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## BEHAVIOUR OF THE BABIRUSA (*BABYROUSA BABYRUSSA*) WITH SUGGESTIONS FOR HUSBANDRY

by

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### INTRODUCTION

The babirusa is a remarkable pig, endemic on the Indonesian islands of Sulawesi, Buru and the smaller Sula and Togian islands. The single species of the genus is divisible into three living subspecies: *Babyrousa babyrussa babyrussa* (Sula Islands and Buru), *B. b. togeanensis* (Togian islands) and *B. b. celebensis* (Sulawesi) (GROVES, 1980), of which only the latter is currently represented in captivity. The species is listed in the IUCN Red Data Book as vulnerable (International Union for the Conservation of Nature and Natural Resources, 1978) and can be considered a marker animal for the disturbance of the primary rainforest. The Indonesian Department of Forest Protection and Nature Conservation (Perlindungan Hutan dan Pelestarian Alam: PHPA) has given it the second most important priority after the Indonesian rhinos.

Very few observations have been made of babirusa in the wild. One behavioural study on five animals was performed on Pangempan, one of the Togian islands (SELMIER, 1983) and recently video recordings of wild babirusa were made on the northern mainland of Sulawesi (PATRY & CAPIOD, 1989; PATRY, 1990). A few other behavioural studies have been made on captive animals. These have been limited to social behaviour between very small numbers of captive animals or are preliminary accounts of observations on larger groups (BOWLES, 1986; MACDONALD et al., 1988).

The present paper reports the results of studies carried out on a large number of babirusa. Observations were made in Antwerp Zoo in Belgium and in the Zoos at Surabaya and Jakarta in Indonesia. These institutions represent 3 different ways in which the babirusa are currently kept in captivity.

In Antwerp Zoo, each animal has its own enclosure; Surabaya Zoo keeps the animals in large groups and Jakarta Zoo houses them in pairs. Each of these different housing techniques had its own implications on the behaviour shown by the animals and this allowed us to make suggestions for their future husbandry.

#### MATERIAL AND METHODS

Observations were made on 76 babirusa in three zoos, 19 animals in Antwerp Zoo during 1988-1991, 44 animals in Surabaya Zoo during the summers of 1987 and 1988 and 13 animals in Jakarta Zoo, also in July and August of 1987 and 1988. Behavioural differences were clearly related to the physical environment in which the animals were kept. It is important therefore to provide a short description of the pen layout and construction in each zoo.

##### *Antwerp*

The animals in Antwerp were usually kept in separate enclosures. The female was only put with the male when she was in oestrus. Mother and infants shared the same pen until the piglets were 6-7 months of age, at which age they were separated and each piglet provided with its own enclosure. Two separate buildings housed the babirusa. Adult breeding animals were kept in a building with six indoor enclosures each with a concrete floor area of 3.4 by 2.0 m, and an adjoining roofed outdoor enclosure measuring 3.4 by 5.1 m. The first 70 cm of the floor of the outside enclosure was brick and the remainder filled with loose white sand. The outside pens were separated from each other and from the public by a wire mesh fence, 2.4m high. The outside pens were connected with one another by means of 70 cm wide doors of the same wire mesh material. In addition a horizontal steel bar, 80 cm high and 70 cm in front of the cage was located between the public and the animals. The young animals were housed off exhibit in 8 newly built stables with outside enclosures. The concrete floor of each indoor pen measured 2.0 by 2.9 m and had an open outdoor enclosure of 2.0 by 3.7 m. The first meter of the floor of the outdoor enclosure was concrete, and the remainder was filled with the same loose white sand as was used in the adult pens. The outside pens were separated by 1.6m high concrete walls and connected to each other by a 1m wide steel gate with vertical bars 8 cm apart.

The animals were fed at 9.00 hrs and 16.00 hrs. Twice a week, the animals were provided with branches and tree trunks; grass was given during the summertime. The pens did not have a mud wallow or a bathing pool. Throughout the year, the babirusa were sponged down with lukewarm water and in hot weather they were hosed down. Fresh straw was provided for bedding daily. A half square meter of floorspace in the indoor enclosure had underfloor heating.

#### *Surabaya*

In Surabaya Zoo, the animals were usually held outdoors in one large group. Females were sometimes separated for mating or prior to parturition. Occasionally, gates were used to subdivide the animals in four adjacent pens. A small pool, several small concrete shelters and a raised concrete feeding platform was available to the group in each pen. At regular intervals, areas of the pen flooded naturally or by pool overflow and were used as wallows. A single feed was given at 8.00 hrs. No bedding was provided.

#### *Jakarta*

In Jakarta Zoo, the animals were generally kept in pairs but the males were rotated after each litter. The accommodation consisted of five outdoor pens situated adjacent to one another, with a sixth outdoor pen off exhibit. Solid walls about 1.8m in height separated four of the pens, the last being divided by a wire mesh fence about 1.2m high. The pens, which were grass covered in parts were higher at the back than at the front. This resulted in the front of the pen being 2m below ground level. Each enclosure was provided with a small pool (2m<sup>2</sup>) and a concrete shelter. The trunks of trees in the pen were protected by wire mesh. A single feed was given at 8.00 hrs. No bedding was provided.

#### *Behavioural observations*

On most occasions, the animals were observed from the public foot path. Detailed observations of the external signs of oestrus, ingestive behaviour and maternal behaviour were made from within the enclosures. Oestrus was observed in 12 females on a total of 37 occasions with the 8 females in Antwerp being studied on at least 3 occasions each. The preparturition and neonatal periods were observed on 9 occasions. On one occasion, the birth of the piglets was recorded using infra red lighting and a time lapse video camera (15 seconds were recorded at 45 second intervals). The distribution of births over 24 hours was derived from records kept at Antwerp since 1974.



The daily activity pattern of 36 babirusa at Surabaya Zoo was observed during the dry season in August 1988. Two detailed studies were carried out; in the first the activities of each individual was noted at 30 minute intervals from 4.30 until 18.00 hrs throughout the day; in the second, the activities of 6 individual animals were recorded every minute from 7.00 to 17.00 hrs. The behaviour categories noted were the following (after BOWLES, 1986):

- Lying                      awake or asleep
- Foraging/Walking      defined as the animal putting its nose to the ground in an attempt to find food. This is usually accompanied by low grunting noises.
- Wallowing                either in mud or water
- Mating

We have structured this paper as a report of the observations from Antwerp Zoo, but where the results from either Surabaya or Jakarta Zoos do not concur with, or are additional to the Antwerp studies, we have specifically drawn attention to these.

## RESULTS

### *REPRODUCTIVE BEHAVIOUR*

#### *Oestrus and mating behaviour*

In the non oestrus female the two labiae of the vulva were thin (less than 5 mm), longitudinally wrinkled and in intimate contact with one another. The vertical axis of the vulva was reduced in length causing the thin wrinkled labiae to pout slightly in the middle. In the oestrus female (Plate 1, left) the labiae were swollen to twice the non oestrus size, increasing in length and thickness. The skin surface was stretched, fleshy, more pink in colour and the labiae were slightly everted, exposing the mucus membranes. Fluid was discharged from the vulva. Often, some of this material moistened the ventral surface of the tail and was distributed by its movements in a semi-circular arc over the posterior of the animal.

In Surabaya, one of the first things the adult males did after they woke up in the morning was to check all the females by nosing their perineal region. The females responded to this by arching their back and defecating and/or urinating. The male put his nose into the stream of urine or nosed and mouthed the faeces.

When a female came into heat the male would follow her, keeping his nose close

to the perineal region and making deep clucking noises at a frequency of 3-5 per second. If the male that initially started following the female was a subordinate male, the dominant male would immediately take over and follow the female himself. If the female was not in oestrus, the dominant male abandoned her almost immediately. If she was in oestrus or coming into oestrus the female would often run away pursued by the male and attempt to hide in a shed or behind other babirusa. If closely pursued by the male she would sometimes lie down in an apparent attempt to prevent mating. When the male was chasing the female, he would raise his head sharply towards other males and thereby seemed to keep them away.

In almost every instance, in Antwerp and Surabaya, the pursued female would at some stage turn to face the male. One or a combination of several behaviours were then observed; the female vocalised in a continuous stream of sound; she pushed her nose against the nose of the passive male; the female could place her snout under the chin of the male and press upwards with the male resisting this pressure but not pushing down enough to press her head lower; she nibbled at the upper forelimb of the male; she nuzzled and licked the skin of the boar's face and behind his ears. It was the female which terminated these behaviours by turning around and walking off, closely followed by the clucking male. On some occasions the male would lie on his side in front of the female and she would then nuzzle and lick the skin behind his ears, the skin of his belly, prepuce and inside legs. The male seemed to respond by adjusting his position to allow her easier access to his ventral surface.

These aspects of the behaviour appeared in different combinations and could repeat themselves several times.

At some stage, the male eventually approached the female from behind, nuzzled her perineal region and put his chin on her lumbar region. If the female was not in full oestrus, she responded by vocalising in a loud continuous stream of sound. She would not stand still but bent her legs, wriggled out from under him and ran away. Subsequently, the whole behaviour spectrum of pushing nose to nose, putting the snout under the chin of the male and nibbling his forelegs reappeared in a seemingly random order. If the female was in full oestrus, she would immediately stand still after feeling the weight of the male's chin on her back and she would allow the male to mount. During the actual mating, both male and female made short staccato clucking noises, but the male vocalised louder than the female. In Antwerp, one copulation session that was more closely observed took about 15 min. During this time, the boar mounted 4 times and each mounting lasted for 48-61 seconds. These sessions were repeated several times during the day. Two other intromissions that were timed lasted 3 minutes and 7 minutes respectively. One mating observed in Surabaya occurred over about 5 minutes and the male appeared to have 4 ejaculations. Before each ejaculation,

the male would thrust about 10 times at a rate of two thrusts per second. After copulation, the male dismounted and stood by her as she lay down. He threatened every babirusa, especially the males, that came near. After about 30 minutes he left the female. In Surabaya Zoo, oestrus females were then mounted by several other males. The female herself did not seem to show any particular choice of mating partner, but the dominant male ensured that he was the first to mate her, keeping all other males away until he had done so.

*End of gestation, parturition and neonatal period*

About 30 days before parturition the female became more antagonistic towards the keeper. The vulva tended to increase in volume and the labiae were swollen, pinkish and stretched, fleshy, more pink in colour and slightly everted, exposing the mucus membranes (Figure 1, right). Fluid was discharged from the vulva and the udder became very prominent. In a group of 14 females, 14 births were recorded. In a group of 14 births for which date of delivery is recorded, 14 births

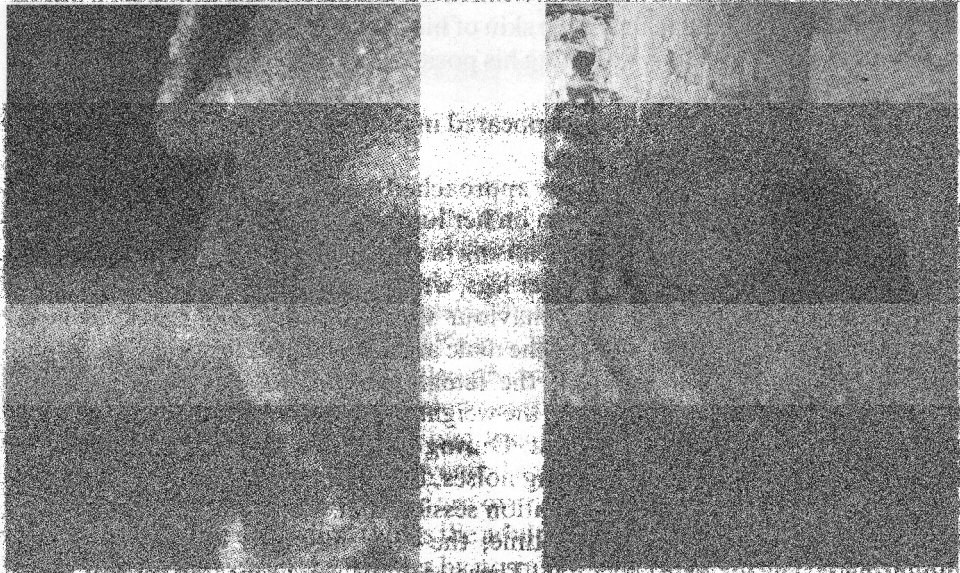


Figure 1. Left: The vulva of an oestrous female demonstrating that the labiae are swollen, and slightly everted exposing the mucus membranes  
Right: A female one day before parturition showing the swollen labiae of the vulva and the prominent udder

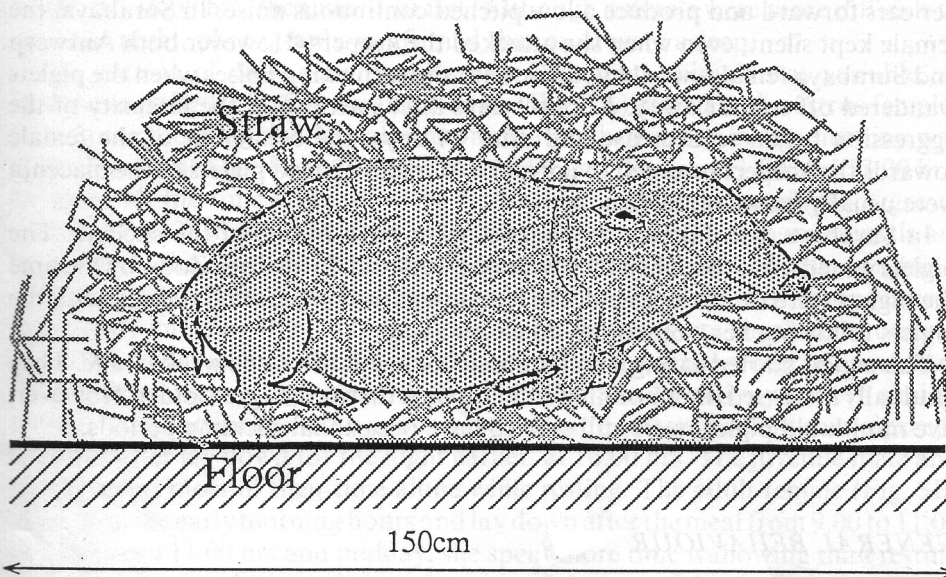


Fig. 1 –The parturition nest of a babirusa

took place between 18.00 and 8.00 hrs and 2 births happened between 8.00 and 18.00 hrs. One delivery of the first group was recorded on video. The female lay on her side when she delivered each of the three piglets. The second was born 4 minutes after the first and the third 23 minutes after the second. The first and third piglets were very active and tried to stand and walk around immediately. The second however hardly moved at all and 5 minutes after birth it showed convulsions and died. Between deliveries, the female stood up and walked around the inside enclosure without apparently paying particular attention to the piglets. She did not lick them dry or attempted to keep them close to her. She inspected the dead piglet once or twice with her nose but then seemed to ignore it and finally lay down on top of it. The initiative for suckling behaviour seemed to be taken by the piglets after the third piglet was born. In Jakarta and Surabaya the piglets were observed to initiate suckling by nuzzling either the female's snout or teats. She would then lie down on her side and expose her udder.

During the first 9 days after parturition, the females were very aggressive; they defended their piglets and attacked other animals and the keeper, when they came too close. In Antwerp, when the door to the inside enclosure was opened the mother usually positioned herself in front of the piglets so that the piglets stood either behind or underneath her. Whenever she felt threatened, she would point

her ears forward and produce a low pitched continuous noise. In Surabaya, the female kept silent, even when she attacked the keepers. However both Antwerp and Surabaya females would vocalise with short clucking noises when the piglets wandered off too far away. About 9 days after parturition the intensity of the aggression began to decrease and after 14 days, the behaviour of the female towards the keepers returned to normal. No traces of dead piglets or the placenta were usually found in the pen.

In Surabaya and Jakarta the females gave birth in one of the shelters. The piglets would leave this when they were one week old. In all three Zoos, by the time the piglets were three weeks old, the female was moving around the pen with the piglets following her, sometimes up to 2m away.

The piglets started eating small amounts of solids after one week of age. They gradually increased the amount of solids in their diet as they grew older. However, five month old piglets were still seen to have occasional suckling periods.

### GENERAL BEHAVIOUR

#### Daily activity

The general pattern of behaviour of a group of 36 babirusa in Surabaya was that animals slept at night and showed a greater range of activity during the day. Just before sunrise animals began to wake up and start walking around and foraging (Fig. 2). Only a very small proportion of the animals were seen lying down between 8.00 and 9.30 hrs because the food was given at this time and foraging was the main activity. There after, the foraging behaviour declined and animals rested or started to wallow. Wallowing behaviour was demonstrated mainly between 9.00 and 14.00 hrs, with an apparent peak from 11.30 until 13.00 hrs. After midday animals increasingly began to lie down until almost all were asleep by

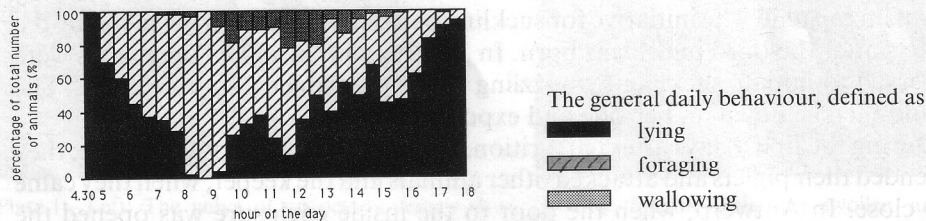


Fig. 2 – The general daily behaviour, defined as lying, foraging, wallowing of a group of 36 babirusa in Surabaya Zoo from 4.30 until 18.00 hrs

17.00 and 18.00 hrs, the time of sunset. Although animals were more difficult to count at night, photographs confirmed that most were asleep.

The pattern of daily activity shown by individual animals was variable, as illustrated in figure 3. The dominant male (Fig. 3A) mated with oestrus females only in the morning and late afternoon. Mating behaviour in the morning was interrupted when the food was offered at 8.00 hrs. Between 11.00 and 13.00 hrs, he spent all the time lying down or wallowing. Although the graph of group activity (Fig. 2) shows that from 14.00 hrs onwards more and more animals are lying down, the dominant male became more active and started mating again.

The now elderly formerly dominant male spent most of his time resting except in the early morning when dunging took place, females were checked for oestrus and food was available. He did not associate with the main group but preferred to remain solitary or together with another old male. An activity pattern similar to that of the dominant male was observed with an adult subordinate male, except that the latter lay down for the night earlier, at 16.00 hrs. The juvenile male and female spent most of their time alone while resting. The adult female (Fig. 3B) foraged in the early morning hours and lay down after the meal from 9.00 to 11.00 hrs. Between 11.00 hrs and midday, she spent more time wallowing than resting but thereafter lay down and slept for most of the rest of the day.

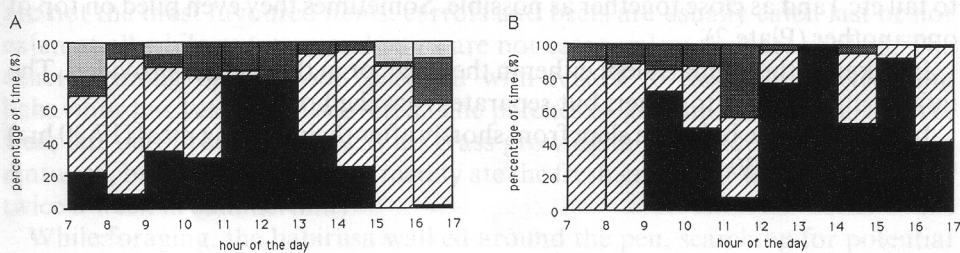


Fig. 3 –The pattern of activity, defined as lying, wallowing, foraging and mating of two individual animals in Surabaya Zoo from 7.00 until 17.00 hrs.  
 A: The dominant male  
 B: A non-oestrus female



### *Sleeping*

In Antwerp, the animals always had free access to their outdoor enclosures by means of a flapping door. In the indoor enclosures, straw was provided for them to sleep in. For short resting periods in spring and summer, the animals usually chose to lie on top of the sand in a particular corner of the outdoor enclosure where they could lie in the sunlight. In Surabaya Zoo the babirusa usually slept through the heat of the afternoon (Fig. 2). It was always the males that initiated the resting periods. Thus they had the first choice of resting places and they preferred to sleep in the same areas of the pen in groups together. The Antwerp babirusa used the indoor enclosure for most of their night time sleeping, sometimes sleeping outside on hot summer days. Autumn and winter periods of daytime rest were spent in the indoor enclosures. Both males and females built sleeping nests with straw and branches. The nests were constructed by carrying packages of straw in the mouth to a corner of the enclosure. This continued until all the straw was piled up into one big heap. The animals then kneeled and crawled under the straw head-first thereby creating a tunnel through the straw. The dimensions of the nest varied with the amount of straw provided, but most sleeping nests were about 1.5m x 1m and 0.5m high. The farrowing nests built by pregnant females seemed to have the same general construction but were a bit larger: 1.5m x 1.5m and 0.75m high. The babirusa slept in 3 positions: lateral recumbency, ventral recumbency with the legs folded under their body and ventral recumbency with the front and hind legs stretched out.

When an oestrus female shares the pen of a male they always sleep in close contact with one another, often lying side by side and head to tail. In Surabaya, the babirusa slept together in groups, in shallow depressions made in the earth. They lay in all sorts of positions (on side, on belly, head to tail, head to head, tail to tail etc.) and as close together as possible. Sometimes they even piled on top of one another (Plate 2).

In Jakarta, the animals slept either in the open, or in the shelters provided. The infants always slept together, but separate from the boar.

In Antwerp, the babirusa slept from shortly after their evening meal (17.30 hrs) till about 7.00-7.30 hrs.

### *Foraging behaviour*

Rooting behaviour on dry or compact ground has so far never been observed. Rooting did occur in the loose sand of the outdoor enclosures in Antwerp but whether this behaviour had a foraging function was not clear. In Jakarta, the animals were seen to turn over logs and stones with their snouts. The animals in

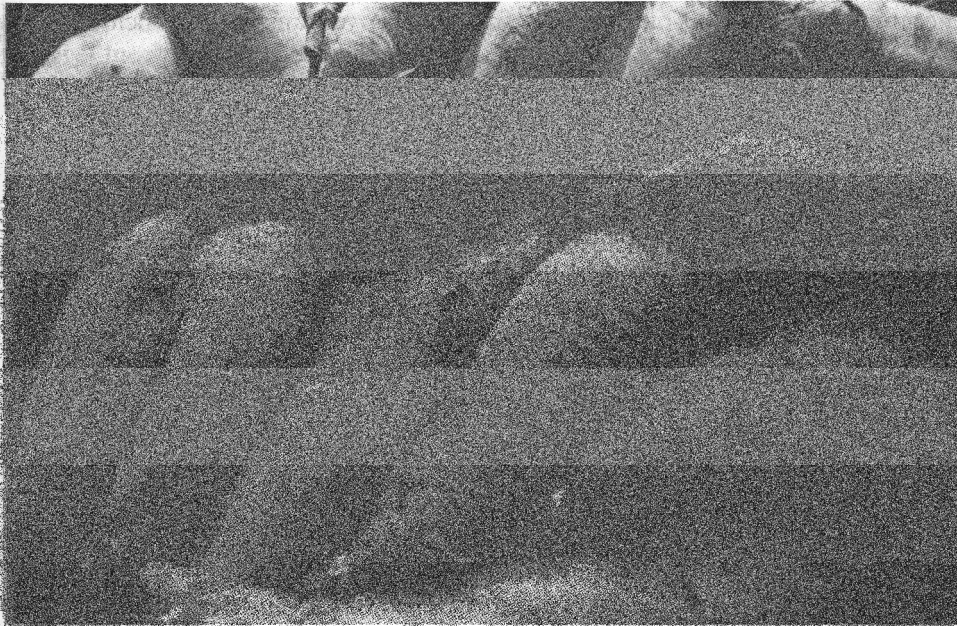


Figure 2. A group of sleeping babirusa in Surabaya Zoo.

Surabaya put their snouts deep in the mud of wallows to come up with a mouthful of this material that then seemed to be sieved: the material was handled within the mouth, while most of it trickled back out at the sides. Babirusa in captivity are offered a variety of roots (carrots, beets, cooked yams and potatoes etc.) but these are not the most favoured items: carrots and beets are usually eaten least or not eaten at all while potatoes and yams are not eaten unless they are cooked. The exact meaning of this food selection with regard to their natural foraging behaviour is yet to be determined. The natural grass in the pen of Jakarta was left unpalatable. There was no grass growing in the outdoor enclosure in Quowarp, but here the babirusa readily ate the fresh grass that was given to their keepers a week in summertime.

While foraging, the babirusa walked around the pen, searching for potential food items with their nose very close to the ground while the rhinarium was continuously twitching. In captivity, this behaviour was displayed to search for hidden food items of their main meal that got scattered around in the enclosure, or to pick up potential food items (leaves, seeds, fruits etc.) that entered their enclosure from the surrounding environment (overhanging trees or shrubs) or were thrown in by the public (eg. peanuts in Surabaya and Jakarta). In Jakarta,

the animals will try to pluck leaves from trees overhanging the enclosure by standing on their back legs and leaning against the fence with their front legs. In neither of the other zoos do the animals have access to shrubs or small trees in their enclosure. However, when branches are given to them by the keepers they will pluck off the leaves and buds or scrape off the bark.

Babirusa, like other pigs, are omnivorous and will hunt for small mammals and birds. Babirusa in Antwerp and Surabaya have caught mice and pigeons that accidentally entered their enclosures. They will also chase and eat baby babirusa if they gain access to their pen. Babirusa are relatively agile and have been seen to run rapidly and turn around very quickly if given enough space. In Surabaya, two young babirusa (6 months) regularly escaped from, and returned to, their pen overnight by climbing the 120 cm fence.

When there is competition for food in Surabaya (for instance when the visitors feed scraps) the most dominant male will take the food. A female will not touch the food if a male is too close.

#### *Ingestive behaviour*

The upper and lower incisors of the babirusa played an important role in the ingestive process. The upper incisors are curved backwards, and hold the food item. The tongue assisted keeping the item in place while the chisel-like lower incisors slid forwards and upwards into the material to chop off the piece that is in the mouth. The tongue then moved this piece to the back of the mouth for grinding. The use of the almost horizontally arranged lower incisors was evident and demonstrated when the animals ate bark from branches: the branch was caught and held tight with the upper incisors and the tongue, while the lower incisors scraped along the branch and peeled off the bark. If the strip of bark could not be bitten off, the animal held the branch down with one of its front legs and tore the strip of bark off with an abrupt swing of the head. The holding down of food items with one of the forelegs is a general technique that the animals used whenever they wanted to eat a large food item that couldn't be bitten to pieces easily (plucking leaves/buds of branches, eating lettuce etc.) or when a food item needed to be kept steady because precision was required (eating corn off the cob, peeling nuts, bananas etc.)

The babirusa jaw is strong and can crack very hard nuts. For instance, when eating dates they first ate the soft part and spat out the pit. However, if all the other favoured food items had disappeared, they very often came back to the pit, picked it up, ground it and ate it. For grinding, mostly straight up and down movements were used with very little lateral displacement on the lower jaw.



### *Dunging*

males went around inspecting by both smell and taste the freshly voided material. The large adult males also inspected the vulva of every female when she moved to this area of the pen.

In Antwerp the babirusa usually went to the outside enclosure to defecate and/or urinate. However, although there was no fixed dunging area in either the outside or inside enclosure, the animals seemed to prefer to defecate under branches and tree trunks. When defecating, both the males and females stood still, arched their back and bent their hind legs. Females urinated in the same position. Males sometimes stood still with all four legs straight when they urinated and sometimes kept walking around while urinating.

### *Wallowing*

where generally there was only a pool, the males appeared to use the pool to the almost complete exclusion of the females. In Surabaya Zoo males bathed singly or in groups of up to four in number. Individual males in Jakarta would sometimes spend periods of 1-2 hours in the water.

Mud wallowing tended to be a group activity with several animals apparently following the lead of an individual. Up to ten animals would lie down and slide into the mud at about the same time. It seemed that the result of the wallow was a layer of wet mud over the whole body. This rapidly dried in the heat, cracked and came off the animal as a grey dust.

### *Dominance*

Dominant and subordinate behaviour was observed in all three zoos. It was examined closely at Surabaya Zoo and the detailed results will be the subject of a separate communication. In general terms babirusa exhibited the signs of being a social animal. The males were ranked in order according to factors including weight and size. Females were subordinate to adult males and expressed that lower status variously by retreating, lowering the head or snickering almost constantly when threatened.

Subadult animals formed the third rank in the social order, and although subordinate to both males and females would also play with both. The dominant

male in Jakarta Zoo, when penned with two juvenile males would also romp and dash about the pen chasing, and being chased by them.

When adult males were placed on each side of a separating fence in Jakarta Zoo, they displayed and rushed at the fence with heads raised. They also rubbed the side of their head against the wire. Previous experience of this behaviour led Antwerp Zoo to organise the animal accommodation such that males were not housed in adjacent pens.

#### DISCUSSION AND RECOMMENDATIONS:

One of the most interesting and puzzling aspects of babirusa behaviour centred on the female's response to the boar when he detected oestrus. We found that the external signs of full oestrus are easily detected in most but not all females; some females do not seem to show any visual signs and this phenomenon of silent heat or silent oestrus has been reported in a number of species, including the domestic sow (FRASER, 1968). Recent studies have also shown that, as in other species, oestrus in the babirusa can be detected by measuring the urinary oestrogen excretion (CHAUDHURI et al., 1990). It was our impression that when in full oestrus, females are less cautious of the keepers and seem to seek human contact such as stroking and tickling. This was in marked contrast to the noise and apparent efforts to escape attention of the male when he was present. It was possible that in Surabaya the females were pursued at the earliest signs of the onset of oestrus by the males; the dominant male's persistent attentions when the female was not yet in full heat may have been driven by the inter-male competition within the pen. However, that was not the case in Antwerp Zoo. Further studies are required to examine these patterns of behaviour and the physiology underlying them.

It is clear that the pre-copulatory behaviour of male and female is highly structured. The different elements can vary considerably in frequency, length and order. How they relate to successful mating is not clear, but it seems to be of critical importance. When animals at the Jersey Wildlife Preservation Trust were kept singly and the male was introduced to the female during oestrus, the normal complex behaviour was shown. After the zoo started keeping the animals as pairs the behavioural elements of oestrus became less noticeable, although the external physical changes in the female remained evident. (BOWLES, 1986) In domestic pigs, the duration of heat in the female is reduced by the continuous presence of the male; the most successful stimulus to elicit repeated ejaculation by the boar is the presence of a new sow in oestrus (HAFEZ, 1975). This suggests that it may be wise to keep babirusa separated from each other until the female comes into

oestrus. The reason why the animals in Surabaya are not affected by all this is because males and females are kept together in large numbers. The males compete with one another for the oestrus females. The guarding behaviour shown by the dominant male is a clear sign of this competition among males. In order to ensure that his sperm fertilises the female, it is important for the dominant male to guard the female before and for a short time after the copulation; he must also mate with her at the right time. It is interesting that in Antwerp, where there are no competing males around, guarding behaviour is absent however, the males do get more aggressive towards the keepers on those days that they are together with the female; They will deny the keepers access to the enclosure.

By way of contrast, during oestrus, the male will allow the female to eat beside him and sometimes she may even eat first. However, as soon as oestrus has passed, the male becomes more aggressive when food is offered, even though he may be very docile towards the female during the rest of the day. He will invariably chase the female away and eat her portion also. The consequence is a stressed and underfed female and an overfed male. One solution is to feed the male and female separately between oestrus periods.

Nest building seems to be an important behaviour in babirusa. When material is provided, elaborate nests are constructed prior to the end of gestation. Studies of other Suidae indicate that parturition nests are a common feature and provide a thermostable environment where the neonatal piglets can lie close together or where they are warmed by the female (FRÄDRICH, 1965 & 1967). In the zoos of Jersey (BOWLES, 1986) and Antwerp (VERCAMMEN, 1991), experience has shown that it is sometimes necessary to put a heat lamp or floor heating in the parturition enclosure.

Parturition takes place after 156-161 days, with most piglets being born on the 158-159th day (VERCAMMEN, 1991). The first few days after parturition, the female is very defensive of her piglets. In all three zoos, the keepers do not enter the enclosure for cleaning or to supply food. Suckling behaviour has been described elsewhere (SELMIER, 1978; BOWLES, 1986; MACDONALD, 1991 and VERCAMMEN, 1991). Most female babirusa have 4 nipples and some have 6 (MACDONALD, 1991). The sixth and most anterior pair is thought to be non-functional but piglets have been seen to suckle this pair (VERCAMMEN, pers. comm.). In the case of one piglet, only one pair of nipples is used (BOWLES, 1986). In the case of twins, each piglet seems to use a pair of nipples; they nurse from the upper nipple first and then move to the lower one (SELMIER, 1978). It is not yet known how the suckling is organised in the case of triplets. Milk flow appears to dry up about six months after parturition. Piglets that try to suckle and cause small nibble-wounds on the females flanks and legs are chased away. In Antwerp, this is taken as the signal to separate the piglets from the mother.

Rooting in the ground with the use of the rhinarium is a predominant feature in the foraging behaviour of peccaries and most pigs (FRÄDRICH, 1967). *Hylchoerus*, and in most parts of its range *Phacochoerus* also root very little (D'HUART, 1991; FRÄDRICH, 1965), but *Babyrusa* is the only pig species that doesn't root in a more compact substratum. Their foraging behaviour, walking around with the snout close to the ground, can be encouraged by scattering their food throughout the pen, so that the animals spend more time gathering it. Branches and trunks in the pen can function as scratching posts as well as alternative material to eat. The exact function of the apparent sieving of mud by the babirusa is not clear. It is possible that the animals are looking for small invertebrates to eat. The fact that the babirusa eat invertebrates and even actively catch and eat small mammals and birds is not unusual. All pigs are omnivorous to some extent (FRÄDRICH, 1967; HAFEZ, 1975).

The technique of holding down food items with one of the fore-feet while tearing off pieces by a brusque upward toss of the head is also used by other pigs (FRÄDRICH, 1967). The cutting into sections by the lower incisors of the babirusa requires a forward and upward movement of the lower jaw. A morphological study of the skull and teeth revealed an almost non-restricted cranio-mandibular joint in babirusa, which easily allows such a movement. The joint and complex cheek teeth also allow the use of transverse masticatory movements (HERRING, 1972) However, when eating sweet potatoes, almost no lateral movement of the lower jaw of the babirusa could be observed. According to Fradrich (1967), *Sus scrofa* and *Potamochoerus* also chew without recognisable lateral movements of the lower jaw, while *Phacochoerus* does show transverse masticatory movements. A possible reason for these differences may be the type of food eaten.

Wallowing is a behaviour typical of ungulates and it probably has a skin maintenance as well as a cooling function (FRÄDRICH, 1965). The latter seemed to be important to the animals in Surabaya (Fig. 2 & 3). When it is not possible to provide a pool or wallow it was found to be satisfactory in Antwerp to regularly sponge the animals down with lukewarm water, or even to hose them down with cold water during the summer. When no bathing is available, the skin of the animals often becomes dry and starts to crack. These symptoms can be cured by rubbing the skin with baby oil.

Finally, it is clear that in order to sponge the animal down or rub it with baby oil, a close relationship is necessary between the keepers and the animal. If started young, the babirusa easily gets accustomed to its keepers. The consequence is that the cleaning of the pens can be done without locking the animals out, oestrus signs in females can be checked from close by, samples for scientific studies can be obtained more easily and medical examinations and treatment can often be

carried out without anaesthetising the animal. For instance, when the belly is rubbed, most babirusa will lie down on their side which gives the opportunity to inspect and treat small wounds or remove bandages after an operation. When the inside of a leg is rubbed, a lying babirusa will automatically lift up its leg so that hoof inspection is possible.

Close attention to babirusa behaviour will contribute to its breeding success, general well-being and further knowledge of its biology.

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## SUMMARY

Observations were made on 76 babirusa in the zoos of Antwerp, Surabaya and Jakarta. The behavioural differences observed were clearly related to the physical environment in which the animals were kept. In Surabaya, where the animals lived in a large group, males daily checked all the females for oestrus and competed for the oestrus females. Courtship was complex and the dominant male guarded the female both before and for about 30 minutes after mating. In Jakarta, the babirusa lived in pairs in adjacent pens. In Antwerp, where the animals are housed singly, oestrus was detected by the keepers and the female was then introduced to the male. When a female was in the same pen, the male would deny the keepers access to the enclosure.

The complex behaviour pattern seen prior to mating was not evident when animals were kept together as a couple all the time.

Babirusa are largely diurnal. Sleeping nests were built if nesting material was provided. When more than one babirusa was kept in a single pen, they usually slept in close contact with one another.

Babirusa did not root in compact ground. They foraged for food by walking around with their snout close to the ground. When there was competition for food, it was the dominant male which ate first. A female would not touch the food if a male was too close. The upper incisors were used to hold food and the lower incisors acted as chisels to cut through it. Almost no transverse masticatory movements could be observed.

The animals were very fond of water and mud and would bathe and wallow whenever given the opportunity.

Analysis of the patterns of behaviour enabled suggestions to be made with respect to the husbandry of the babirusa, its management and the role of the keeper.