EXPERIENCES WITH HARBOUR PORPOISES, *PHOCOENA PHOCOENA*, IN CAPTIVITY: MORTALITY, AUTOPSY FINDINGS AND INFLUENCE OF THE CAPTIVE ENVIRONMENT

S. H. Andersen, Odense University, Niels Bohrs Alle, 5000 Odense, Danmark

Introduction

This paper gives a survey of the fate of 67 harbour porpoises collected alive from Danish waters and kept in captivity for bioacoustical and physiological investigations.
Even if the harbour porpoise is a common species in coastal waters of the temperate parts of the Northern Atlantic and Pacific Oceans, this species has been kept in captivity only in few places and for short periods. Jones (1970) notes: Hagenbeck Zoo 1864, Londen 1862, New York Aquarium 1970 and to this list can be added Copenhagen Zoo 1970 and Mystic Marine Life, Connecticut 1976. For scientific purposes harbour porpoises have been kept in Holland 1958, Bergen 1964 and since 1962 in our lab. Most of the animals noted in captivity were collected from strandings and fishing gear and only the animals used in Bergen, Holland and 2 of ours have been caught purposely. Generally the harbour porpoise is considered a fragile and difficult species to keep in captivity and this article confirms that mortality among animals that have caught themselves in nets or have been washed ashore is high (Andersen 1974a, Gewalt 1971, Ridgway 1972, Ray 1966).

Material

32 female and 35 male harbour porpoises have been collected alive in the years 1962 to 1976 from inner Danish waters.
Table I gives the length frequencies of 47 animals and shows that we have mostly been offered animals of ½ - 1 years old, i.e. equal to or less than about 120 cm.

TABLE I
LENGTH OF 47 OUT OF 67 ANIMALS COLLECTED ALIVE

Length groups cm	N
90 - 99	2
100 - 109	7
110 - 119	15
120 - 129	6
130 - 139	4
140 - 149	5
150 - 159	4
160 - 169	4

TABLE II
ORIGIN OF 67 HARBOUR PORPOISES

	N
Pondnet	59
Plaice net	3
Herring net	1
Lumpsucker net	1
Actively caught	2
Stranded	1

Table II gives a survey of the origin of the porpoises. The majority have been taken from pond nets (Fig. 1), where they become enclosed in a net cylinder leaving ample space for them to swim and to surface. In gill and drift nets set for flatfish, cod, herring, lumpsuckers and salmons they most often drown but in shallow water the animals may succeed to lift the nets to the surface.
The yearly mean intake of animals in the period was 4.5, ranging from 2 to 10 individuals.

Transport

Since we donot catch our porpoises ourselves our supply of porpoises depends solely on the fishers interest in our work. We prefer to take the animals ourselves directly in the nets but

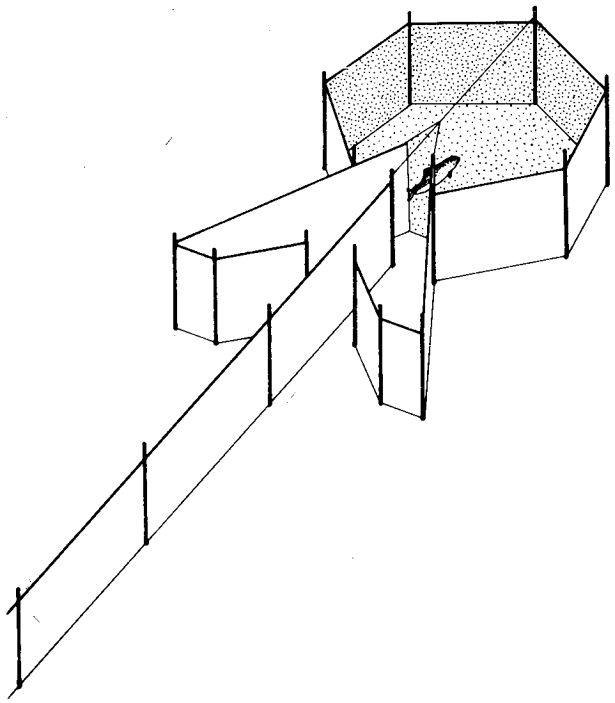

Fig. 1. A typical Danish pond net. The vertical parts of the net rise just above the surface.

often they are already transported to the nearest harbour on the deck, in the boats fishpond and await us there or in a floating fish trap in the harbour.
Usually the fishers empty their nets in the early morning and we arrive to the harbour some 6 hours later. The transport on land in a conventional porpoisestretcher (Ridgway 1972) usually lasts 1 - 1½ hours.
Rough weather, hot sun, noisy and polluted harbour water and improper handling of the animals are obvious causes to the often bad condition in which we receive the animals.

Holding facilities

Between 1962 and 1974 the lab was stationed in an abandoned harbour with 4 meshwire enclosures with varying waterdepth from 0 to 3 m and the largest enclosure was 8 x 16 m. An indoor experimental tank supplied with natural seawater measured 6 x 8 m. The water quality was highly unsatisfactory since oil spill from ships and a refinery was a weekly event and public bathing from a nearby beach was frequently forbidden because of sewer outlets. In 1970 we began to experiment with chlorinated and artificial sea water and since then we have used only land pools and chlorinated water. At present, our holding pool holds about 1000 m^3 and the quarantine and measuring tank hold 12 and 45 m^3, respectively. Water turnover is 1½ hours, filtercapacity is 5 $m^3/m^2/h$, pH is 8.0 - 8.2, free chlorine is about 1 ppm and combined chlorine in indoor and outdoor pools is 2.0 and 4.0 ppm respectively.

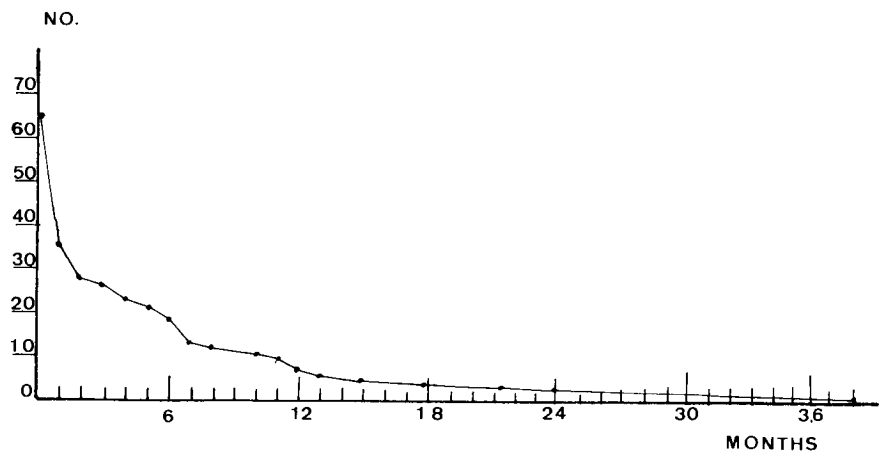

Fig. 2. Survivaltime in 67 captive Harbour Porpoises, **Phocoena phocoena.**

Mortality and autopsy findings

Fig. 2 shows the mortality of the 67 animals collected alive. Mortality is high during the 1st and 2nd month and it shows too that we have kept an animal for 39 months. This is our maximum up to 1976. The high mortality is further analyzed in table III.
We were early aware that many animals were diseased at arrival (Andersen 1968). Among the 7

TABLE III

MORTALITY IN CAPTIVITY

THE FATE OF THE 67 ANIMALS COLLECTED ALIVE

	N	%
Dead during transport	7	10.4
Dead within 1 month	25	37.3
Kept alive more than 1 month	35	52.3
Total	67	100.0

animals that died during transport 5 were subjected to autopsy. The findings are listed in table IV and it is obvious that these animals were debilitated to a degree that they would have died anyway in nature.

The fate and autopsy findings from the animals that died within 1 month of captivity is given in table V. Again it is seen that apart from the 2 animals that drowned - one of which at autopsy revealed chronic pulmonary heart disease - they are all "problem children" or diseased and debilitated and thus cannot be expected to live long in captivity.

35 animals have survived transport and 1st month of captivity and a survey of their fate and the autopsy findings is given in table VI. Also among these animals pulmonary heart disease has been a major problem and if the entire autopsy material is compiled approximately 30% of the animals have succumbed from this syndrom.

It is worth also to note that dermatomycosis with fatal termination has occurred in 4 animals. Three were spontaneous outbreaks and one followed inocculation. It seems to be a problem to the Danish harbour population since about 20% of the 108 animals received dead or alive by the lab were infected with dermal fungus.

We conclude therefore that about 50% of the animals we receive are diseased or high risk animals. Whether these animals are indicating a bad state of health of the Danish harbour porpoise population or they represent that part of the population which naturally is diseased and thus is easy to catch is still open to questions. The high incidence of pulmonary diseases often in connection with severe lungworm infestation is remarkable and deserves further investigation.

TABLE IV

AUTOPSY FINDINGS IN 5 ANIMALS DIED DURING TRANSPORT

Chronical pulmonary heart disease in connection with lungworm infestation	5 cases
Dermatomycosis	2 cases
Pneumothorax	1 cases
Pleuritis	1 cases
Esophagal ulcerations	4 cases
Mandibular osteomyelitis	1 cases
Flukes in liver or pancreas	4 cases
Nematodes in esophagal stomach	2 cases
Tapeworm	1 cases
Heartworm	1 cases

TABLE V

FATE OF 25 HARBOUR PORPOISES THAT DIED OF WERE LET OUT AGAIN DURING THE 1st MONTH OF CAPTIVITY

	N
a. Pulmonary heart disease in connection with heavy lungworm infestation, died on day 3,4,4,7 and 9 respectively	5
b. Orphaned sucklings that died on day 8,12,22 respectively after unsuccessful attempt to feed them	3
c. Animals from gill nets that died on day 1 and 4 respectively	2
d. Accidentally drowned	2
e. Animals let out again, refused to eat	2
f. Hemorrhagic pneumonia, died on day 5, 15, unknown respectively	3
g. No exact cause of dead could be stated but autopsy showed: abortion (2 cases) kyphosis (1), enteritis (1), lungworms (2), liverfluke (2), heartworm (1) and severe infestation of stomachworm (1)	5
h. Animals without information in our file	3

TABLE VI

FATE OF 35 HARBOUR PORPOISES THAT SURVIVED 1 MONTH OF CAPTIVITY

	N
Not subjected to necropsy	6
2 Let out again in fear of infection with dermatomycosis	
2 Transferred to Copenhagen Zoo	
1 Accidentally drowned	
1 Chlorine intoxicated	
Chronical pulmonary heart disease in connection with lungworm infestation	10
Chronical and acute pneumonia	6
Dermatomycosis	4
Pulmonary necrosis after inhalation therapy	1
Pleuritis	1
Enteritis	2
Debilitated by parasites and esophagal ulcerations	5

Experiences with pregnant animals

The lab has received 4 pregnant animals. One drowned accidentally and is without informations in our file. The fate of the 3 others is given in table VII. Møhl-Hansen (1954) has reviewed the literature on the season of delivery and the weight and length of the newborn harbour porpoises in Scandinavian waters. Time of delivery is in June and the calves weigh 6 - 8 kg and measure 80 - 90 cm. Judged from this only 1 of our pregnant fermales delivered a full term foetus, the other 2 were abortions.

These experiences do not invite to take in late pregnant animals.

TABLE VII
DATA FROM PREGNANT ANIMALS

	No. 1	No. 2	No. 3
Mother, length, cm	Unknown	160	156
Date of arrival	May 1st	April 17th	April 30 th
Date of delivery	May 4th	May 1st	June 26th
Number of days from capture to delivery	4	15	57
Number of days from delivery to death	28	11	205
Infant, length, cm	Unknown	61	76
Infant, weight, kg	Unknown	2.9	6.9
Infant state	Not full termed	Full termed	Full termed
Transportation hours	3½	1	1
Autopsy findings in the mother	Lacking	Heavily parasited in: stomach, liver, lung, heart; and dematomycosis.	Pleuritis

Mortality and carceration

The harbour porpoise is protected in Danish waters since 1967 and the lab is granted an exemption to receive and to keep this species. Therefore, it is natural to reflect on how many animals have succumbed directly due to our holding facilities, improper care and experimentation, and what has been done to reduce this mortality. As seen from table VIII, 9 of the animals have succumbed from the above mentioned reasons.
Accidental drowning is now excluded since we use only land pools, and transport injuries like kyphosis and scoliosis have not been seen for years since we have informed our suppliers on the proper handling - e.g. not to lift the animals by the tail!

TABLE VIII
MORTALITY DUE TO CARCERATION

Accidentally drowned	3 animals
Chlorine intoxication	1 animal
Malnutrition	3 animals
Inocculation with fungi	1 animal
Kypho-scoliosis	1 animal

Chlorine intoxication should now be very unlikely. Chlorination is now routine and automatic. Since the 3 orphaned sucklings died from malnutrition 4 sucklings have been reared and lived in captivity for 6, 10, 13 and 18 months, respectively (Andersen 1974b).
Mortality due to transport and carceration should thus have been brought to a minimum with the experience we have gathered.

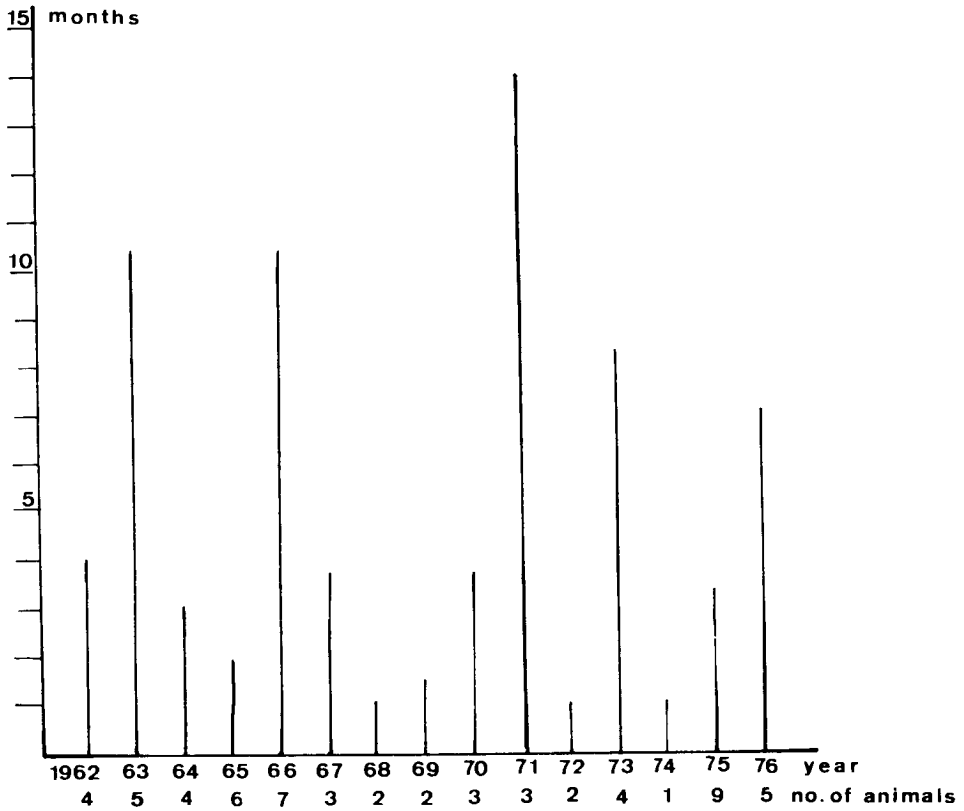

Fig. 3. Yearly mean survival time. The bottom line gives the number of animals received per year. The mean of their survival times is diagrammed.

Discussion

Having kept harbour porpoises for 15 years it is natural to ask if we have made any progress with this species and if the improvement can be expressed in a lower mortality.
Fig. 3 shows the yearly mean survival length and it is a disappointing fact that progress in keeping this species in captivity can not be demonstrated.
Several factors may have influenced this lack of succes, but we have only few parameters to investigate.

TABLE IX

	Prechlorination period 1962 - 1969		Chlorination period 1970 - 1977	
I: Animals dead during transport	n	% of autopsy material	n	% of autopsy material
no. subjected to autopsy	4		3	
incidence of pulm. diseases	2		3	
incidence of lungworm infest.	2	100	3	100
	2	100	3	100
II: Animals that survived transport				
no. subjected to autopsy	33		27	
incidence of pulm. diseases	22		24	
incidence of lungworm infest.	10	46	18	75
	16	73	14	58

The use of chlorinated artificial saltwater

Since 1970 we have used chlorinated artificial seawater and land pools of different sizes. With the knowledge gathered from human swimmingpools it is natural to focus upon the irritating effect of chlorine, specially the combined chlorine, on mucus membranes of the lungs, since pulmonary diseases are common among our animals.
The concentration of combined chlorine ("chloramines") in the air above the water surface depends on the concentration in the water and the ventilation of the air above the water. In our indoor pool the concentration of combined chlorine is kept at levels - 4 ppm - which other dolphin species, e.g. *Tursiops truncatus*, tolerate for years. But our ventilation is most probably inadequate since combined chlorine can always be smelled in the room. In the outdoor pools the combined chlorine can be kept 2 times lower due to the solar ultraviolet radiation, and the ventilation is usually appropriate.
Table IX shows that the incidents of pulmonary diseases among animals that have been kept alive for more than 1 month has increased from 44 to 79% of the autopsy material from prechlorination to chlorination periods. This increase could be a result of an increased incidence of lungworm infestation but in the autopsy material this frequency has fallen from 75 to 50%.
This correlation suggests chlorination to be responsible for a higher incidence of pulmonary diseases.

Longevity and holding facilities

A year after the lab was established, an indoor pool circulated with natural seawater was ready and after this, the animals were frequently moved between the harbour enclosures and the indoor pool. Therefore our data do not permit us to make comparisons between longevity in these two kinds of holding facilities.

Other effects of carceration

In the nutritional environment we donot see problems. We feed mostly herrings with vitamin supply as in other dolphinaria and the food quality is that of human consumption.
In the psychic environment there may be many serious causes for a high mortality, but it is almost impossible objectively to define these causes. Dolphins have only few objective signs which can give us a hint of their psychic state of health. It always ends up with a kind of feeling or believe. It is our general impression that 2 - 3 animals together, not disturbed too often (physical examination e.g.), not placed suddenly in too complicated training programs, in water of constant chlorine and salt concentration grow well, adapt well to our activities around and in the pools and exhibit normal behaviour (Amundin 1974, Andersen 1976).
But great individual differences are noted and experimental work with this species is very depending on the animals collaboration and planning of experimental work is difficult.

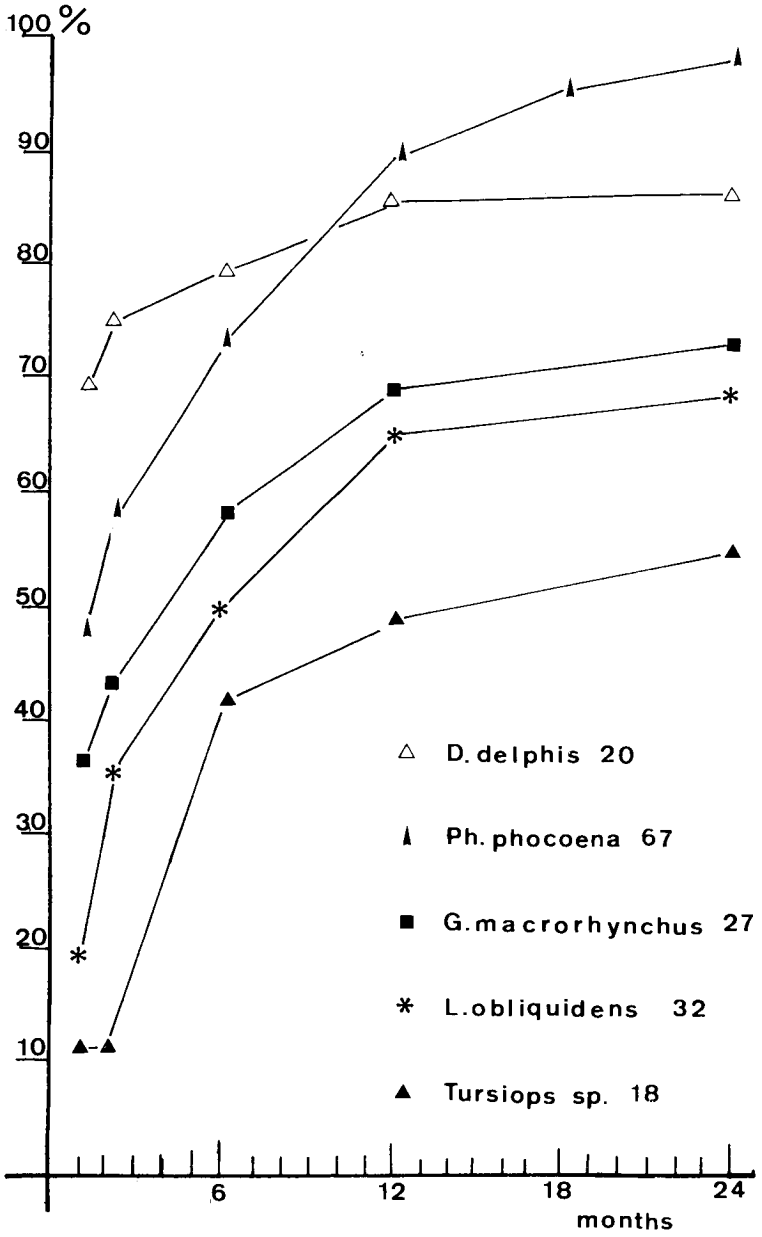

Fig. 4. Mortality in Cetaceans during capture and captivity. Except for the Harbour Porpoise, the curves are redrawn from Walker (1975).

Comparison of longevity to other dolphin species

Walker (1975) has published longevity of 4 other dolphin species in captivity and his data are rearranged in Fig. 4 together with our data from the harbour porpoise. It is worth mentioning that the animal material in Walker's data is selected by inspection of the animals before they are catched and they are actively caught. Our animals have caught themselves in nets and judged from the state of health of the animals that die during transport and during the first month of captivity, these animals seem to be selected.

Mortality in the very first months is the second highest among the 5 species, mortality rate in the first 12 months is like that of *Globicephala macrorhynchus, Lagenorhynchus obliquidens* and *Tursiops sp.* but longevity is considerably shorter.

With the holding facilities available to us and with the selected animal material with which we have to work we need to conclude that the harbour porpoise is a difficult species to keep in captivity. They certainly gave us a lot of problems but they taught us a lot, too!

Literature cited

AMUNDIN, M. (1974): Occupational Therapy for Harbour Porpoises, Ph. phocoena. J: Aquatic Mammals *2:3*, 6-11.

ANDERSEN, S. H. (1968): Physiological Ranges of Blood-Chemical Parameters in Captive Harbour Porpoises, Ph. phocoena (L.) Nord. Vet. Med. *20*, 267-278.

ANDERSEN, S. H. (1974a): A Typical Case History of the Net-Caught Harbour Porpoise, Ph. phocoena, from Danish Waters. J. Aquatic Mammals *2:3*, 1-6.

ANDERSEN, S. H. (1974b): The Rearing of Suckling Harbour Porpoise, Ph. phocoena. J. Aquatic Mammals *2:2*, 23-27.

ANDERSEN, S. H. (1976): The Taming and Training of the Harbour Porpoise, Ph. phocoena. Cetology *24*, 1-9.

GEWALT, W. (1971): Phocoena bei Cuxhaven gestrandet. Z. Säugetierkunde *36*, 61-63.

JONES, M. L. (1970): History of Marine Mammals in Captivity with Notes on their Longevity. Proc. 7th. Annual Conf. on Biological Sonar and Diving Mammals. Stanford Res. Inst., Calif., U.S.A.

MØHL-HANSEN, U. (1954): Investigations on Reproduction and Growth of the Porpoise, Ph. phocoena, from the Baltic. Vidensk. Medd. Dansk Naturhist. Forening *116*, 369-396.

RAY, C. (1966) In: Norris, K. (ed.): Whales, Dolphins and Porpoises. Univ. Calif. Press. Berkeley and Los Angeles, U.S.A.

RIDGWAY, S. H. (1972): Mammals of the Sea: Biology and Medicine. C. C. Thomas, U.S.A.

WALKER, W. A. (1975): Review of the Live-Capture Fishery for Smaller Cetaceans Taken in Southern California Waters for Public Display, 1966-73. J. Fish. Res. Board of Canada *32:7*, 1197-1211.