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Selected problems of organising exhibition areas for common hippopotamus (*Hippopotamus amphibius*) - zoological data

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Abstract: *Selected problems of organising exhibition areas for common hippopotamus* (*Hippopotamus amphibius*). The aim of this article is to identify and analyse key zoological data concerning common hippopotamus. The data will be used for establishing guidelines for organisation of expositions for group (family) of common hippopotamuses with associated species. The information obtained from written sources such as biological data concerning hippopotamus, natural environment, behaviour (social organisation, locomotion, territorial behaviour, agonistic behaviour, reproduction, maternal behaviour) and biotic interdependencies (symbiotic interrelations) were used to design a number of project guidelines necessary for creating an exhibition in zoological gardens. The results obtained from this research will be the first stage of designing rules for organising exhibition areas, which would resemble hippopotamus' natural habitat.

Key words: common hippopotamus, design exhibition, design zoo, behaviour, natural environment

INTRODUCTION

Common hippopotamus (*Hippopotamus amphibius*) is one of the biggest land mammals and it has the strongest influence on the natural aquatic and land ecological system. In zoological gardens, hippopotamus is considered a main species to which other species are selected in order to organise a combined enclosure. Such exposition reflects the natural environment of the animals and their interdependencies. The visitors are able to watch the animals with their whole range of behaviours, reactions, relations with other animals, which makes the exhibition more attractive. Designing such an exhibition requires co-operation of a number of experts including: zoologists, animal breeders, dendrologists, architects and landscape architects. The first stage is to identify and analyse all zoological data (that is cooperation with a zoologist), which determine common hippopotamus' natural habitat and can influence the organisation of a quasi-natural habitat (with all interdependencies mentioned above) in a zoo.

RESEARCH METHOD

The research was based on finding zoological data in printed sources. Information to be considered included: biology of the animal (physical, psychical and intellectual potential), natural habitat, behaviour (social organisation, locomotion, territorial behaviour, agonistic behaviour, reproduction, maternal behaviour) and biotic interdependencies (commensalism and protocooperation).

The obtained information was analysed and a number of project guidelines, which were crucial for establishing rules for organisation of exhibitions in zoological gardens, were identified.

RESULTS

Results of the research are presented in the tables below. This zoological data allows to identify initial project guidelines for organisation of exhibitions in zoological gardens.

Table 1. Initial project guidelines-results of common hippopotamus' zoological data (hippopotamus biology) analysis.

	Zoological data	**Project guidelines**
Hippopotamus' biology	height 140 cm, weight 3200 kg (Laws 1984; Oliver and Laurie 1974)	Barriers and fences should endure pressure higher than 6000 kg
	Specific outer skin layer (thin epidermy) without sweat glands and thus his organism loses water at several times rate of other mammals (Oliver and Laurie 1974)	Hippopotamus must have constant access to water

Hippopotamus' biology describes its physical abilities as well as consequent directions for construction and equipment of the exhibition (e.g. endurance of the fence).

Table 2. Initial project guidelines-results of common hippopotamus' zoological data (natural environment) analysis.

	Zoological data	**Project guidelines**
Natural environment	The 2 essential requirement is water deep enough to submerge in and nearby grassland (Oliver and Laurie 1974)	Water reservoir with diversified bottom, with average depth of 1.5. An close to open grasslands
	The best conditions for hippopotamus are to be found in Mizima Springs at Tsavo West National Park (Kenya). There are 3 water reservoirs with constant water flow (2.3 m^3/s). The reservoirs are not influenced by seasonally, which prevents overcrowding and violence. Sufficient amount of water prevents fights for water access and illustrates interdependencies between animals and their environment (Deeble and Stone 2001)	conditions for hippopotamus' exhibitions in zoological gardens are based on the Environmental conditions in Mizima Spring
	The bottom should be slope and hard so that the herd could rest in water and the offspring could be fed without having to swim (Oliver and Laurie 1974)	as specified in 'zoological data'
	They avoid steep banks (Oliver and Laurie 1974)	Steep banks of a water reservoir could be the boundaries of exhibition
	They prefer to graze in areas such as grasslands with short blades of grass rather than areas with rough long grass (Field 1970; Kingdon 1979; Laws 1984)	Basic ground of the exposition should be a lawn. Rough long grass should be grown along the boundaries
	Hippopotamus' population density up to 31 individuals / km^2 can be devastating for the vegetation and soil (Field 1970; Kingdon 1979; Laws 1984); which corresponds to 32 000 m^2 per one hippopotamus	If areas per one individual are smaller, the animals must be fed

Information about the natural environment are direct guidelines for designing the exhibition's landscape and its elements such as: size of the area, size and depth of water reservoir, water exchange level, shape of the bottom and shores of the reservoir, animal structure and type of vegetation

Fig. 1. Hippopotamus resting in water or on a bank during the day tolerates close contact (Christine and Michel Denis-Huot 1995)

Table 3. Initial project guidelines-results of common hippopotamus' zoological data (behaviour) analysis.

		Zoological data	**Project guidelines**
Behaviour	**Social organisation**	Hippopotamus resting in water or on the bank during a day tolerates close contact, but can be aggressive to members of his herd (Laws 1984; Oliver and Laurie 1974)	Sufficient size of the exposition, which allows the animals to be separately
		When foraging, hippopotamuses are unsociable: each animal becomes an independent unit, except for females with dependent offspring (Estes 1991)	Separate boxes indoors
		High population density in water can be dangerous to young individuals, which could be trampled (Estes 1991)	Sufficient size of the reservoir allowing the animals to hang out separately
		A typical herd consists of 10-15 individuals, but its size could vary from 2 to 50 individuals (Estes 1991)	as specified in 'zoological data'
		An average density: in a lake-7 hippopotamuses on every 100 m of coastline, and 33 individuals on every 100m of a river bank (Laws 1984)	As specified, from 3 to 14 m of coastline for each hippopotamus

		Zoological data	Project guidelines
Behaviour	**Social organisation**	The highest density of population is during the dry season. During rains hippopotamuses can roam far distances from water reservoirs (Kingdon 1979; Laws 1984; Verheyen 1954b; Karstad and Hudson 1986)	Stable exhibition, constant volume of water in the reservoir
		Mature bulls control 50-100 m section of a river or 250-500 m of a lakeshore and shallows, regarding the area as their private territory (Laws 1984)	As specified for rivers (50-100 m)
		Territorial males tolerate other young males (before puberty) unless they try to compete and show sexual activity. When the young males become rivals they are fiercely forced out of the territory (Estes 1991)	Potential possibility to keep two males; preferably with two separate enclosures
		Hippopotamuses communicate with smell, hearing, touch, loud roaring. Spreading dung and urinating on land plays a key role in their social life (Frädrich 1967; Kingdon 1979; Oliver and Laurie 1974)	water filters required
		Visual signals play a key role in daylight: yawning, rubbing against each other, building dung mounds	Inform the visitors (signs) about the dung mounds
	Activity/locomotion	Hippopotamuses feed during a night and rest digesting (chewing) in daylight (Estes 1991; Klingel 1991)	Smaller size of exhibition as compared to natural habitat's size
		Move along paths as long as 2.8 km (Estes 1991; Klingel 1991)	Designing the paths in the enclosure
		They forage about 5 hours a day usually travelling as far as 3-5 km, the maximum distance is 10 km (Klingel 1991)	During pasturage, hippopotamuses travel further than cows
		When diving, they close the nostrils and roll the ears. When surfacing, they open the nostrils breathing out and spread water with ears crating 'showers' (Estes 1991; Klingel 1991)	Build a glass partition in order to expose hippopotamuses under water
		Usually stay under water for 104 s, but are able to hold for 5 minutes (Kingdon 1979)	
		They are good swimmers but can also gallop up to 30 km/h in an emergency, although a jouncy trot is normally the fastest gait (Estes 1991)	
		They can climb steep banks, yet cannot jump and are reluctant even to step over obstracles (Estes 1991)	Steep banks of reservoir and obstacles can be the boundary of exhibition
	Territorial behaviour	Territorial bulls have frequent ritualized encounters: after approaching the common boundary, they stop and stare at each other, then turn tail, elevate their rumps, and shower dung and urine over each other with rapidly paddling tails, following which they withdraw (Laws 1984)	Two territorial males can be exposed in two separate areas divided by a small barrier (tree trunk)
		Building dung mounds within territories (Bourlière and Verschuren 1960; Oliver and Laurie 1974; Verheyen 1954b)	Inform the visitors (signs) about the dung mounds

		Zoological data	Project guidelines
Behaviour	**Agonistic behaviour**	Territorial males do not tolerate each other and are often cruel to young males (attack and kill them) (Verheyen 1954b)	Provide a place to escape for the young hippopotamus (inaccessible for the adult male)
		Mothers can attack males to protect their offspring. Young males can be seriously injured or die in this attacks (Oliver and Laurie 1974)	
		Males begin testing themselves by the time they become adolescent at 7 years (Frädrich 1967; Guggisberg 1961; Hediger 1951; Kingdon 1979; Laws 1968; Laws 1984; Laws and Clough 1966; Luck and Wright 1964)	Inform the visitors (signs)
		Aggression is most frequent and intense during the dry season, when living conditions become hard (lower water volumes and higher density) animals often become aggressive (Oliver and Laurie 1974)	Create a stable exhibition, no changes in water volumes
	Reproduction	When copulating, the male pursues the female into water until she turns and clashes jaws with him, then forces her into prostrate submission, whereupon mounts; the female's head is often forced underwater, and when she raises it to breathe, the bull may snap at her (Kingdon 1979; Klingel 1991)	Gently slope banks; the depth along the banks should be no more than 1.5 m
	Maternal behaviour	Before delivery the female alienates from the herd on land or in shallow water and rejoins it after 10 – 14 days (Laws 1984)	Ensure a closed part of the exhibition for the delivering female (14 days)
		Offspring are adapted for nursing underwater (Laws 1984)	Build a glass partition in order to expose hippopotamuses under water
		Small calves may be left in the 'crěches' guarded by 1 or a few hippos (Verheyen 1954b); in the ' crěches the offspring is playing and chasing one another (Estes 1991)	Inform the visitors (signs)

Fig. 2 . Small calves may be left in the 'crěches' guarded by 1 or a few female hippos (Christine and Michel Denis-Huot 1995)

Information about common hippopotamus' behavior describes the shape and equipment of the exhibition in more detail. It describes social interdependencies within a group of hippopotamuses and the necessary arrangements to be done in order to observe natural animal behavior and avoid pathologies. Direct guidelines determine the following: requirements: a sufficient space to rest (size of the area, separate cells, size and depth of water reservoir), minimum length of the shore line, need to maintain a stable water level in the reservoir, need to filter the water, shape of the reservoir's shores, need to provide a separate enclosure for each male and a nursing enclosure for a female (for 14 days since delivery). Moreover, the information tells us how to arrange the surrounding of the exposition in order to suit the visitors needs such as building a glass partition wall in the side of the water reservoir as well as what kind of information should be placed on information signs.

Table 3. Initial project guidelines-results of common hippopotamus' zoological data (Biotic interdependencies - symbiotic interrelations) analysis.

	Zoological data	**Project guidelines**
Biotic interdependencies (symbiotic interrelations)	Fish clean the hippopotamus' skin at the same time feeding on it; hippopotamuses help them stretching fingers and stand astride. This allows the fish to clean hardly accessible parts of the hippopotamus' body. Hippopotamuses often visit a 'car wash' that is a place where fish are gathered (Deeble and Stone 2001)	Build a glass partition in order to expose hippopotamuses under water in the reservoir (internal and external exhibition)
	Sharks fish of the carp family are the main cleaners (Deeble and Stone 2001)	
	Barbel *Barbus barbus* fish feed on dung and clean the gaps in hippopotamus' feet (Deeble and Stone 2001)	
	Small cichild fish feed among the tail's hair (Deeble and Stone 2001)	
	Garra fish clean scratches (Deeble and Stone 2001)	

Analysis of biotic interdependencies confirms the necessity to filter water in the reservoir in order to preserve clear water. This will allow the visitors to watch the animals under water as well as to create symbiotic relations between the hippopotamuses and fish. To allow visitors to watch this interaction, it is necessary to build a glass partition wall in the side of the water reservoir.

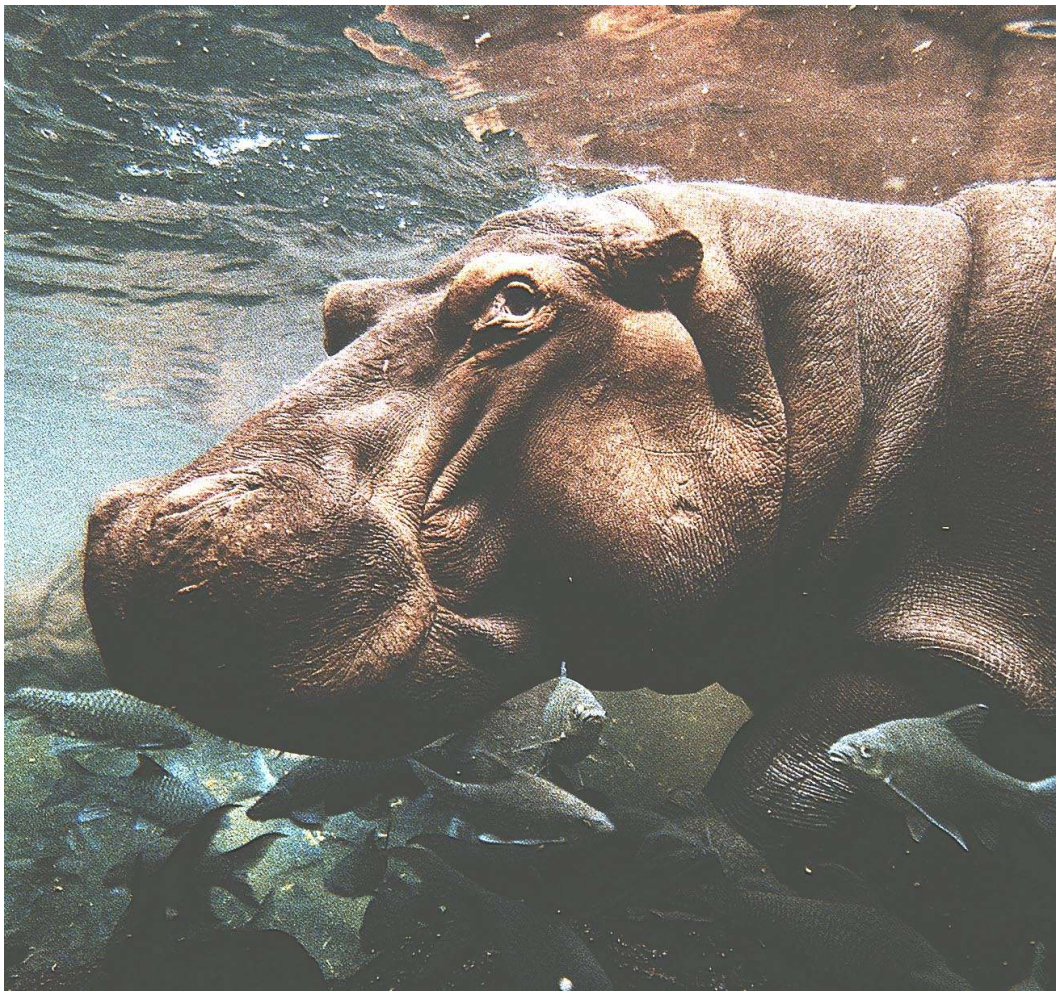

Fig. 3. Fish clean the hippopotamus' skin at the same time feeding on it (Deeble and Stone 2001)

CONCLUSIONS

1. The data obtained in this research allowed for establishing guidelines for organisation of exhibitions for common hippopotamus in zoological gardens as well as identifying basic project guidelines.
2. Another stage will be establishing project guidelines based on zoological and project data
3. The data can be confirmed by an on site inspection in selected zoological gardens. Selected in common hippopotamus exhibitions should have water filtering facilities operating non stop
4. Based on the information concerning natural habitat, it can be noticed that constant and sufficient volumes of filtered water (not influenced by draught periods and shrinking reservoirs) significantly reduce hippopotamus' aggression.
5. Symbiotic interdependencies with fish require clean water in order to ensure favourable conditions for the fish and allow visitors to watch the cleaning process.
6. The results allow for a draft of the exhibition and its elements such as: size of the area, size and depth of water reservoir, shape of the bottom and shores of the reservoir, arranging the fence and surroundings of the exhibition as well as functional division of the enclosure.

REFERENCES

Bourlière F. and Verschuren J., 1960: L'ècologie des ongules dunParc National Albert. Ins. Parcs Nat. Conge Belge, Brussels, 2 vols

Deeble M., and Stone V., 2001: Hipopotamy [in:] National geographic Polska, nr 11 (26): 32-47

Estes R.D. 1991: The Behaviour Guide to African Mammals. Including Hoofed Mammals, Carnivores, Primates. The University of California Press

Field C., R., 1970: A study of the feeding habits of *Hippopotamus amphibius* Linn. in the Queen Elizabeth National Park, Uganda, with some management implications. Zool. Afr. 5: 71-86

Frädrich H., 1967: Das Verhalten der Schweine (Suidea, Tayassuidae) und Flusspferde (Hippopotamidea). Handb. Zool. 8(26): 1-44

Guggisberg C., A., W., 1961: Simba, the Life of the Lion. Cape Town: Howard Timmins.

Hediger H., 1951: Observations sur la psychologie animale dans les Parcs Nationaux du Congo Belge. Ins. Parcs Nat. Congo Belge, s. 4

Karstad E. L. and Hudson, R. J., 1986: Social organisation and communication of riverine hippopotami in southwestern Kenya. Mammalia. 50: 153-164

Kingdon J. 1979: The Kingdon field guide to African Mammals. Academic Press, London and New York: Natural World

Klingel H. 1991: The social organization and behaviour of *Hippopotamus amphibius*. African Wildlife: Research and Management: pp 73-75

Klingel H. 1995, Fluctuating fortunes of the river horse. Natural History 104(5): 46-57

Laws R., M., 1968: Dentition and aging of hippopotamus. E. Afr. Wildl. J. 6: 19-52

Laws R., M., 1984: Hippopotamuses. [in:] Macdonald 1984a: 506-511

Laws R. M., Clough G. 1966: Observations on reproduction in the hippopotamus *Hippopotamus amphibius*. [in:] Comparative Biology of Reproduction in Mammals ed. I. W. Rowlands, 117-140. London: Academic Press

Luck C. P. Wright P. G. 1964: Aspects of the anatomy and physiology of the skin of the *Hippopotamus amphibius*. Quarterly Journal of Experimental Physiology 49(1): 1-14.

Oliver R.C.D., Laurie W.A. 1974: Habitat utilisation by hippopotamus in the Mara River. E. Afr. Wildl. J.: 12, 249-271

Verheyen, R. 1954b: Monographie éthologique de l'hippopotame. Brussels: Institut des Parcs Nationaux du Congo Belge

Streszczenie: *Wybrane problemy urządzania terenów ekspozycyjnych dla hipopotamów nilowych.* Celem pracy jest wyszukanie i analiza głównych danych zoologicznych o hipopotamie nilowym, które są podstawą do określania zasad urządzania ekspozycji dla grupy (rodziny) hipopotamów nilowych wraz z towarzyszącymi gatunkami. Informacje z literatury takie jak: dane biologiczne o hipopotamach, naturalne środowisko, behawior (organizacja społeczna, przemieszczanie się, zachowania terytorialne, zachowania obronne, rozmnażanie, zachowania macierzyńskie), współzależności biotyczne (związki symbiotyczne) posłużyły do wyodrębnienia kilkunastu wskazań projektowych niezbędnych do stworzenia ekspozycji w ogrodach zoologicznych. Uzyskane wyniki są pierwszym etapem do określenia zasada urządzani ekspozycji, która będzie odzwierciedleniem habitatu hipopotama nilowego.