Nat. Hist. Bull. Siam Soc. 26:25-34. 1975

OBSERVATIONS ON THE USE OF NATURAL LICKS BY UNGULATES IN THE HUAI KHA KHAENG WILDLIFE SANCTUARY, THAILAND

J. Seidensticker[1] and *J. McNeely*[2]

From November 27 to December 10, 1974, we undertook a preliminary ecological survey of the Huai Kha Khaeng Wildlife Sanctuary. This 407,750 acre area, in the mountains near the Burmese-Thai border in Uthai Thani Province, is the largest remaining uninhabited remote area in Thailand (BURNS 1969). According to Mr. Pong Leng-Ee, Chief of the Wildlife Management Division of the Royal Forest Department, this is a key area where the Thai Government has a priority interest in developing its wildlife management programme.

We visited this region on Mr. Pong's suggestion and with logistical support from the Wildlife Management Division. Our preliminary objectives were to broadly define and identify problem areas, especially those related to the Khwae Yai Hydroelectric Scheme, make initial observations on distribution and numbers of the more conspicuous animals, and to assess logistical needs for intensive ecological surveys. Our preliminary findings were presented in a report to the Wildlife Management Division (MCNEELY and SEIDENSTICKER, 1974). The purpose of this note is to describe certain geological and chemical features of some natural mineral licks we found along the Huai Kha Khaeng and to discuss the importance of these in the lives of the large ungulates in the area.

We wish to express appreciation to Drs. Boonsong Lekagul, Joe T. Marshall and D. Burns for advice and loan of equipment, and to Mr. Pong Leng-Ee and the Wildlife Management Division for support and

1) Present address: Office of Zoological Research, National Zoological Park, Washington, D.C., 20009 U.S.A.

2) Association for the Conservation of Wildlife, 4 Old Custom House Lane, Bangkok.

encouragement. The help of S. Thomas, who accompanied us on this trip and assisted in manuscript preparation, is gratefully acknowledged. Dr. A. Franzmann shared his ideas with us and made helpful comments on the manuscript. The first author thanks Dr. J. Eisenberg for the courtesies extended to him during his stay at the National Zoological Park-Smithsonian Institution, Washington, D.C.

Findings

We surveyed the Sanctuary on foot. Beginning at the Huai Ai Yoh ranger station, we walked west by trail to the Huai Kha Khaeng, then turned south on a route which paralleled the river, switching sides frequently and often walking in the stream. We did not encounter a well-travelled trail again until we were near the southern border of the Sanctuary.

Tall clumped bamboo stands, along with early invaders, were prominent along the stream banks annually inundated by monsoonal high water. Evergreen forests covered the valley bottom and hillside ravines and stream beds. Open deciduous forests with mainly a grass understory covered many of the surrounding hills. Many areas in the Sanctuary showed signs of extensive slash-and-burn agriculture, at least within the past century.

All the licks we located were near the valley bottom but above the zone annually inundated by high water. Lick No. 1 (see Table), called Pong Nai So, is a 2-ha open area near the junction of the Huai Kha Khaeng and the trail from Huai Ai Yoh ranger station. Nos. 2, 3 and 4 were small licks several kilometers apart located below the confluence with the Huai Ai Yoh, well back from the river, on the west side. Samples from Lick No. 5 were collected from a large marshy area with scattered clumps of bamboo near the west bank of the river a few miles north of the confluence of the Huai Mae Thi.

The only geological surveys available for this region are very general. The geological map prepared by JAVANAPHET (1969) shows the presence of three basic parent material types: (1) granite, dating from

the Carboniferous, (2) the Ratburi Formation, a massive light-grey limestone interbedded with shale, sandstone, mudstone, conglomerate, and volcanic tuff, dating from the Carboniferous and Permian, and (3) the Kanchanaburi Formation, which is a group of shales, sandstones, and sandy shales in many places metamorphosed to phyllite, argillite, quartzite, and slate, from the Carboniferous, Devonian, and Silurian. Soils in the Sanctuary for the most part are shallow and stony (PENDLETON, 1961). There are recent alluvial soils in some of the valley bottoms. From the 1:1,000,000 scale geological maps available, the lick areas we located were in the regions with granite parent material.

DALKE *et al.* (1965) felt that water was the carrier of the mineral sought by elk *Cervus canadensis* at 17 natural licks in the mountains of central Idaho (USA), an area which also has a granitic parent material. At only one site did the investigators find any positive signs of recent soil licking. In Africa, WEIR (1972) and JARMAN (1972) found that elephants *Loxodonta africana* excavated pits in clay soil; after filling with water during the wet season, these became a source of sodium salts in aqueous solution. Similar zoogenous pools were found in the Nepal *terai* (SEIDENSTICKER, unpub. obs.), but these were made by the Indian one-horned rhinoceros *Rhinoceros unicornis*. COWAN and BRINK (1949), working in the Rocky Mountain National Parks of Canada, found both wet and dry licks and noted a differential use of these by the large ungulates: bovids utilized the dry licks and cervids more often utilized the wet licks. Springs and seeps occurred at all the licks we found and at each lick there were signs of substantial soil licking. Both soil and water may be important components of these licks and a differential use of these components by the large ungulates may well be occurring.

In this reconnaissance we did not collect water samples; we limited ourselves to a collection of soil samples only from the lick sites, to serve as a basis for preliminary comparison and give direction to future research (see Table). The most striking feature that the results of these analyses show is the variation from lick to lick and the variation even in the samples collected from the same lick area.

Table 1. Constituents of soil samples collected from natural licks in the Huai Kha Khaeng Wildlife Sanctuary, Thailand, December 1974.

Lick No.	pH	P (ppm)	K (ppm)	Ca (me/100 g)	Mg (me/100 g)	Sand %	Silt %	Clay %
1	7.4	52	62	1.10	1.46	88	5	7
2	7.7	2	86	18.75	16.56	63	11	26
3	6.1	1	62	0.98	1.98	72	8	20
4	6.6	1	68	5.00	5.42	–	–	–
5 a	7.7	32	42	9.00	6.14	56	13	31
5 b	6.9	6	92	1.25	2.92	68	11	21
5 c	8.6	8	56	1.16	1.30	82	5	13
5 d	8.5	70	62	4.00	19.27	39	17	44

Soil sample analysis by the Soils Chemistry Laboratory of Kasetsart University, Bangkok, courtesy of Chalermsi Watcharakuk.

COWAN and BRINK (1949), comparing samples from 11 licks from the Rocky Mountain National Parks of Canada, found large amounts of sodium, magnesium, calcium, and iron; phosphorus and chlorine occurred in small amounts. In western Montana (USA), STOCKSTAD *et al.* (1953) found sodium, calcium, and magnesium, but chlorine, sulphur and iron occurred less in lick soils than in non-lick soils. KNIGHT and MUDGE (1967) in the Sun River area (USA) and DALKE *et al.* (1965) found sodium bicarbonate and sodium sulphate to be significantly more abundant in the water from licks than elsewhere. In Kanha National Park in India, SCHALLER (1967) found that levels of phosphate and calcium were appreciably higher in the soil sample from licks than in those from surrounding soils. Elephants used large lick areas with visible deposits of what appeared to be sodium chloride in the Gunung Leuser Reserve, Sumatra (KURT, 1973). WEIR (1972) found the behavior and distribution of African elephants strongly influenced by availability of environmental sodium, and BOTKIN *et al.* (1973) found evidence to suggest that the availability of sodium controls moose *Alces alces* populations in northern ecosystems. Our results are inconclusive as to which particular element in licks the wild ungulates were seeking. But recognizing the complexity

and interspecific variation in mineral metabolism, one cannot expect to understand the utilization of licks by wildlife populations through the analysis of soil and/or water samples alone. It is more to the point at this stage to look at the animals themselves.

Elephant *Elephas maximus*, tapir *Tapirus indicus*, wild swine *Sus scrofa*, sambar *Cervus unicolor*, barking deer *Muntiacus muntjac*, banteng *Bos javanicus*, gaur *Bos guarus*, and wild water buffalo *Bubalus bubalis* are presently found in the Sanctuary. (In addition Fea's barking deer *M. feae*, hog deer *Cervus porcinus*, Eld's deer *C. eldi*, and serow *Capricornis sumatrensis* possibly occur there, but much less is known about their status). The tracks of elephant, sambar and barking deer were found in lick areas more frequently than those of swine, banteng, gaur, and tapir; tracks of buffalo were not observed in lick areas.

The wild water buffalo, the last remaining in Thailand, appeared to be divided into two separate populations; one was located in the riverine tall grass areas near the confluence of the Huai Ai Yoh and a second group, downstream, was concentrated mostly outside the Sanctuary in an area recently abandoned by Karen farmers. We cannot say if they too are using some lick areas as there are certainly licks we did not discover; it is possible they are not. Judging from old tracks, Lick No. 5 was well within the range of at least one population. Botkin *et al.* (1973) found that aquatic macrophytes had 500 times more sodium than found in terrestrial vegetation. If sodium is a mineral sought in licks by ungulates feeding primarily on terrestrial herbaceous vegetation, it could explain why the water buffalo, if feeding on aquatic vegetation, may obtain adequate amounts of sodium and thus not frequent lick areas.

The local distribution could be the primary reason we did not observe the other wild cattle at the lower licks. Both banteng and gaur tracks were recorded at Lick No. 1 and gaur tracks were seen at Lick No. 3. This corresponds closely with their distribution in the Sanctuary, as we were able to discern from tracks. Other factors, however, may be operating. Jarman (1973) noted in Zambia that there was almost a total separation in the utilization of zoogenous pools (see above) by elephants, rhinoceros *Diceros bicornis*, and Cape buffalo *Syncerus caffer*. He also

noted differential utilization by the sexes in Cape buffalo. HEBERT and COWAN (1971) noted differential seasonal use of licks by the sexes in mountain goats *Oreamnos americanus* in North America.

Tapir tracks were observed only in Lick No. 1. This did not seem to correspond with their distribution in the Sanctuary. Tapir tracks were frequently seen in the evergreen forest near the river and even in the deciduous forest on the ridges. Gross analysis of their droppings indicated they were feeding mostly on browse and fruits. That tapirs were not frequenting licks may have been associated with the physiological needs associated with their diet. At the National Zoological Park (Washington, D.C., USA), South American tapirs are given blocks of salt as a matter of course with all the hooved stock, but M. Roberts (pers. comm). reports these blocks are little utilized as compared, for example, with the cervids.

A similar phenomenon may be occurring with the wild swine. They are not ruminants; they do not digest cellulose. Omnivores, they feed mostly on fallen fruits, roots, invertebrates, and even vertebrates, including carrion. In the Huai Kha Khaeng, swine were numerous, avoiding only the deciduous forest areas with shallow and rocky soils. Their sign was especially common in those areas along the streams which are flooded during the rainy season, where the soft, sandy soil offered ideal conditions for feeding on tubers and edible roots. Though there were sign in the vicinity, swine had not visited Lick No. 1, but had visited other lick areas, possibly more for wallowing than seeking particular minerals. JARMAN (1972) reported that in Zambia, warthogs *Phacochoerus aethiopicus* wallowed but did not ingest soil at lick sites.

The tracks of sambar, barking deer, and elephants were found at all licks. We observed sambar coming to Lick No. 1 during an all-night observation period and we heard elephants at Lick No. 5 both day and night; a herd of elephants we followed for two days seemed to move from lick to lick. These species are widely distributed throughout the Sanctuary and all are known to feed on browse, grass and forbs. During this season, just after the rains, we suspect they were concentrating their feeding on the more succulent or herbaceous plants and plant parts.

Elephants, for example, were spending much time in the tall grass areas along the stream and there was evidence that they were breaking down bamboo and feeding on the leaves. The occurrence of these species at licks at this time of year may be associated with the seasonal use of different classes of forage. STODDART and SMITH (1955) have emphasized that livestock grazing on green feed consume considerably more salt than those grazing on dry feed. African elephants are known to have a particularly precarious sodium budget. In many areas sodium must be obtained from sources other than the food plants themselves (WEIR, 1972).

Discussion and Management Implications

In summary, the differential use of mineral licks by large ungulates in the Huai Kha Khaeng Sanctuary can be traced to one or a combination of factors: 1) their distribution in the Sanctuary; 2) the physiological demands related to the class of forage taken, which includes the plant part taken and the stage of maturity; and 3) physiological demands of the digestive process itself, which can relate to both the species and the sex-age class involved. Other factors, of course, could be involved, such as differences related to the soil parent material or the successional stage and vigour of the vegetation. We should note that plants common to the evergreen forest floor have a high tolerance for shade, but KLEIN (1970) notes this tolerance is associated with a lowered growth rate, which results in lowered nutritive quality. This could be a factor for those species which are widespread in the Sanctuary; a species may use licks when associated with one vegetation type, such as evergreen forest, but not when associated with other vegetation types.

FRANZMANN *et al.* (1975) have recently outlined some of the complexities of mineral metabolism and have attacked the widespread notion that wild animals do not suffer from mineral deficiencies. These workers are approaching the problem of mineral deficiencies, and nutritional status in general, through the study of the animal's blood chemistry (FRANZMANN, 1972; LERESCHE *et al.*, 1974) and through other indicators, such as hair shaft analysis (FRANZMANN *et al.* 1975). This research trend is aimed at freeing the manager from having to rely on

secondary indicators, such as population composition, natality, mortality, and habitat analysis, to determine populations' relationship with their habitat. LERESCHE *et al.* (1974) point out that these indicators in effect summarize only the manifestations of nutritional, behavioural, environmental and genetic forces acting upon a population. Considering the precarious status of so many of the large mammals in Asia and our lack of even preliminary information (see LEKAGUL and MCNEELY, *in press*), there is little doubt that preservation of most wild populations will require very precise management programmes. To succeed these programmes will eventually have to be based on an analysis of individual primary factors rather than their collective manifestations.

As outlined above, the present state of our knowledge does not specifically guide the manager in his decision-making, but the manager must be aware of the potential consequences of alteration of mineral availability; it is a factor which must be weighed when any change in land-use or other management practices is considered. GEIST (1971), for example, found that mountain sheep *(Ovis dalli, O. canadensis)* included in their yearly cycle as many as five specific home-range areas, one of which was a salt-lick range. Use of salt-lick ranges corresponded to needs related to the class of forage used at various seasons. Judging from the work which has been done, very similar utilization patterns probably exists for the large mobile mammals such as elephant and wild cattle in the Huai Kha Khaeng, and in mountain areas in general, which have extreme heterogeneous environmental conditions.

Apart from the nutritional importance of licks, a knowledge of their location is most important in order to find these large ungulates under conditions which can facilitate close approach. This is extremely difficult to achieve in these upland monsoonal forests and has obvious implications for study. It also is a factor in terms of tourist viewing and poaching control. Lick sites offer perhaps the best opportunity for tourist viewing of many of the large mammals, although care must be exercised to minimize disturbance. Also, the licks are exploited by poachers, as evidenced by the *machans* at the Pong Nai So lick, so patrol activity could be productively routed to include these sites.

REFERENCES

BURNS, D.M., 1969. A survey of the Huay Kha Khaeng. Conservation News **9**: 21-26.

BOTKIN, D.B., P.A. JORDAN, A.S. DOMINSKI, H.S, LOWENDORF and G.E. HUTCHINSON, 1973. Sodium dynamics in a northern ecosystem. Proc. Nat. Acad. Sci. USA, **70**: 2745-2748.

COWAN, I. McT. and V.E. BRINK, 1949. Natural game licks in the Rocky Mountain National Parks of Canada. J. Mammal. **30**: 379-387.

DALKE, P.D., R.D. BEEMAN, F.J. KINDEL, R.J. ROBEL and T.R. WILLIAMS, 1965. Use of salt by elk in Idaho. J. Wildl. Mgmt. **29**: 319-332.

FRANZMANN, A.W., 1972. Environmental sources of variation in physiological values of bighorn sheep. J. Wildl. Mgmt. **36**: 924-932.

FRANZMANN, A.W., A. FLYNN and P.D. ARNESON, 1975. Hair mineral elements of Alaskan moose. J. Wildl. Mgmt. **39**: 374-378.

FRANZMANN, A.W., J.L. OLDEMEYER and A. FLYNN, 1975. Minerals and moose. N.A. Moose Conf., Winnipeg, Manitoba 11 (*in press*).

GEIST, V., 1971. Mountain sheep. Univ. Chicago Press, Chicago, Ill. 283 pp.

HEBERT, D. and I. McT. COWAN, 1971. Natural salt licks as a part of the ecology of the mountain goat. Can. J. Zool. **49**: 605-610.

JARMAN, D.J., 1972. The use of drinking sites, wallows, and salt licks by herbivores in the flooded Middle Zambezia Valley. E. Afr. Wildl. J. **10**: 193-209.

JAVANAPHET, J.C., 1969. Geological map of Thailand. Dept. of Mineral Resources, Ministry of National Development; printed by Royal Thai Survey Dept. Scale 1 : 1,000,000. 3 sheets.

KLEIN, D.R., 1970. Food selection by North American deer and their responses to over-utilization of preferred plant species, pp. 25-44. In A. Watson (ed.), Animal Populations in Relation to their Food Resources. Blackwell Scientific Publications, Oxford. 477 pp.

KNIGHT, R.R. and M.R. MUDGE, 1967. Characteristics of some natural licks in the Sun River area, Montana. J. Wildl. Mgmt. **31**: 293-299.

KURT, F., 1973. Der Gunung Leuser Survey 1970. Zeitschrift des Kolner Zoo **16**: 59-74.

LERESCHE, R.E., U.S. SEAL, P.D. KARNS and A.W. FRANZMANN, 1974. A review of blood chemistry of moose and other Cervidae with emphasis on nutritional assessment. Natural. Can. **101**: 263-290.

LEKAGUL, B. and J. MCNEELY, *in press* Mammals of Thailand. Association for the Conservation of Wildlife, Bangkok. 800 pp.

MCNEELY, J. and J. SEIDENSTICKER, 1974. Huay Kha Khaeng : A preliminary ecological survey, 27 November to 10 December 1974. Association for the Conservation of Wildlife, Baugkok. 6 pp.

PENDLETON, R.L., 1961. Provisional map of the soils and surface rocks of the Kingdom of Thailand. Soil Survey Unit, Technical Division, Department of Rice. Printed by the Royal Thai Survey Department, Thailand. Scale 1 : 1,000,000. 3 sheets.

SCHALLER, C.B., 1967. The Deer and the Tiger : A study of wildlife in India. Univ. Chicago Press, Chicago, Ill. 370 pp.

STOCKSTAD, D.S., M.S. MORRIS and E.C. LORY, 1953. Chemical characteristics of natural licks used by big game animals in western Montana. Trans. N. Am. Wildlife Conf. **18** : 237-257.

STODDART, L.A. and A.D. SMITH, 1955. Range Management. McGraw-Hill Book Co., New York. 547 pp.

WEIR, J.S., 1972. Spatial distribution of elephants in an African National Park in relation to environmental sodium. Oikos **23** : 1-13.