secondary forest in Singapore was very different from that of the original primary forest. He determined that most plant species in the secondary forest succession were of the Euphorbiaceae and Urtiaceae while Rubiaceae species were not numerous. Corner (1952) also listed plants of the secondary forest and yet, of these species, only 17.5% were eaten by tapirs in Taman Negara. It seems evident that the resident tapirs were animals of the primary forest and not of the forest fringe and that primary forests are more suitable for supporting populations of tapirs than are secondary forests.

Trees which are important commercially in other areas (Vincent and Sandrasegaran, 1965) and which were eaten by tapirs (with feeding percentages, where available) were *Dacryodes rostrata*, *Santiria laevigata*, *Eugenia griffithii*, *E. cerasiformis*, *Eugenia* sp., *Knema malayana* (66), *K. stenophylla* (71), *Gymnacranthera forbesii* (50) and a Lauraceae. Although they were browsed, tapirs did not seem significantly to damage any of these timber species in the area under study.

Under normal circumstances, the browsing habits of the tapir may bring additional plant foods within reach of sambar (*Cervis unicolor*), barking deer (*Muntiacus muntjak*), and chevrotains (*Tragulus napu* and *T. javanicus*). Tapirs also appear to be important distributors of seeds from forest fruit trees.

The evidently-unique ecological significance of the tapir in the forest ecosystem is still to be defined, but certainly the species should not be allowed to become rare. Resident tapirs could not be termed over-abundant at the time of the study. If population increases ever caused the forest-understory range to become severely overbrowsed, however, both the habitat and these slow-breeding animals might recover only very slowly if at all.

With agricultural land-clearing and logging operations rapidly advancing throughout Malaysia, the total number of tapirs must be diminishing rapidly at this moment. While Malaysian tapirs are reported (Medway, 1974) to occur in selectively-logged forests following secondary regrowth, their invasion there may take years and cannot occur if tapir populations do not exist nearby.

Though tapirs were observed to use salt licks, the extent of their attraction is not known. Tapirs were readily attracted to the lick at the trap site and perhaps visit such mineral-saturated areas frequently. Whether they are an essential item on tapir ranges must be learned.

Immobilization of tapirs at salt licks may be simplified if a crossbow, such as has been developed in South Africa (Pienaar, 1968: 151), is used to deliver the dart, especially where trapping is infeasible. M-99 had a rapid effect on both sexes of tapirs and the darted animals made little attempt to escape. Tracking near salt licks, especially after rain, is not difficult and a darted animal should easily be traced and located there.

Aerial surveys are necessary effectively to radio-track tapirs. Maintaining contact by ground-tracking is difficult in thick vegetation and the animals can cover considerable distances. The possibility exists, however, to use two or more permanent ground stations on the tops of ridges overlooking relatively level areas. Such an arrangement seems possible in the Tenor River valley (Figure 1) where a 612 m steep-sided ridge lies to the north and the southern hills vary between 137 m and 230 m in elevation.

The preservation of at least some of West Malaysia's unique primary forest is recognized as being of world importance. These tracts also comprise the environment of the tapir and it is essential that they be maintained so as to ensure the cultural, scientific, recreational and potentially-economic values of this and other wildlife.

Based on this study, it is recommended that:

(1) Sample plots or transects in tapir ranges be monitored regularly to determine if preferred forage species are maintaining their abundance. By concentrating efforts on the relatively-few preferred plants the work is diminished considerably and the expertise needed by field workers is greatly reduced. Surveys of available browse

must include not only plants near the ground but also those which could be pushed down by tapirs. Reference plant collections are essential to aid field crews.

(2) Since it is essential to maintain natural conditions in a national park, the causes of either excessively-dense or of sparse populations be investigated. Management measures must be restricted to those which are essential to insure that nature is protected. If a population-limiting factor exists which is not of natural origin, efforts could be undertaken towards its modification. In a very few places where visitor interest might be stimulated and result in greater protection for the national park, the selective propagation of tapir food plants might be justifiable but would have to be undertaken on a cautious basis. On tapir ranges outside natural areas, trained personnel could test the feasibility of removing non-food plants in the understory in the effort to encourage the growth and reproduction of tapir forage species. In logged forests, this practice might be conducted on a more aggressive scale.

(3) The ecological relations and physiological effects of salt licks be determined, perhaps for all wildlife. Evidence as to whether mineral licks are essential to the welfare of tapirs could begin to be gathered if park personnel could determine whether tapirs are absent from areas in Taman Negara where licks are lacking. Natural salt licks should be preserved in both logged and

unlogged forests. In natural areas such as Taman Negara, however, the establishment of artificial salt licks would be detrimental to the integrity of the area.

(4) Ecological studies of tapirs be carried out in secondary forests of different ages to determine the extent to which different logging intensities affect tapirs, and perhaps other wildlife.

(5) Park personnel living at the Kuala Tahan headquarters be relocated outside the national park. Park buildings also should be sited away from the park boundary so that gardens, playing fields, and other unnecessary signs of human occupation can return to forest conditions.

SUMMARY

The Malayan tapir, *Tapirus indicus*, which occurs in Burma, Thailand, Peninsular Malaya and Sumatra, Indonesia, was studied in the primary rainforest of Taman Negara (literally, "The National Park") of West Malaysia.

Tapir tracks were followed and information on feeding, defecation, urination, movements and resting behaviors were obtained. Over 115 species of plants were browsed and fallen fruits were eaten. The plant families Rubiaceae and Euphorbiaceae were found to be the most significant in the diet, and as these small trees and shrubs dominated the rainforest understory in the research area, it was indicated that tapirs in the Malaysian rainforest are adapted to the primary forest and not to the forest fringe. Tapirs selected only the young leaves and twigs of most plants. Characteristically, tall saplings were either broken off at a height of about 1 m or pushed down before browsing.

Food preferences, based on the percentages of a particular plant browsed, were computed for 46 species of which 27 species, browsed more than 75%, were listed as preferred forages. The effects that tapirs have had on the

understory range can be estimated by analyzing sample plots or transects and the condition and trend of those preferred plant species there.

Tapirs bring additional plant foods within reach of other ungulates and they appear to be important in the distribution of seeds from forest fruit trees. Other ungulates in the forest ecosystem were not present in sufficient numbers to indicate competitive interactions. The impact of tapirs on forest trees which are of economic importance on other lands was minimal in Taman Negara.

Salt licks were often used by tapirs. However, the ecological aspects and physiological importance of their use is not known.

Defecation often occurred in streams and ponds. Urination by females appeared to occur more frequently and be less concentrated than for males.

Three tapirs were trapped, immobilized and radio-collared. Single 0.7 ml doses of "Immobilon" (etorphine hydrochloride (M-99) and acepromazine) successfully immobilized adult tapirs. These instrumented tapirs were tracked both from the air and on the ground. One male had a home range of 12.75 km^2. An area of 0.52 km^2 was occupied over a period of at least 27 days, during which time an association with a female and her young occurred. Transmitted signals were horizontally polarized by the of hills, ridges, and spurs severely limited reception distances.

Four species of ticks, Amblyomma testudinarium, Haemophysalis semermis, H. nadchatrami and Dermacentor astrosignatus, were collected from three tapirs. Only A. testudinarium had previously been noted for T. indicus (Kohls, 1957).

As an endangered species, management of the tapir seems to be necessary in West Malaysia where the rate of logging and agricultural land-clearing is rapid and accelerating. As a natural area, management in Taman Negara was not found to be required at the present time. To increase the suitability of other areas for tapirs, the selective removal of non-food plants in the understory and the selective propagation of tapir plant foods is suggested. Monitoring of tapir ranges should be carried out in conjunction with habitat changes, using food preference data as indicators of range condition and trend.

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APPENDIX

Appendix. Plants eaten by tapirs in the research area, Taman Negara, Malaysia, 1976.

Scientific Name	Local Name	Growth Form	Percentage Eaten (No. of Specimens)
Rubiaceae			
Lasianthus pilosus	kentul tampoi	shrub	45 (1)
L. attenuatus	jerangil hangus	shrub	+
L. bracterscens	sarik bateng	shrub	+
L. maingayi	kentul tampoi	shrub	76.2 (4)
L. griffithii	tenboh	shrub	100 (1)
L. oblongus	pengkras	shrub	50 (1)
Lasianthus sp.	letup	shrub	75 (1)
Urophyllum hirsutum	cabal	shrub-tree	+
U. streptopodium	cabal	shrub-tree	+
#U. glabrum	cabal	shrub-tree	82.5 (2)
Urophyllum sp.	narum	shrub-tree	85 (2)
Ixora pendula		small tree	+
Ixora sp.		shrub	+
Psychotria ovoidea		shrub-tree	+
Psychotria sp.	pecang	shrub-tree	92.5 (2)
Timonius wallichianus		tree	+
Prismatomeris malayana	banran	shrub	81.6 (11)
Gardenia sp.		shrub	+
*Uncaria sp.		climber	+
Rändia anisophylla		tree	+
Canthium domesticum		tree	+
Other species	pengemang		100 (1)
	camakob		85 (1)
Euphorbiaceae			
Macaranga denticulata	mahang hijau	tree	96 (3)
M. triloba	mahang merah	tree	+
#@M. hypoleuca	mahang puteh	tree	90 (2)
M. curtisii var. glabra	mahang hijau	tree	92.5 (2)
Aporosa aurita		shrub-tree	+
A. nigricans			+
A. praineana	tembasa		95 (1)
A. stellifera	metkot		100 (1)

Appendix (cont'd.).

Scientific Name	Local Name	Growth Form	Percentage Eaten (No. of Specimens)
A. symplocoides	metkot		100 (1)
A. pseudoficifolia	somkledung	shrub	32.5 (2)
Aporosa sp.	ubat meriam	small tree	70 (3)
#*Baccaurea parviflora*	kemai	small tree	88 (1)
B. pyriformis	jentek		100 (1)
Baccaurea sp.			+
Antidesma pendulum			+
A. tomentosum			+
#*Croton argyratum*		tree	+
Erismanthus obliqua		shrub	+
Pimeleodendron griffithianum			+
Elateriospermum tapos	perah	tree	+
Blumeodendron subrotundifolium			+
Araceae			
Homalomena rubra	kemoiyang	herb	50 (4)
H. griffithii		herb	+
H. deltoidea	kemoiyang hijau	herb	100 (2)
Amorphophallus sp.	sampah		100 (2)
Anadendrum montanum		climber	+
Aglaonema simplex		herb	+
Acoris calamus		herb	+
Melastomaceae			
Memecylon oligoneuron	klandis	shrub-tree	80 (1)
M. heterophleurum		tree	+
M. dichotomum	klandis	shrub-tree	65 (2)
#*Memecylon* sp.	nipis kulit	tree	+
Phyllagathis rotundifolium	tanglis	herb	+
Melastoma imbricatum	kenudok	shrub	+

Appendix (cont'd.).

Scientific Name	Local Name	Growth Form	Percentage Eaten (No. of Specimens)
Styraceae			
Symplocos rubiginosa		tree	+
S. crassipes var. *curtisii*	nirat	tree	100 (2)
S. ferruginea	nirat kecil	tree	50 (3)
Symplocos sp.	tenboh	tree	100 (1)
Olacineae			
Gomphandra capitulata		shrub	+
G. quadrifida var. *ovalifolia*	ubat kera	shrub	83.2 (4)
G. q. var. *quadrifida*		shrub	+
Strombosia maingayi			+
Moraceae			
Ficus ribes	ara	tree	53.3 (3)
#*F. semicordata*	gaboit	tree	100 (2)
#*Streblus elongatus*		tree	+
Guttiferae			
Garcinia rostrata			+
G. nigrolineata	asam ketam	tree	100 (1)
G. opaca var. *dumosa*			+
Ebenaceae			
Diospyros sumatrana	behtne	tree	65 (3)
D. latisepola		tree	+
D. buxifolia		tree	+

Appendix (cont'd.).

Scientific Name	Local Name	Growth Form	Percentage Eaten (No. of Specimens)
Myrtaceae			
Eugenia griffithii			+
E. cerasiformis			+
¢*Eugenia* sp.			+
Sapotaceae			
Payena lucida			+
Chrysophyllum lanceolatum		tree	+
Palaquim hispidum		tree	+
Myristicaceae			
Knema malayana	pendarah	tree	66 (1)
K. stenophylla	pendarah	tree	71 (1)
Gymnacranthera forbesii	pelanyil		50 (1)
Leguminoseae			
#*Millettia atropurpurea*		tree	+
#*Parkia speciosa*	petai	tree	60 (2)
Other species			+
Burseraceae			
Dacryodes rostrata			+
#*Santiria laevigata*			+
Rosaceae			
Prunus glisea			+
P. arborea var. *stipulacea*			+

Appendix (cont'd.).

Scientific Name	Local Name	Growth Form	Percentage Eaten (No. of Specimens)
Meliaceae			
Sandoricum koetjape		tree	+
#*Aglaia* sp.		shrub	+
Palmaceae			
Caryota mitis			+
Pinanga disticha		shrub	+
Liliaceae			
Dracaena elliptica	belakoh	shrub	+
D. pendula			+
Ampelidaceae			
Vitis cinnamomea		climber	+
**Vitis* sp.		climber	+
Myrsinaceae			
Ardisia colorata		shrub-tree	+
Gnetaceae			
Gnetum gnemon		tree	+
Actinidiaceae			
Saurauia leprosa	pahung		92.5 (2)
Magnoliaceae			
Michelia sp.			+
Loganiaceae			
Strychnos axillaris		climber	+

Appendix (cont'd.).

Scientific Name	Local Name	Growth Form	Percentage Eaten (No. of Specimens)
Amaryllidaceae			
Curculigo latifolia	cateng	herb	80 (3)
Chloranthaceae			
Chloranthus officinalis		shrub	+
Annonaceae			
Xylopia ferruginea		tree	+
Commelinaceae			
Forrestia griffithii		herb	+
Gesneriaceae			
Boea sp.			+
Acanthaceae			
Lepidagathis longifolia		shrub	+
Polygalaceae			
Polygala venenosa		shrub	+
Voilaceae			
Rinorea anguifera			+
Selaginellaceae			
Selaginella willdenonii	rumput badak	club moss	+

Appendix (cont'd.).

Scientific Name	Local Name	Growth Form	Percentage Eaten (No. of Specimens)
Sapindaceae			
Xerospermum intermedium	gigi buntal	tree	67.5 (2)
Saxifragaceae			
Polyosma flavovirens			+
Proteaceae			
#Helicia attenuata	jering tupai	shrub	95 (1)
Rhamnaceae			
Ventilage oblongifolia	tandok	climber	20 (1)
Celastraceae			
*Passifloraceae		climber	+
Lauraceae		tree	+

#Also browsed by elephants, Elephas maximus (Olivier, pers. com.).

*Also browsed by seladang, Bos gaurus (Weigum, 1972).

@Also listed by Medway (1972).

¢Noted by Foenander (1952).

+Extent of browsing unmeasured.