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A digging trough as occupational therapy for Pacific Walrusses (*Odobenus rosmarus divergens*) in human care

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Summary

Walrusses in human care often show stereotyped behaviour, the most obvious form of which is circle swimming. This is probably due to boredom, resulting from a lack of occupation with feeding behaviour. In this study a digging trough with different food sources was offered to 4 Pacific walrusses. The digging trough with the food source helped to reduce the stereotyped swimming behaviour of these walrusses.

Introduction

When animals cannot or need not perform essential parts of their natural behaviour, for instance normal elements of feeding behaviour, disturbed behaviour such as injurious behaviour and stereotypes may develop. Such behaviours can be considered symptomatic of chronic stress (Wiepkema, 1987). When the animals are kept in man-made enclosures, the severity of their problems can often be reduced significantly by enabling them to have good contact with conspecifics, by enlarging and enriching the enclosure itself (Markowitz, 1982), or by giving the animals adequate human attention (Kastelein & Wiepkema, 1988). However, sometimes animals need to perform specific motor patterns as an intrinsic part of their feeding programme. For instance, when chickens cannot perform normal scratching and pecking to take in food they start to peck at conspecifics and may even damage each other by means of feather-pecking (Blokhuis, 1986). Another well-analysed example is that of pigs kept in an environment in which they cannot, and need not, root to obtain food (a common situation in present day farming). Under such conditions pigs have a strong tendency to root at each other, which may result in injuries (Ruiterkamp, 1985).

Walrusses are benthic feeders, and their food consists mainly of bivalve molluscs. Because a mature walrus eats between 40 and 80 kg of food a day (Fay, 1982 and Nelson & Johnson, 1987), it has to spend a large amount of time digging in the substrate to find and process the molluscs. Fay (1982) described a walrus with 3000 fresh bivalve siphons in its stomach and Nelson & Johnson (1987) reported furrows in the ocean floor with an average length of 47 m and a width of 40 cm, made by walrusses in search of food. There seems to be no diurnal feeding pattern in walrusses (Fay, 1982).

Because of practical husbandry difficulties, walrusses in marine parks have so far not been offered the opportunity to dig in order to collect their daily food. Presumably as a result of this most of these walrusses show disturbed behaviour, such as stereotypical swimming patterns and abrasion of their tusks (Pournelle, 1961; Pederson, 1962; Brandes *et al.*, 1074; Ruempler, 1976; Fay, 1982 and Dittrich, 1987). Often this abrasion is said to be due to the fact that the animals are housed in pools with concrete sides and bottoms. However, it seems very unlikely that this aspect is a main causal factor, since in the wild walrusses are also confronted with hard rocks on their haulout areas. It is more plausible that because of some form of chronic stress a walrus will rub its tusks against a hard surface. So far, most establishments have thought to solve this problem by removal of the tusks. This is, however, only a treatment of the symptoms, since the real cause of the abrasion may be the absence of a rooting substrate. The fact that some walrusses in a facility do not abrase their tusks, while others do, is probably due to individual variation in coping with the situation. The following observations support the foregoing considerations:

— Every day during the summer two of the walrusses at the Harderwijk Park take part in 5 educational shows (each lasting 20 min). Their tusks always grow during this season. However, in winter when the park is closed their tusks get worn down again.
— Once the animals were locked up in their roofed quarters for one night, because the level of the pool water was lowered for maintenance purposes. That night one animal ground its tusks down 2 cm.

A previous study with these animals (Kastelein *et al.*, 1989) showed that molluscs could be used to

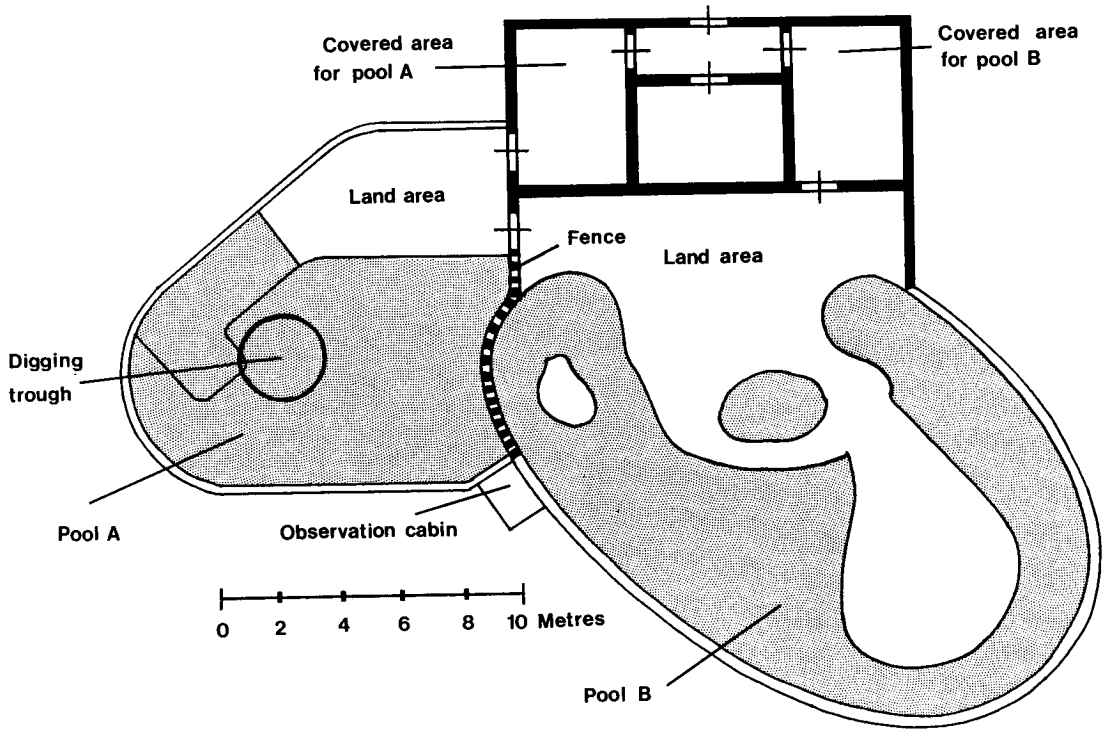

Figure 1. The study area showing the large pool (B), and the small pool (A) in which the digging trough was placed.

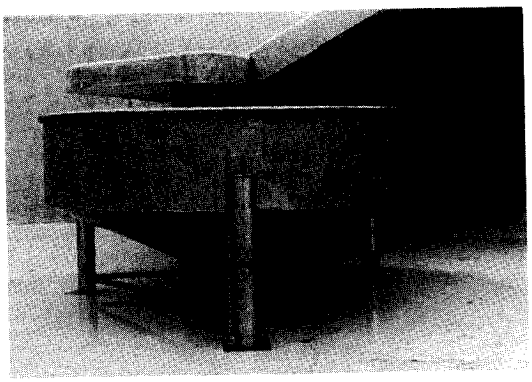

Figure 2. The stainless steel digging trough.

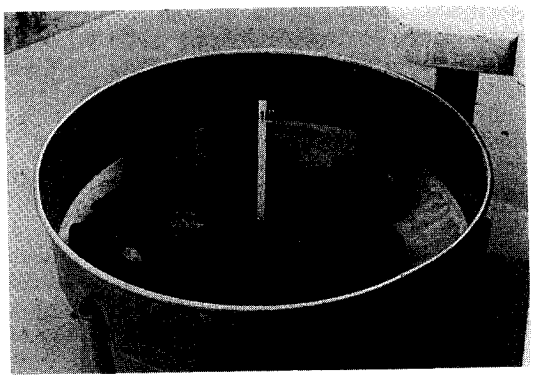

Figure 3. The digging trough filled with 20–55 cm diameter stones as used in this study.

occupy walrusses, but that this would require many feedings a day of this expensive and hard to get food source. In the present study we offered walrusses a rooting area in which the food (fish and molluscs) was hard to find, so that they had to search for it. We hoped that this would fulfil the need to root, and that it would occupy the animals with useful behaviour and therefore prevent disturbed behaviour.

Materials and methods

Study animals

The Harderwijk Marine Mammal Park houses two pairs of Pacific walrusses (*Odobenus rosmarus divergens*). One pair (codes: OrZH001 and OrZH002) was born in 1974, and the animals have been kept together at the park since that same year. The other pair (codes: OrZH003 and OrZH004) was born in

Table 1. The presence of the digging trough and food source offered during 4 test period of 8 days each

Test	Period	Duration (days)	Presence of digging trough	Food source offered in trough
1	27/10–06/11	8	—	—
2	18/11–27/11	8	×	gapers
3	30/11–09/12	8	×	whole fish
4	14/12–24/12	8	×	pieces of fish

Table 2. The duration of the two loop types that each walrus swam. S.D. = standard deviation. N = number of loops recorded

Animal	Average duration long loop (sec)	S.D.	N	Average duration short loop (sec)	S.D.	N
Adult male	37.6	3.6	17	33.3	4.8	42
Adult female	28.0	3.7	22	24.7	1.8	25
Young male	24.7	2.1	7	23.0	1.3	2
Young female	17.8	2.4	11	20.0	5.0	5

1982. These animals arrived at the park in 1985 and have been kept together since then. Each pair has its own pool.

Study area

The walrus facility consists of two separate outdoor pools with adjacent land areas which are partially covered (Fig. 1). The pools are 4 m deep. Through a fence the 2 pairs of walrusses can visually and vocally interact with each other. Moreover, they can touch each other with their flippers and vibrissae. An observation cabin, from which both pools could be observed through 2-way mirrors (to prevent disturbances to the animals), was placed next to the study area (Fig. 1).

This study was carried out in November and December 1987 when the park was closed to the public. The pool was surrounded by a fence to reduce the influence of the park personnel. The environment was kept as constant as possible. The only variables were air temperature, water temperature, wind direction and force, air pressure, and precipitation, and these were recorded four times per day. During the study the air temperature varied between −3 and +14°C. The water temperature varied between +5 and +13°C.

Food

The walrusses were hand-fed 4 times a day on their normal diet of Herring, Mackerel, Whiting, Sprat and Squid. The young pair received 15–35 kg each per day. A previous study on the same animals showed that the walrusses would eat gapers (*Mya arenaria*). This species of bivalve mollusc was also used in the present study.

Rooting trough

A stainless steel rooting trough (surface area: 5.2 m^2; depth available for substrate: 50 cm) was built (Fig. 2). This trough was placed above the drain in the small pool and secured to the concrete floor (Fig. 1). Because the bottom of the trough consisted of a grid and was shaped like a funnel, the dirty water in the trough was constantly sucked into the drain, keeping the pool water and the trough clean.

Choice of substrate

Although mud or sand would have been the ideal digging substrate, pebbles were used in order to maintain good water quality. First small pebbles (diameter: 1–1.5 cm) were put into the digging trough. Unfortunately these pebbles passed through the grid and into the water pumps. To prevent damage to the pump fans, larger pebbles were used (diameter: 2–6 cm). These pebbles created a new problem: the walrusses started to eat them in large quantities. Large terrestrial mammals, such as ant eaters, feeding on invertebrates, often swallow up to 50% debris like sand, pebbles, wood etc. (McNab, 1987). In the wild

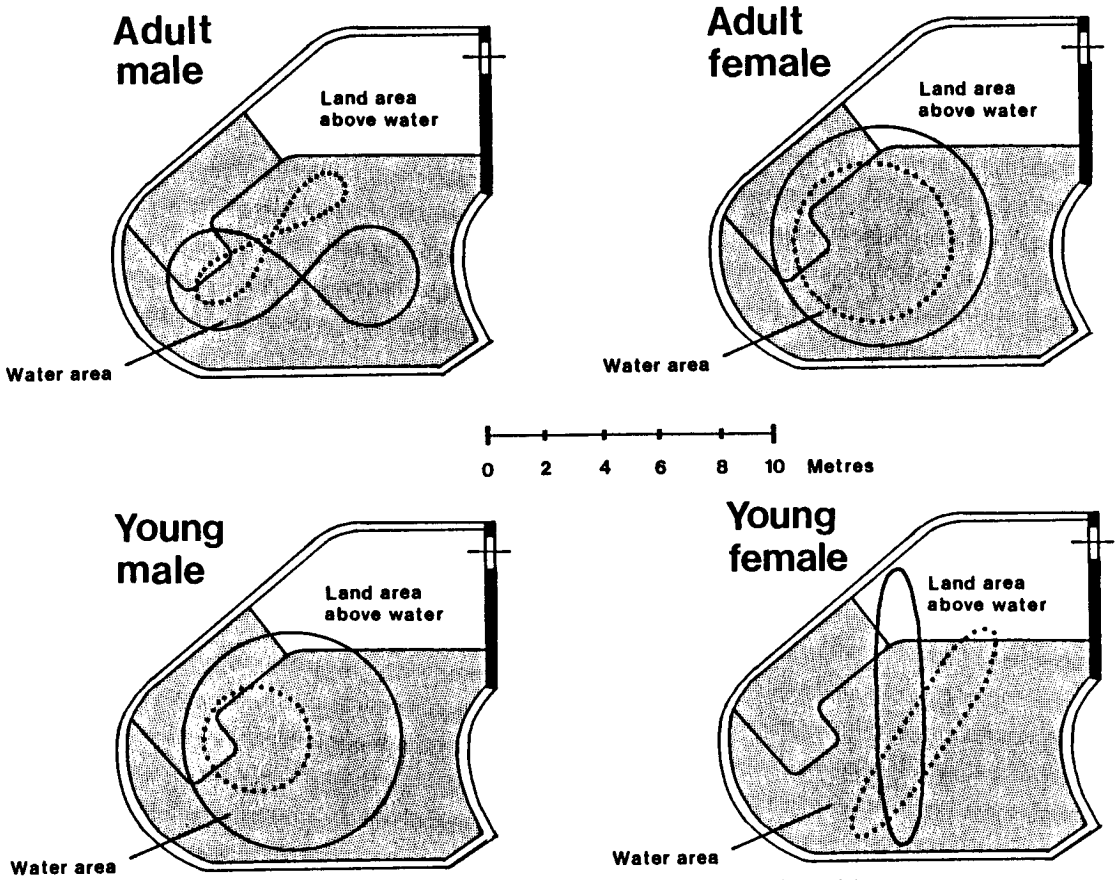

Figure 4. The shape of the loops that the 4 walrusses swam in pool A.

walrusses also eat indigestible material, but it is not clear to what extent (Fay, 1982). To prevent ingestion of pebbles, they were replaced by large stones (diameter: 20–55 cm) which could be moved around in the digging trough (Fig. 3). These stones created a rough substrate with a large surface area and lots of cracks to hide food.

Methods

The study consisted of 4 test periods, each of 8 days (Table 1). During the first test period the baseline behaviour of both pairs of walrusses was recorded. After the rooting trough was put in place the animals were allowed to get used to this change in their environment for 5 days. Then, for 8 days, gapers were put into the trough three times per day (in between the regular hand-feedings). Each time approximately 15 gapers were thrown into the trough from above the water surface. Because molluscs are difficult to obtain, approximately 50 fish (7.5 kg) were thrown into the trough 3 times a day for the next period of 8 days. Later, in order to investigate whether an increase in number of food items would increase the feeding time, pieces of fish (120 pieces, 7·5 kg) were offered 3 times a day in the trough for a period of 8 days.

Because of the large size differences the two pairs of walrusses were not put into one pool together. Because we were interested in the effect of the digging trough on both pairs of walrusses, and because only one digging trough was available, the animals swapped pools twice a day, in such a way that the young animals were in pool A (containing the trough) between 16.45 and 12.00 hrs the next day, and the older animals between 12.00 and 16.45. Each pair received 3 feedings of food in the trough during the period that they were in pool A. Because these walrusses do not show a distinct daily activity cycle this swapping probably had no influence on the comparison of data recorded during the morning and afternoon.

Observations

During all 4 test periods the following behaviours were recorded: rest on land; rest in the water; regular circle swimming; examining the pool's floor; rooting

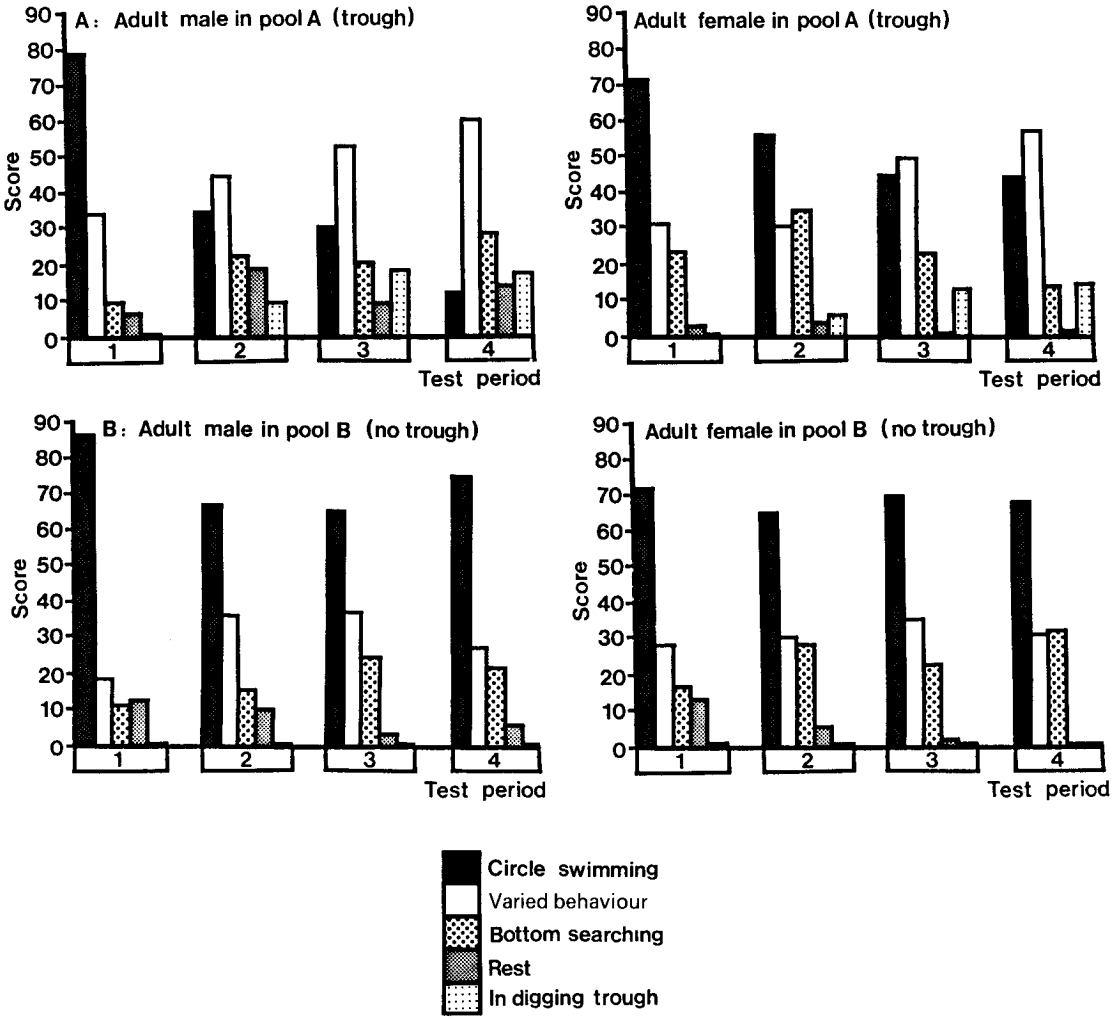

Figure 5. The records of behaviours of the adult walrusses during the 4 test periods (A) in pool A (containing the digging trough, 12.30–16.15) and (B) in pool B (08.00–11.45 hrs). Maximum score: 16 (observations per day) × 8 (test days) = 128.

in the trough; and other behaviour. During the day (08.00–18.00 hrs) the behaviour of each animals was recorded once every 15 min. During the night the same was done once per hour.

Whenever circle swimming was noted in pool A, and the observer was not occupied with the regular registrations, the shape and duration of the circles were recorded. Also the place of each respiration during circle swimming was recorded. For this purpose the pool was divided by a grid of imaginary lines.

Results

Routine behaviour (circle swimming)

All four animals swam loops. The adult animals spent more time circle swimming than the young animals. For this reason more circles of the adult walrusses are recorded than of the young walrusses (Table 2 and Fig. 4).

The young male swam figures-of-eight, the adult female and young male both swam circular loops, and the young female swam ellipse shaped loops. Two loop types could be distinguished for each animal; a long loop. and a shorter version which had roughly the same shape, but was different in length and, except for the young female, shorter in duration. The duration of at least one type of loop did not vary much for each animal (see the standard deviation in Table 2). The animals did not always surface during one cycle, but when they did, it was always in the same place.

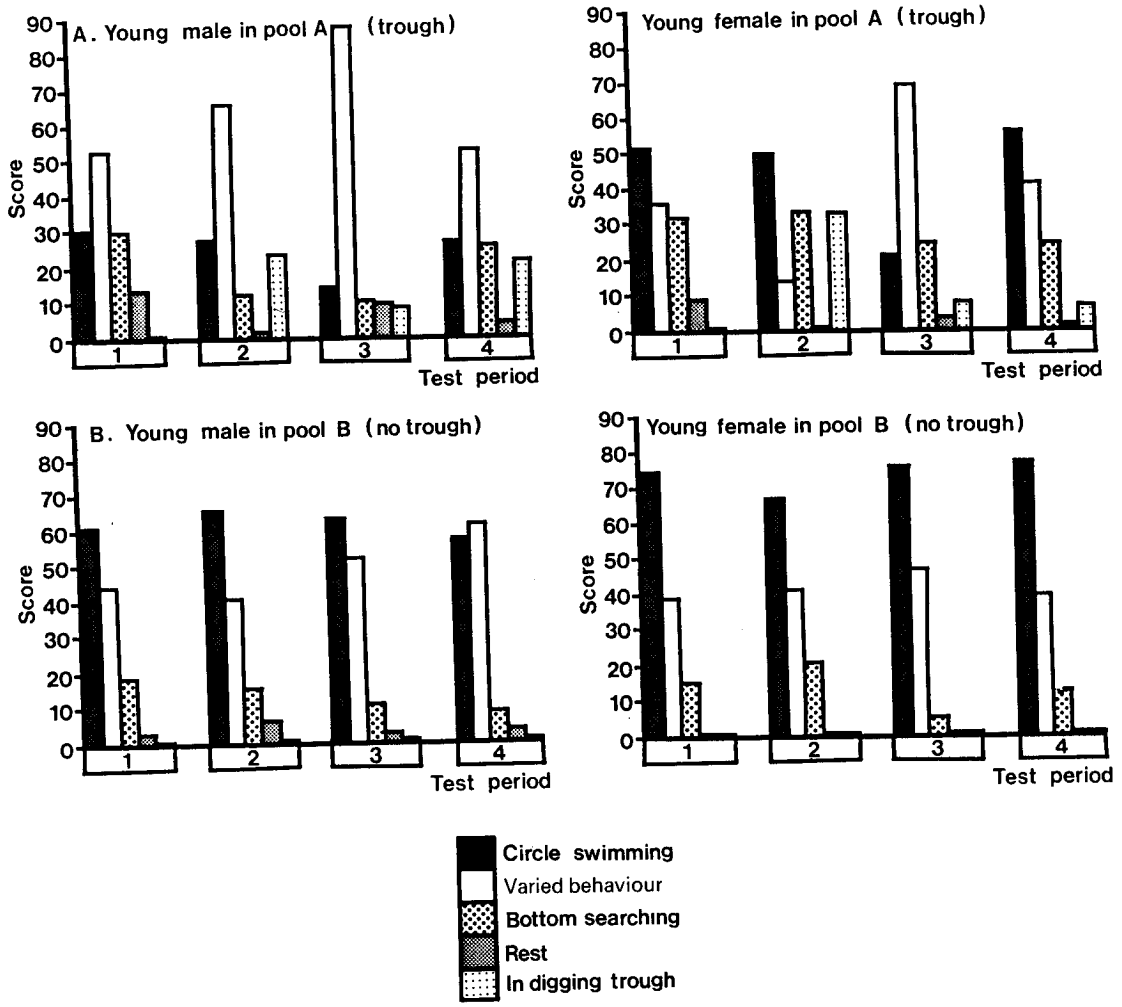

Figure 6. The records of behaviours of the adult walrusses during the 4 test periods (A) in pool A (containing the digging trough, 08.00–11.45) and (B) in pool B (12.30–16.15 hrs). Maximum score: 16 (observations per day) × 8 (test days) = 128.

Because the shape and duration of each loop was fairly constant, and because this circle swimming does not serve an obvious goal, it may be called stereotypy.

Behavioural changes

After the initial inspection of the new object in their environment, the animals paid no attention to the digging trough during the 5 days prior to the test periods.

Adult male

During the baseline period the adult male spent a large amount of time circle swimming (Fig. 5A). This proportion of time decreased substantially when the trough with gapers was offered. The time spent circle swimming decreased further when fish was offered and even a little further when pieces of fish were offered. The score of varied behaviour showed the opposite trend. The animal spent more time in the trough when whole fish and pieces of fish were given than when molluscs were fed. During test period 2, 3 and 4, while it was in pool B, the animal only showed a small decrease in the time spent circle swimming (Fig. 5B).

Adult female

The adult female also spent a large proportion of its time circle swimming during the baseline period (Fig. 5A). This proportion decreased when gapers were offered, but not as dramatically as it did with the adult male. It decreased even further when whole fish

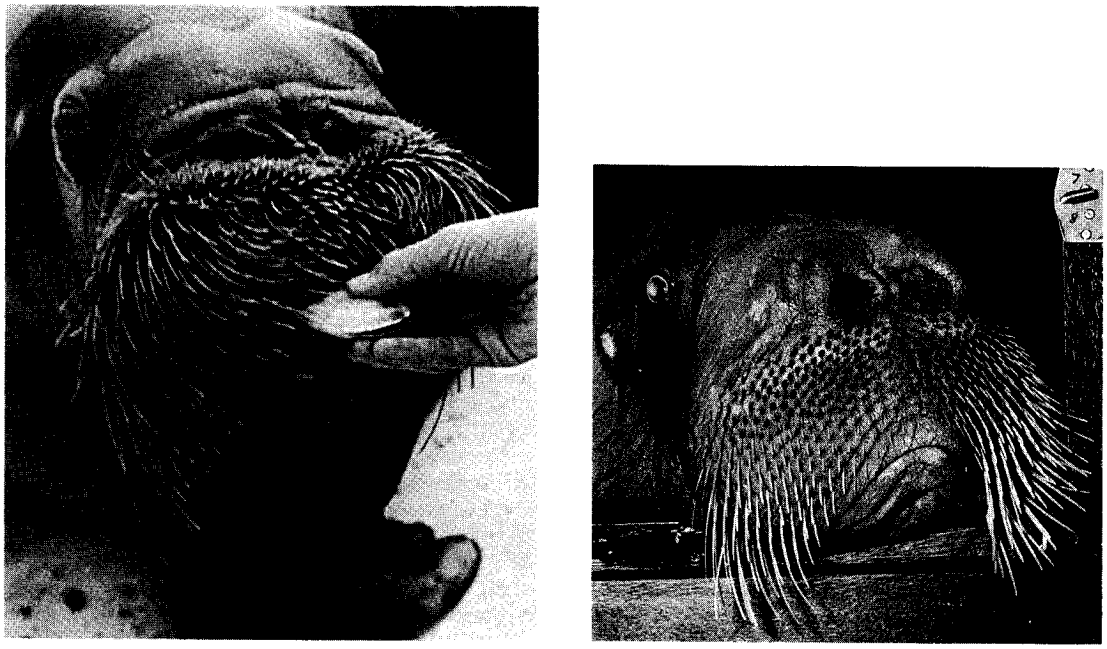

Figure 7. The wear of the vibrissae. (A) The young male walrus (OrZH003) eating a gaper prior to the placement of the digging trough, and (B) the same animal after the third test period.

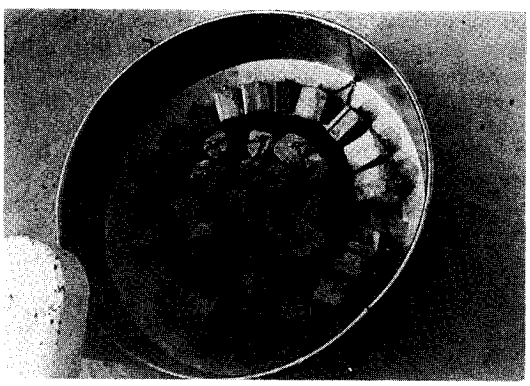

Figure 8. The digging trough containing concrete blocks interconnected by a chain as used after this study.

were offered. There was no difference in behaviour between the period in which whole fish and that in which pieces of fish were offered. Like the adult male, the female spent more time in the trough when whole and pieces of fish were given than when molluscs were fed. During its stay in pool B (periods 2, 3 and 4) the animal also showed hardly any decrease in time spent circle swimming (Fig. 5B). The score of varied behaviour remained fairly constant.

Young female

The young female spent less time circle swimming than the adult animals during the baseline period in pool A (Fig. 6A). This hardly decreased when gapers were offered, but decreased more strongly when whole fish were offered. After that period an old tusk infection started to bother the animal. Her food intake dropped and her head was painful. Presumably for this reason the animal started to swim in circles during the period when pieces of fish were offered. Unlike the adult walrusses the young female spent more time digging in the trough when molluscs were fed than when whole fish were fed. During its stay in pool B (in all 4 test periods), the amount of time spent circle swimming and in varied behaviour remained almost constant and high (Fig. 6B).

Young male

The young male spent less time circle swimming than all the other animals during the baseline period in pool A (Fig. 6A), and somewhat less when the trough and gapers were offered. The time spent circle swimming decreased even more when whole fish were given, but increased when pieces of fish were offered. The score of varied behaviour increased when gapers were offered and even further when fish was given. Like the young female, the young male spent more time in the trough when molluscs were offered than when whole fish were given. Both the score of circle

swimming and varied behaviour were fairly constant and relatively high during the test periods in pool B (Fig. 6B).

The presence of a digging substrate not only changed the behaviour of the walrusses. It also made morphological changes. Because the animals had to move the stones and had to use the vibrissae to investigate the prey, the vibrissae wore down during the study (Figs 7A and B).

Discussion and conclusions

Good methodology would have required the removal of the digging trough from the pool at the end of the study to see whether the behaviour of the animals returned to baseline levels. However, because of the success of the digging trough and the expense and labour involved in removing it from the pool, it was decided to leave it in place. The following two factors are in favour of the idea that the change in behaviour was due to the presence of the trough with different food items: (1) no trend was seen during the 8 days of the individual test periods, and (2) the behaviour of the 4 animals in pool B (without the digging trough) only changed slightly during the 4 test periods.

The digging trough (with food source) helped to reduce the time spent circle swimming by the walrusses. This was not just because time was needed to dig in the trough, since the animals only spent a small proportion of their time in the trough. When offered the opportunity to dig, the time spent on varied behaviour increased. This suggests that the trough (with a food source) improved the overall activity of the animals. The walrusses were not interested in the digging trough when no food was in it. This seems to suggest that walrusses do not simply root without a fair chance of obtaining a food reward. This is contrary to the findings of Wood-Gush & Beilharz (1983) who offered pigs a trough filled with earth. Just the filled trough without any food source changed their behaviour. They spent a lot of time rooting in the substrate and this was interpreted as a reduction of boredom. Maybe the fact that we used stones instead of a sand or mud substrate made the animals avoid the trough when no food source was available.

There was variability in the effect of the different food sources, offered in the trough, on the 4 walrusses. The adult male and female were the best occupied with pieces of fish. The young animals were better occupied with whole fish than with gapers. Whether pieces of fish would have improved their behaviour even more than whole fish could not be evaluated due to the young female's tooth problem. The fact that these walrusses spent more time in the trough when fish were offered than when molluscs (their natural prey) were offered, is maybe due to the fact that they are used to eating fish. It is also difficult to compare 15 molluscs (0.6 kg of meat) with 17 fish (2.5 kg). They differ both in energy content and processing time.

A pair of walrusses seemed to influence each other. They often showed similar behaviour simultaneously. This could explain the fact that the young male's time spent circle swimming increased when that of its partner became more frequent, because of the tusk infection.

The vibrissae wore off during the study until they had reached the length seen in walrusses in the wild. The reduced usage of vibrissae in zoos often results in very long vibrissae (Fay, 1982). The shortening of the vibrissae probably improves the discriminatory ability of the walrusses (Kastelein & van Gaalen, 1988).

The walrusses often lifted stones out of the trough, and deposited them around the edge of the pool. Some of these stones fell from the edge and damaged the concrete bottom of the pool. Therefore, after this study measures were taken to prevent the destruction of the concrete. The stones had to stay in the trough. Because it is difficult to drill holes in rock, concrete blocks, of the same size as the stones used in this study, were loosely interconnected by a chain so that the walrusses could still move the blocks to a certain extent, but could not lift them from the trough (Fig. 8).

The digging trough (filled with different food items), worked well as an occupational therapy for these walrusses. However, additional occupation would be needed to completely replace all aspects of feeding behaviour seen in the wild by other positive behaviour. In the field walrusses first have to swim to the feeding grounds, find good mollusc beds, dive deeper than in this study and then, mainly by using the tactile information from their vibrissae, excavate the molluscs in dark and/or murky water. The animals in this study kept their eyes open and seemed at least partially to be foraging on eyesight.

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