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The Mineral Content of Food Plants of the Sumatran Rhinoceros (*Dicerorhinus sumatrensis*) in Danum Valley, Sabah, Malaysia

Key words: *Ca:P ratio; Danum Valley;* Dicerorhinus sumatrensis; Diospyros *sp.;* Eugenia *sp.; mineral licks; Sabah; salt licks.*

Salt licks are known to be an important source of minerals for herbivores (Emmons & Stark 1979). For the two-horned Asiatic or Sumatran rhinoceros, *Dicerorhinus sumatrensis*, the role of salt licks in its mineral nutrition is still unclear. Studies in Indonesia have indicated that *D. sumatrensis* supplements its mineral requirements by using salt licks (Van Strien 1985). In contrast, *D. sumatrensis* was also observed to live in the Endau Rompin forest of Peninsular Malaysia where salt licks are not known to exist (Flynn 1980, 1981). In Sabah salt licks are present in several locations and believed to affect rhino distribution (Payne 1992).

There is very little information on mineral nutrition of the Sumatran rhinoceros in Danum Valley, Sabah (*ca* 5°00′N, 117°30′E) (Ahmad 1987, Hamid 1990). Works by Mokhtar *et al.* (1990) have ruled out wallow soil as a possible mineral source for the Danum rhinos. Although several mineral licks were discovered in the area as recently as September 1992, there is still no evidence of use of these licks by rhinos. To provide more information on the mineral nutrition of the Danum Valley Sumatran rhinos, we have carried out a survey on the mineral content of the rhino food plants. Assuming that food plants

TABLE 1. *Danum Valley food plants eaten by* D. sumatrensis.

Family	Species	Observed frequency of being eaten
Euphorbiaceae	*Mallotus wrayi*	1
	Mallotus sp.	2
	Koilodepas cf. longifolium[a]	1
	Koilodepas sp.	—
	Macaranga sp.	2
	Macaranga beccariana	—
	Blumeodendron sp.[a]	3
Dipterocarpaceae	*Shorea* sp[a]	2
Ebenaceae	*Diospyros* sp.[a]	4
Rubiaceae	*Psychotria woodii* Merr.	2
	Pavetta cf. axillaris	2
	Pavetta sp.	1
	Croton oblongifolius Burm.[a]	1
	Uncaria cf. borneensis[a]	2
	Uncaria sp.	—
	Ixora eliptica[a]	2
	Piper cf. retrotractum Vahl.	1
	Piper sp.	—
Lauraceae	*Litsea* sp.	2
Meliaceae	*Aglaia odoratisima* Bl.[a]	2
Melastomataceae	*Kibbesia cf. korthalsiana*[a]	2
	Kibbesia sp.	1
	Memecylon cf. peniculatum Jack	1
	Memecylon sp.	2
Apocynaceae	*Kopsia dasyrachis* Ridl.[a]	1
Annonaceae	*Friesodielsia* sp.[a]	1
	Popowia tomentosa[a]	1
Anisophylleaceae	*Anosphyllea* sp.[a]	2
Styraceae	*Styrax* sp.	1
Zingiberaceae	*Zingiber* sp.[a]	2
Myrtaceae	*Eugenia* sp.	7

[a] Indicates species of food plants not reported in earlier studies in other parts of southeast Asia (Van Strien 1974, 1985).

are the principal mineral source for these animals, we collected, identified, and analyzed plant species known to be eaten by them. The results of that study are presented in this paper.

Plants were obtained along trails used by *D. sumatrensis*. Specimens were collected based on the presence of rhinoceros foot prints near a plant which showed signs of having been eaten. The Sumatran rhino feeds in a distinctive manner, tearing off leaves by incising the terminal 10–20 cm of the shoot. All plants collected were dried in a solar drier and identified if possible, to species; or, if not, to the level of genus. Five grams of the dry and pulverized plant tissue were then digested in concentrated nitric acid to yield a solution analyzed for Na, Ca, Mg and K using a Perkin-Elmer 2380 atomic absorption spectrophotometer. The P content was analyzed via the molybdenum blue-ascorbic acid method (Murphy & Riley, 1962).

A total of 31 food plant species from 13 families were observed to be eaten by *D. sumatrensis* (Table 1). This is about one-third of the total species of food plants reported in numerous studies in Southeast Asia from 1905 to 1970 (Van Strien 1974). More recent work by Flynn (1980) in Endau Rompin has reported about 150 species consumed by *D. sumatrensis*. Among 31 species recorded in Danum Valley, 15 species have not previously been reported elsewhere (Table 1). Most species recorded were from the Euphorbiaceae, Rubiaceae, and Melastomataceae families. However, the most frequently exploited food

TABLE 2. *The content of several elements (macronutrients) of the food plants of* D. sumatrensis *(% dry weight).*

Species	Na	K	Ca	Mg	P
Blumeodendron sp.	0.03	1.87	0.31	0.62	0.10
Zingiber sp.	0.02	2.74	0.20	0.34	0.17
Shorea sp.	0.05	0.70	0.25	0.21	0.12
Macaranga sp.	0.03	1.07	0.21	0.18	0.25
Litsea sp.	0.003	0.87	0.13	0.30	0.10
Koilodepas sp.	0.03	1.38	0.31	0.32	0.13
Aglaia odoratissima Bl	0.03	1.73	0.49	0.64	0.11
Uncaria cf. borneensis	0.02	0.89	0.06	0.16	0.08
Psychotria woodii	0.05	1.10	0.15	0.35	0.05
Kibbesia sp.	0.03	0.66	0.17	0.57	0.10
Memecylon sp.	0.01	1.82	2.10	1.15	0.12
Pavetta sp.	0.03	1.59	0.05	0.78	0.13
Diospyros sp.	0.45	0.20	1.65	0.84	0.05
Macaranga beccariana	0.03	0.69	0.31	0.19	0.13
Piper sp.	0.01	0.12	0.04	0.31	0.10
Eugenia sp.	0.04	0.65	0.08	0.27	0.10
Mallotus sp.	0.10	1.74	0.14	0.41	0.17
Uncaria sp.	0.01	3.49	0.30	1.28	0.12
Mangifera sp. (fruit)	0.05	0.48	0.20	0.40	0.10
Naphelium sp. (fruit)	0.006	0.72	0.48	0.24	0.08
Diospyros sp. (fruit)	0.01	1.45	0.29	0.12	0.14
Baccaurea sp. (fruit)	0.16	—	0.01	0.05	0.03
Mean	0.06	1.23	0.36	0.44	0.11
Standard deviation	0.09	0.82	0.51	0.32	0.05

plants were *Eugenia* sp. (Myrtaceae), *Diospyros* sp. (Ebenaceae) and *Blumeodendron* sp. (Euphorbiaceae). About 71 percent of these food plants were analyzed for minerals.

Because the actual mineral requirements of *D. sumatrensis* are unknown, its needs have been estimated to be similar to that of a horse (Van Strien 1985). The minimum mineral requirements for the diet of a horse are Na: 0.35 percent, K: 0.4 percent, Ca: 0.3 percent, Mg: 0.09 percent and P: 0.20 percent (Maynard *et al.* 1979). A comparison of these values with the average mineral content of the rhino food plants (Table 2) indicates that the diet of the Danum Valley rhinos will not be deficient in any of these elements except for Na and P. The Na content of the Danum Valley food plants is about six times lower than the Na requirement for a horse. It remains possible that the calculated mineral requirements for domestic animals are much higher than those for similar sized wildlife. In the Gunung Leuser Park, Van Strien (1985) observed that Na content of food plants was about one-tenth of the requirement estimated for a horse. The P content of the diet of the Danum Valley rhinos is slightly lower (0.11%) than the requirement for a horse, but lies in between the values reported by Van Strien (0.15%) and Flynn (0.07%).

Although averages over many food plants suggest a potential dietary deficiency in both Na and P for *D. sumatrensis*, an examination of these elements in individual food plants indicates otherwise. Three species of food plants are unusually rich in Na: *Diospyros* sp. (0.45%), *Mallotus* sp. (0.10%), and the fruit of the *Baccaurea* sp. (0.16%). Whereas, *Macaranga* sp. has a P content of up to 0.25 percent which exceeds the minimum requirement, while the *Zingiber* sp. and *Mallotus* sp. have comparable values (0.17%). Thus, it is possible that by concentrating on these food plant species, *D. sumatrensis* could avoid a deficiency of either Na or P.

The Ca:P ratio in the diet also should be considered, as the absorption of each of these elements is influenced by the concentration of the other. The average Ca:P ratio for food plants collected from Danum Valley is about 3:1 (Table 2) which is superior to the ratio of 12:1 reported by Flynn (1980, 1981) and 18:1 reported by Van Strien (1985). A mature horse can cope with a Ca:P ratio of up to 6:1 if there is sufficient intake of P (National Research Council 1978). The high Ca:P ratio reported by Van Strien and Flynn is due to the high content of Ca in their samples.

Memecylon sp. was generally rich in most elements especially K, Ca and Mg (Table 2), but does not appear to be a principal food of rhinos. On the other hand, one of the most frequently eaten plants in

Danum Valley, *Eugenia* sp., which has also been recorded as a food item of *D. sumatrensis* in other parts of Southeast Asia (Van Strien 1974), contains rather low amounts of most minerals compared to other food plants analyzed. Belovsky (1978) has shown that some large herbivores will balance intake of mineral-rich plants with other species rich in energy.

In conclusion, the diet of *D. sumatrensis* in Danum Valley contains sufficient major minerals for the overall nutrition of the animal without relying on other mineral sources such as salt licks. Based on our data, distribution of rhinos in Sabah need not necessarily be linked to the presence of mineral sources such as salt licks as suggested by Payne (1992). The original distribution of the rhino in fact remains unknown since historically extensive hunting activities have confused any reasonable estimation of such distribution.

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