
Cranial morphology in the European otter, *Lutra lutra* (final report)

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This paper presents a comparative examination of the cranial morphology concerning the Eurasian otter *Lutra lutra*. The aim was to find evidence for possible subspecies, as the exact knowledge of the systematic situation is important for sensible planning of breeding and reintroduction programs.

Metric measurements and nonmetric characters of 389 skulls were taken from 15 European populations. Subsequently the variation in cranial form and sexual dimorphism was examined and also the nonmetric characters were used to determine the epigenetic distance between the populations.

Unfortunately a definite result could not be obtained. Indeed the populations were differentiable, but the morphological differentiation was not correlated with

the geographical separation and no taxonomic relevance was recognizable. Instead there is evidence, that especially the cranial variation of males is submitted to a directed selective force, which has similar effects even in distant areas. It is discussed whether slightly different reproductive strategies could be responsible. Furthermore it was noticed, that in heavily fragmented and reproductively isolated populations morphological changes (genetic drift) can appear after only a few generations. A basic problem in this examination was the partially too small sample size and the large time span over which the otters had been collected. Further investigations referring to morphological changes by genetic drift as well as comparisons with genetic and molecularbiologic examinations are clearly required.

Investigations on the social and reproductive behaviour of captive White rhinoceroses (*Ceratotherium simum simum*) (final report)

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In this Ph.D. thesis, captive White rhinoceroses were observed for their social behaviour. Some animals were also studied when they were confronted with changing feeding conditions, i.e. when food was offered on just one heap (clumped feeding) or in as many heaps as animals present (dispersed feeding). Clumped feeding is comparable to the common keeping routine in most zoos.

All animals were involved in aggressive interactions, both as actor and recipient. Since it was impossible to identify an α -animal, towards which no aggressive acts were directed, ranking was done according to COULON (1975). In all 5 groups the male was the aim of most aggressive behaviours. Since he retreated

in most cases, his social position was low. The relationship of both genders is discussed in detail in the thesis, since females actually communicate formal subordination (MEISTER 1997). The females that were regularly cycling or mated, or which were accompanied by a calf, were the top-ranking animals. The feeding experiments revealed that rhinoceroses were more aggressive when food was clumped, but just as under dispersed feeding conditions, most interactions were threat displays. These tendencies could be observed not only while the animals were feeding, but also during the rest of the day. An increase in aggression was also reported for White rhinoceroses normally kept on a pasture, if they were

fed with hay at just one feedingsite (O'CONNOR 1982). Due to these changes in frequency, White rhinoceroses seem to resemble "scramble" feeding types according to the WRANGHAM (1980) and VAN SCHAIK (1989) models. According to HAND (1986), "scrambled" species establish a more non-hierarchical, egalitarian social system. A feature of this social system is that the individual signals its current motivational status, e.g. by an obvious willingness to "fight", both in advance of and during a conflict situation. In this study, motivation (M) as an internal state was therefore operationalized by the term (MEISTER 1997):

$$M = \frac{\text{Total number of agonistic acts received}}{\text{Number of times the recipient retreated}}$$

In nearly all animals, the motivation to pass in a contest situation increased under clumped feeding conditions and decreases under dispersed feeding conditions. Feeding time decreased during clumped feeding WALKER (1997) could demonstrate that feeding time decreased if grass was offered to captive White rhinoceroses that were normally fed with hay. This observation points at the impact of competition on behaviour. The hypothesis of a motivational influence could be further proved in this study since the number of aggressive interactions decreased as a function of time in the clumped feeding situation. On the one hand, this may be the effect of a certain habituation when each animal has gained access to the feeding-site. On the other hand, the motivation to fight for food may decrease, since the animal becomes less hungry or the resource value decreases since there is less food left.

Since agonistic interactions proved to be "stressful" (e.g. VAN HOLST 1994, CREEL ET AL. 1995), free cortisol was analysed by microtitreplate enzyme immunoassay (EIA). In contrast to the assumption, the urinary cortisol concentration of the male, as main recipient of aggressive acts, was not elevated. A significant difference could be found

between the females that were the highest and lowest ranking animals of this group. The number of sociopositive contacts in captive White rhinoceroses is small compared to the number of aggressive acts (3:1 - 6:1). This agrees with the findings in many social ungulates in the wild. According to VAN SCHAIK (1989) "scramble" feeding type species do not need to form coalitions and alliances that are re-inforced by numerous sociopositive contacts. Therefore, a change in feeding style should not cause a change in the frequency of sociopositive interactions. Against this prediction, the number of sociopositive contacts decreased under dispersed feeding conditions. Most of these interactions took place between bonded females (dyads or triads). This kind of relationship occurs both in the wild and in captivity (e.g. OWEN-SMITH 1974, 1975; O'CONNOR 1982; MIKULICA 1991). In the present study bonded females "assisted" their partners in agonistic interactions especially with the male. No advantage of being with one's bonding partner could be observed as far as access to the feeding-site was concerned. Nevertheless, the triads and dyads, respectively, avoided each other when several feeding sites were available and they fed frontal to each other in the clumped feeding situation. Bonded females preferred to feed side to side.

Since the number of sociopositive interactions grew concurrently with the number of aggressive acts, these interactions could act as re-inforcement of the specific bondage which in turn may function as a kind of "social support". In the dyads, mainly one female kept contact to her bonding partner, i.e. she followed in most cases. Bonded females showed synchronous behaviours and their time-budgets were therefore very similar. The animals' activity depends on their age as well as on the keeping modus: Young animals were more active than the older animals, and activity in general was higher if the animals had the opportunity to graze or if they were fed several times during the day. WALKER (1997) could also demonstrate that

White rhinoceroses fed with gras are more active than when they were fed with hay. Feeding time increased during dispersed feeding, while time spent resting declined.

These results demonstrate that keeping conditions have an impact on the social behaviour of captive White rhinoceroses. The permanent presence of the male causes difficulties: Due to space-restrictions and the number of shadowed resting sites, feeding-sites, objects (such as tree-trunks, stones etc.) he is often forced to interfere with a female's individual distance. This interference causes aggression. Therefore, the keeping conditions should be improved with regard to the fact that both genders avoid each other, if the female is not (coming) into estrous.

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Haematologic and chemical blood reference values in the physiology of the brush-tailed-bettong (*Bettongia penicillata* Gray 1873)

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In its homeland Australia the Brush-tailed-Bettong (*Bettongia penicillata*) is threatened to become extinct. Therefore it is among the species listed in the Convention on International Trade in Endangered Species

(CITES I) concluded in Washington, DC. Its preservation is part of the efforts of the EEP. Successful reproduction however is often endangered by diseases occurring in the breeding stocks. Unfortunately diagno-

stic and therapeutic approaches pose immense problems with these animals.

Up to now little is known about the physiology of the Brushed-tailed-Bettong. This study contains new data on the haematology and blood chemistry of the bettong, that will hopefully increase our understanding of the physiology and at the same time improve the diagnostic possibilities in the case of disease.

The establishment of reference values can help to determine "healthy" and "sick" individuals, so that it is possible to interpret the findings in a blood sample. Possible correlations between age, sex or keeping conditions and blood findings are investigated as well.

For the study 85 blood samples were collected from 58 "healthy" male and female Brushtailed-Bettongs held in captivity. The ages ranged from three months up to 13 years. 15 samples from ten sick animals were evaluated separately. All samples were taken without any kind of anaesthesia from the lateral tail vein (*Vena coccygea lateralis*). For the establishment of reference values different parameters were examined. The hematologic examination included PCV (Packed cell volume), total WBC (White Blood Cell Count) and differential WBC. The results are shown in table 1.

The analysed chemical blood constituents were blood glucose, urea, creatinine, total protein, total bilirubin,

cholesterol and the enzymes AST, ALT, AP, GGT, (1-amylase and lipase). The results are shown in table 2 and 3.

The analyses of the chemical parameters were all done by a Hitachi 704 autoanalyzer. Reference values were established by computation of the $\bar{x} \pm 2$ range or the 95 (i.e. 97.5) - % - percentil - interval of the parameters. Analyses of variance were made to determine the dependance on sex, age and the influences of living conditions. Sex-related differences were reflected in the reference values, by establishing a sex-specific range. The dependancies of age or keeping conditions were discussed. Because of the little number of tested animals in the age-classes and in the different keepings no separate reference values were established. In case of infectious diseases the total WBC of sick Brush-tailed-Bettongs showed only a little increase.

The differential MTC showed in six of eight cases a clear modification. The normally high number of Lymphocytes declined, whereas the number of neutrophilic segmented granulocytes increased. A range of the chemical blood values could not be seen in this cases.

Table 1: Haemogram of *Bettongia penicillata*

	Reference Value	Range
Packed cell volume %	44 - 56	39 - 56
PMite blood cells/mikro/l	male 4000 - 11900 female 3400 - 11200	3400 - 11900
Basophils %	male 0 - 2 female 0 - 5	0 - 5
Eosinophils %	0 - 8	0 - 9
Neutrophilic stab cells %	0 - 3	0 - 3
Neutrophilic segmented granulocytes %	18 - 49	18 - 53
Lymphocytes %	42 - 73	39 - 74
Monocytes %	1 - 10	1 - 10