DANISH REVIEW OF GAME BIOLOGY Vol. 13 No. 5

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by
B. CLAUSEN & S. ANDERSEN

Med et dansk resumé:
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af marsvin *(Phocoena phocoena)*
i danske farvande og status over
deres helbredstilstand

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Abstract

Clausen,[1] B. & S. Andersen[2], 1988: Evaluation of Bycatch and Health Status of the Harbour Porpoise *(Phocoena phocoena)* in Danish Waters. - Dan. Rev. Game Biol. **13** (5).

149 harbour porpoises were collected during the period August 1980 to February 1981. The animals were taken as bycatch by Danish fishermen.

The purpose of the survey was to evaluate: the size of the bycatch in relation to the various types of fishery; the state of health of the population including investigations on load of parasites; the reproductive status of the animals; and the tissue content of mercury, cadmium, PCB and DDT.

The material is, when possible, compared to information and results from a survey which was performed during 1941-43.

The survey shows a considerable bycatch of harbour porpoises. The animals do not seem to be caught in any special type of net.

As the large and, accordingly, older animals are now only seldom seen the investigation indicates that the population structure has changed since 1941-1943. The females are now shorter and thus probably younger when they become pregnant. All this could very well be caused by the large bycatch of harbour porpoises.

The reproductive capacity of the animals seems to be good compared to the reference material from 1941-43. The harbour porpoises caught in 1980-1981 do not seem more heavily parasitised than those animals previously taken.

It is proposed that the load of parasites in harbour porpoises from Danish waters ought to be compared to the load of parasites in other West European populations.

Further studies should be concentrated on more accurate recordings of the bycatch of harbour porpoises, and on the possible means of minimising or preventing this bycatch.

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Contents

Introduction

According to ANDERSEN (1982), the migration of the harbour porpoise *(Phocoena phocoena)* from the North Sea to the Baltic Sea through Danish waters virtually ceased during the period 1940-1950. Preceding this, an inward migration occurred in early spring and an outward migration took place in the following January. The cause of these changes of occurrence is as yet unknown.

From 1962 to 1982, ANDERSEN (1982) found a considerable bycatch of harbour porpoise in nets set for cod fish, flat fish, herring, lumpsuckers and also in connection with trawl fishery. During the same period an increasing percentage of subadults, obviously abandoned young and, subsequently, fewer adult animals were recorded. Furthermore, recent surveys give reason to believe in a declining population (KINZE 1987).

Among the live harbour porpoises which had been received since 1962 for bio-acoustic investigations at Odense University, it was found that about 50% of the animals were diseased on arrival or were high risk animals (ANDERSEN 1978). This does not necessarily mean that the state of health of the Danish harbour porpoise population was correspondingly poor, as the special method of catching - by pond nets - might have selected for certain specimens and therefore biased the catch. Nevertheless, in connection with the change of occurrence it was considered important to investigate the health status of the free-ranging harbour porpoise.

The purpose of the present study is to evaluate the size of the bycatch of harbour porpoise in Danish waters, and to relate autopsy findings and toxochemical analyses to the health status of the animals.

From December through to February in 1941-1943, a total of 695 harbour porpoises were caught in the Little Belt during migration from the Baltic Sea to the North Sea by chasing and successive netting of the schools (Asterisk in Fig. 1). These animals were examined by Møhl-Hansen, Zoological Museum, University of Copenhagen, who recorded body-length, weight, sex, pregnancy status and rate of parasitic infection for most of the animals. The results of the present study are, as far as possible, compared with the above-mentioned investigation of harbour porpoise conducted nearly 40 years ago (MØHL-HANSEN 1954, WESENBERG-LUND 1947). The material from the investigation performed in 1941-43 is in the following report referred to as reference material.

The harbour porpoise in Danish waters has since 1967 been protected by law, which means that catching, transport and purchase is prohibited. Furthermore, since Denmark signed the Washington Convention, the landing of any kind of cetaceans caught outside Danish jurisdiction requires permission from the National Agency for the Protection of Nature, Monuments and Sites.

Acknowledgements

The authors would like to thank the late cand. scient. J. A. Guildahl, The Royal Veterinary and Agricultural School, Copenhagen, Denmark for the final identification of the parasites, the late Prof. O. Karlog, Biological Institute, Odense University, Denmark for performing the analyses of cadmium and mercury content, Dr. L. Reutergardh and Dr. Mats Olsson, Swedish Museum of Natural History, Stockholm, Sweden for performing the analysis of chlorinated hydrocarbon content, Dr. N. Friis, National Veterinary Laboratory,

Copenhagen, Denmark, for the mycoplasma investigation and cand. scient. H. G. Nielsen, Zoological Museum, University of Copenhagen, Denmark, for performing the age determination.

Finally, the authors would like to thank all fishermen, employees at fishing auctions and fishing inspectors at the various ports, without whose help and cooperation the present survey would have been impossible. The investigation was financially supported by the World Wildlife Fund, Denmark.

Materials and methods

The investigation includes collection and registration of a number of harbour porpoises that had incidentally drowned in nets and trawls in the North Sea, the Skagerrak and in the Danish domestic waters.

The collection was organised through fish auctioneers and fishery inspectors from most of the fishing ports along the Danish coast. These people, backed up by our posters, informed the fishermen about the survey. To facilitate participation by the fishermen, wrapping material was deposited in the ports and shipping expenses were refunded. A tag followed the animal with information regarding date of collection, fishing ground, fishing gear and name of fisherman. Each fisherman was awarded 50,- Dkr. per animal, which was equivalent to the wholesale price of 10 kg of herring, in the hope that this reward was high enough to encourage participation, yet not so high as to cause intentional catching.

Additional information regarding the type of fishery involved in the bycatch was obtained from interviews with some of the fishermen who caught the harbour porpoises.

After delivery, the animals were kept at a temperature of 4°C until they arrived within a few days at the National Veterinary Laboratory (NVL) for autopsy.

The age of the animals was determined according to cement layers in the teeth by H. G. Nielsen (NIELSEN 1972). Age is given in months, presuming that parturition takes place in June (GASKIN et al. 1984).

Parasite burden of harbour porpoises was evaluated and registered according to the scale: 3 for heavy infections; 2 for moderate; and 1 for slight infection. After autopsy, the preliminary identification of the various parasites was confirmed by parasitologists at the Royal Veterinary and Agricultural University, Copenhagen. Examination of the ear for earworms was only performed in the last 120 autopsies.

Kidney and blubber were stored at -20°C until analyses for cadmium (Cd), mercury (Hg), PCB and DDT content could be conducted. The Cd and Hg analyses were performed on freeze-dried kidney tissue in a flameless atomic absorbtion spectrometric analysis according to LINDSTEDT (1970). The results are expressed as wet weight (w.w.).

The PCB and DDT analyses of the blubber were performed in accordance with methods described in JENSEN et al. (1979). The results are shown as proportion of the total blubber.

In search for mycoplasma, approximately ⅔ of the animals were examined. Pneumatic lung tissue was taken from a representative sample of 88 harbour porpoises and was comminuted in a 10% suspension diluted to 10^{-6} in tubes and incubated at 37°C. After 4 days, sub-cultures were developed on solid medium, the Hayflich (HAYFLICH 1965) type of medium with arginine being used (Dr. N. FRIIS, pers. comm.).

Results

Bycatch and fishing methods

From August 1980 to February 1981 the Laboratory received 149 harbour porpoises.

The numbers of harbour porpoises landed in the different harbours are given in Fig. 1. Ninety-one of the animals were caught west of Jutland, 18 in the Skagerrak, 31 in the Cattegat, 6 in the Great Belt and 3 in the Baltic Sea. Table 1 gives more specific information on the 149 harbour porpoises related to month of collection, type of fishing gear used and sexual composition. It can be seen that the main part of these animals (88%) was collected in September/November and that 61% of the total number was trapped in connection with cod nets. According to the fishermen, cod fishery with nets takes place almost all year round in the North Sea and in the Skagerrak. Two ports have specialised in the so-called 'wreck-fishery', where nets are set across wrecks in the area bounded by Grimsby - North Holland, Hook of Holland and Harwich. On other fishing grounds the nets are placed on the sea bottom on stone reefs or sand at 20-40 m water. The nets are manufactured from a 0.5 mm nylon mono-filament, with a mesh size of 70-120 mm. Day and night net settings are equally common.

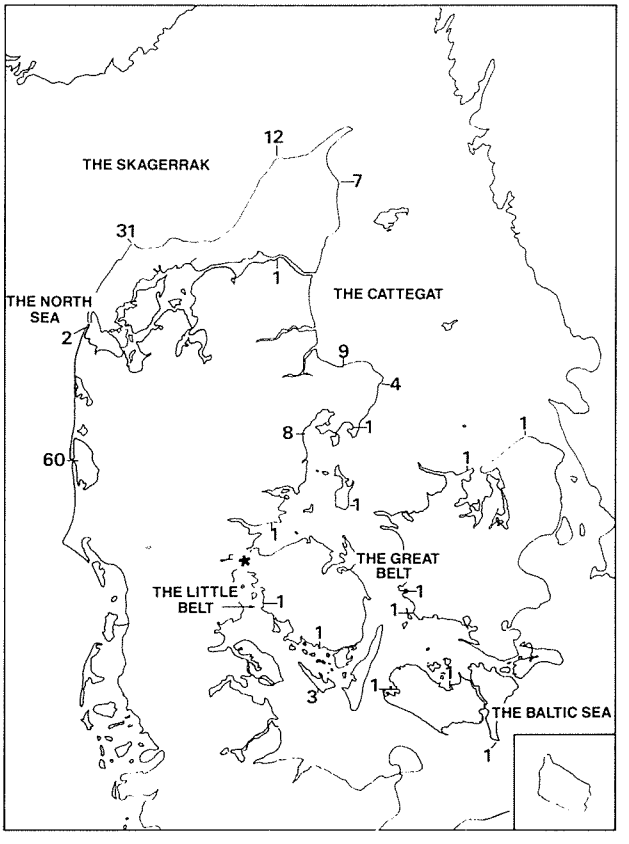

Fig. 1. The geographical distribution of fishing ports involved and the number of harbour porpoises landed there in 1980-81. Reference material from 1941-43 was collected in the area marked with an asterisk.

The plaice net fishery, which also takes flounders and dab, occurs along the coast with nets of about 1.5×30 m, often in chains. Materials and mesh size are approximately the same as for cod nets. It is essentially an all-year-round fishery and is to a substantial degree performed by semi-professionals in the Cattegat and inner Danish waters. Night settings are the most common.

Trawling occurs all year in the North Sea, the Skagerrak and the Cattegat for cod, herring, sprats, whiting and coalfish for direct human consumption and for trash fish.

According to the interviewed fishermen, trawls are operated at a maximum depth of 50 m water as mid-water trawling. The harbour porpoises are often seen following the trawls, catching fish squeezed out through the meshes. Apparently, some animals enter the trawl and become trapped when the boat stops hauling and the trawl entrance collapses.

Fig. 2 shows the distribution of animals based on body-length in relation to the type of fishing gear. Animals caught in 'other nets' are, however, omitted. It appears that the different types of nets do not select for any particular size of harbour porpoises.

Of the 149 harbour porpoises, 78 were males (52%) and 71 females (48%). The sex ratio of the reference material was 392 males (62%) and 238 females (38%).

Length and weight of the 149 harbour porpoises caught in August to February 1980-1981 are given in Fig. 3 related to sex and pregnancy-status. Fig. 4 gives comparable data for the 150 animals in the reference material, which were caught mainly during the same season in 1941-1943.

Fig. 5 illustrates age and length of 149 harbour porpoises caught in 1980-1981 in relation to sex and pregnancy.

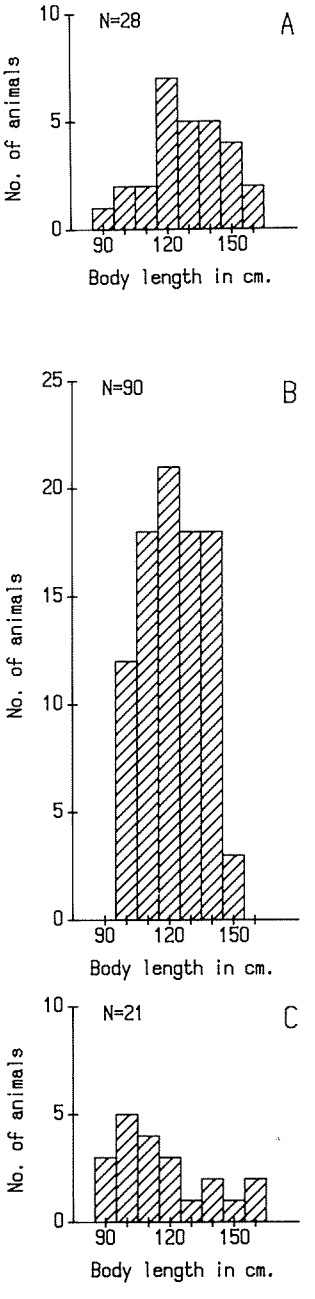

Fig. 2. Group distribution according to body length in the 1980-81 material caught in A: Trawl, B: set nets for cod and C: set nets for plaice.

Table I. The 149 harbour porpoises collected from August 1980 to February 1981 presented in relation to month of collection, fishing method and sex.

		Month of collection								
Fishing method	Sex	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Total no.	%
Trawl	♂	1	1		10	2			28	19
	♀	1	1	1	10	1				
Cod net	♂		14	11	18	6			90	61
	♀		10	8	16	4	2	1		
Plaice net	♂		6	6	2				21	14
	♀		5		2					
'Other nets'	♂				1				10	6
	♀		5	4						
Total no./month		2	42	30	59	13	2	1	149	100%

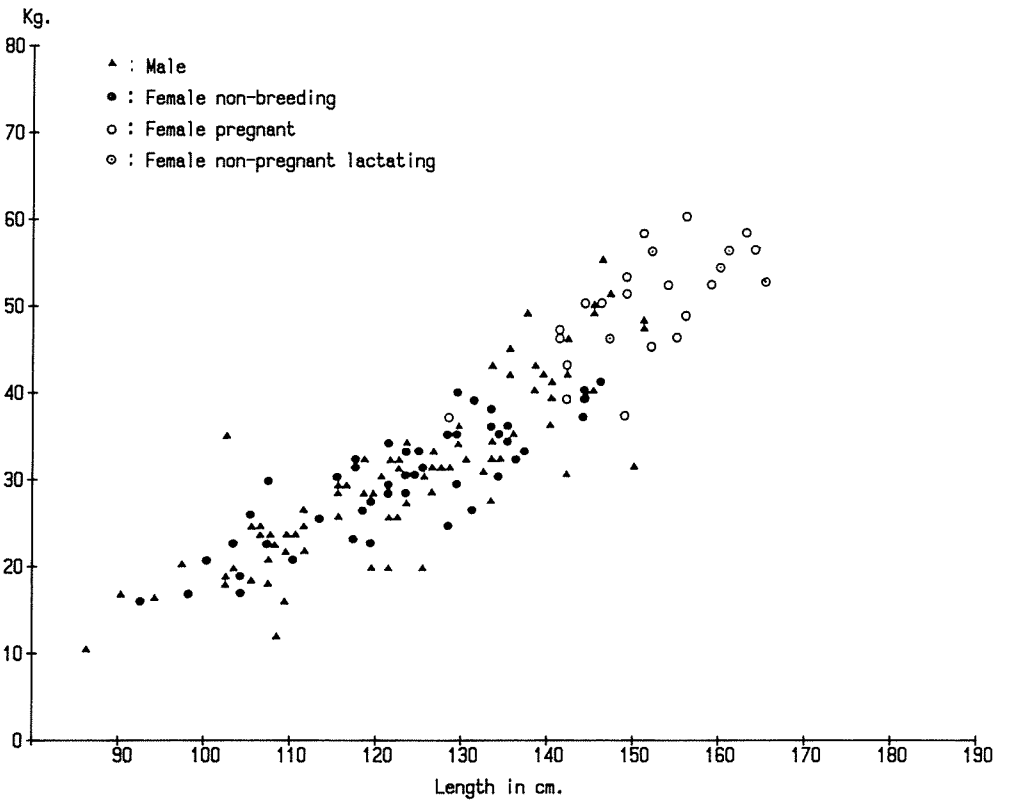

Fig. 3. Weight and length of the 149 harbour porpoises caught from August to February 1980-81, in relation to sex and pregnancy.

Health status evaluated on the basis of autopsy

All the animals but one had drowned and/or were injured in the head in connection with the netting.

Only two animals were found fatally diseased. One, a 122-month-old female, was caught in a net in the Cattegat in August. A general infection had developed from two 10× 10× 15 cm abscesses in the wall of the uterus. The other, a 111-month-old female, was found stranded in September. An infection had developed from a 5× 5× 5 cm abscess in the left ovary. Both animals were lactating and pleurisy and peritonitis had developed. A hemolytic streptococcus (Lancefield gr. L) was found in the abcesses and body cavity in the two animals. In both cases the infections had probably developed in association with pregnancy. The parasitic status did not differ from the average.

Skin and skin-lesions

Parasites were not seen on the skin of any of the harbour porpoises.

However, greyish asbestos-like spots were seen in the skin, these being irregular and varying in size from a few cm up to 10 cm in diameter. The lesions were found only in a small number of animals. They

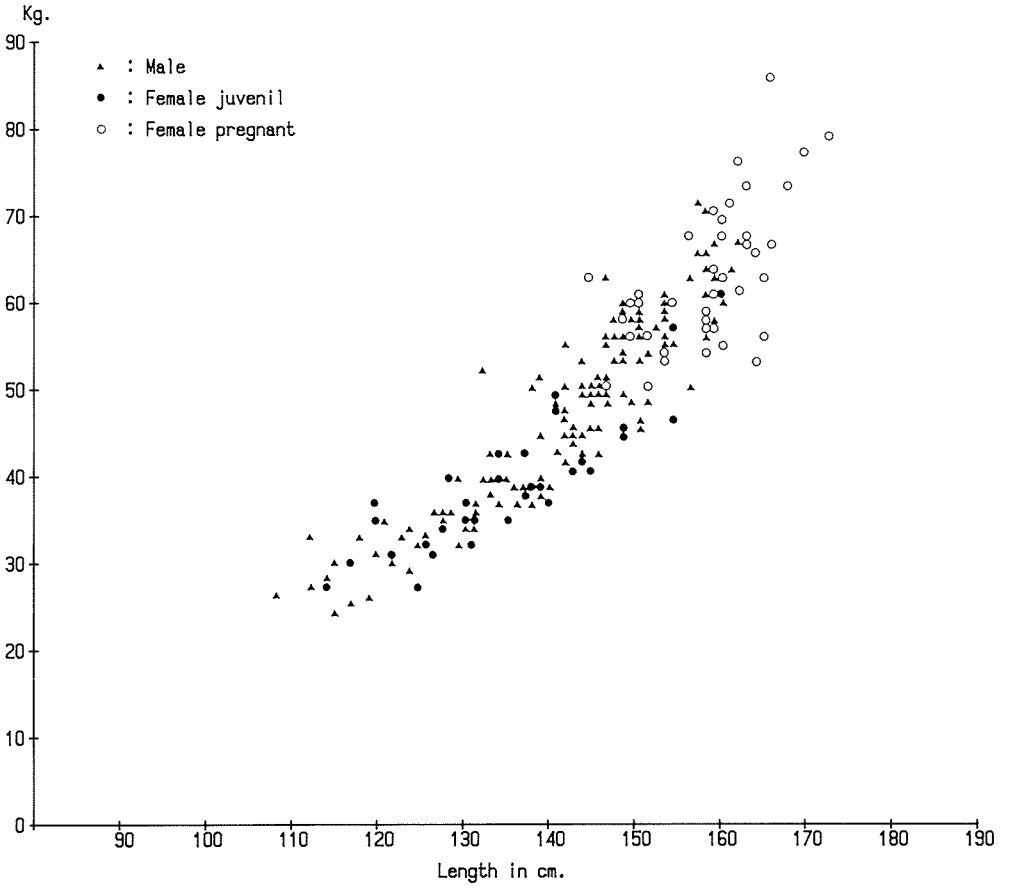

Fig. 4. Weight and length of 150 harbour porpoises caught in November and December 1941-43, in relation to sex and pregnancy.

could be seen on various parts of the body, head or tail and occurred in different age-groups. In a few cases, fungi were seen in histological sections. Similar grey spots have previously been seen in 20% of 108 harbour porpoises found dead or taken into captivity (ANDERSEN 1974 & 1978). Skin lesions have developed from these spots, finally causing the death of the captive harbour porpoises.

From previous experiments with eight harbour porpoises in captivity, it was found that a fungus could be cultured on sabourauds agar at 20°C from such lesions. The fungus could, when transferred to another harbour porpoise, cause the same lesions. Due to sterile mycelium in both tissue and culture, the micro-organism involved could only be classified as belonging to the group of imperfect fungi (B. CLAUSEN & S.ANDERSEN, unpubl.).

Subcutaneous fat and muscles

The thickness of subcutaneous fat in the 94 animals older than one year varied from 1 to 3.2 cm, with a mean of 1.9 cm (measured in the umbilicus region). The 55 animals less than one year old were fatter, having from 1.5 to 3.2 cm thick subcutaneous fat, the mean being 2.5 cm. Only in the stranded one of the two fatally diseased harbour porpoises had the colour of the fat changed from the normal white to dark yellow. Substantially thicker subcutaneous fat layer was found in the reference material, ranging from 4 to 6 cm in young animals

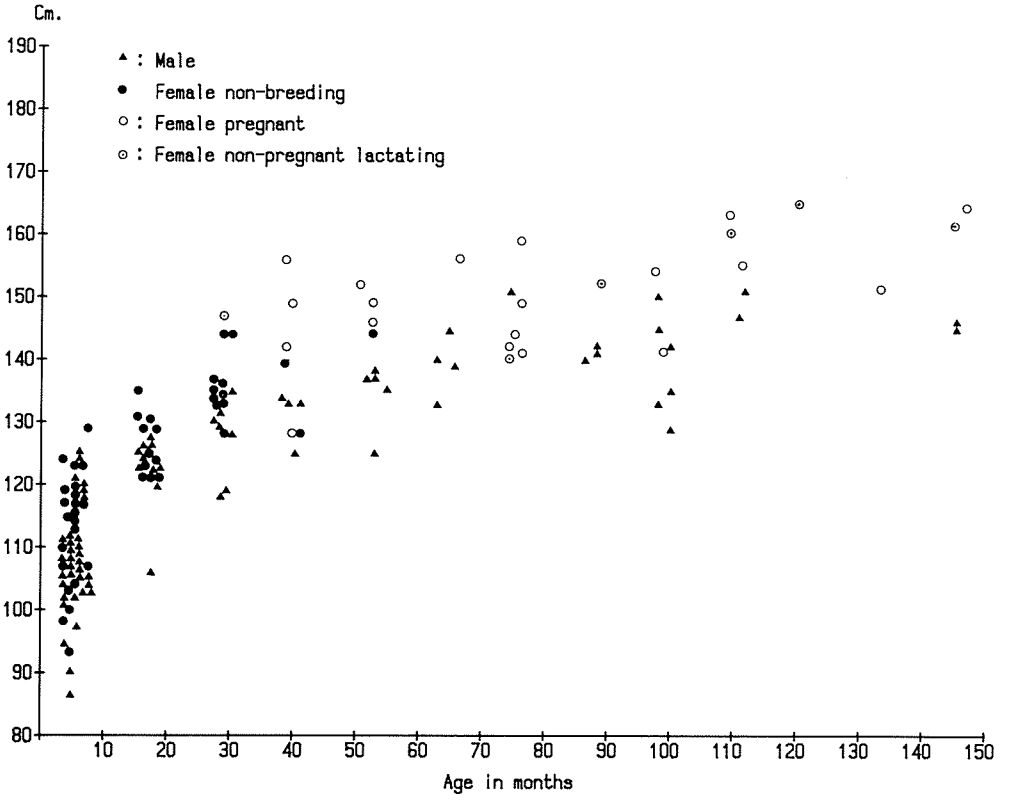

Fig. 5. Length and age of the 149 harbour porpoises caught in 1980-81, in relation to sex and pregnancy.

and from 2.5 to 3.5 cm in adult females. These animals were, however, taken in mid-winter when water temperatures were low.

The muscles were well developed in all animals and no pathological changes were observed.

Head

Earworms *(Stenurus minor)* were demonstrated in 11 of 49 animals less than one year old (22%) and in 50 of 71 animals more than one year old (70%). The rate of infection in relation to age and sex is given in Fig. 6.

The earworms were found in both males and females and seem to appear during the first year of life. The animals apparently remain infected for the rest of their lives.

The worms were found in numbers up to about 100 in the ear cavity around os bullae. Neither bacteriological infection nor large pathological changes were observed in connection with presence of worms.

The teeth were normally developed. They were worn in the older animals, but not down to the gingiva. All teeth appeared intact even in the old individuals.

Respiratory system

Lungworms *(Pseudalius inflexus)* were found in 17 of the 55 harbour porpoises less than one year old (31%) and in 91 of the 94

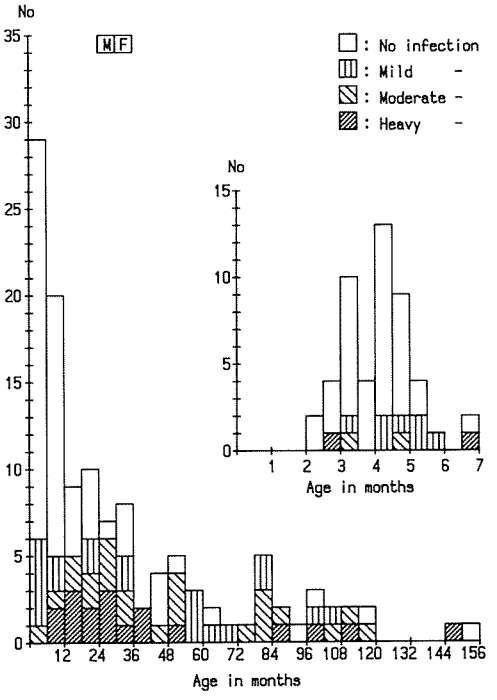

Fig. 6. Infection rate with ear worms (Stenurus minor) in 120 harbour porpoises, in relation to sex and age. Left column within each age group indicates males (M), and right column females (F).

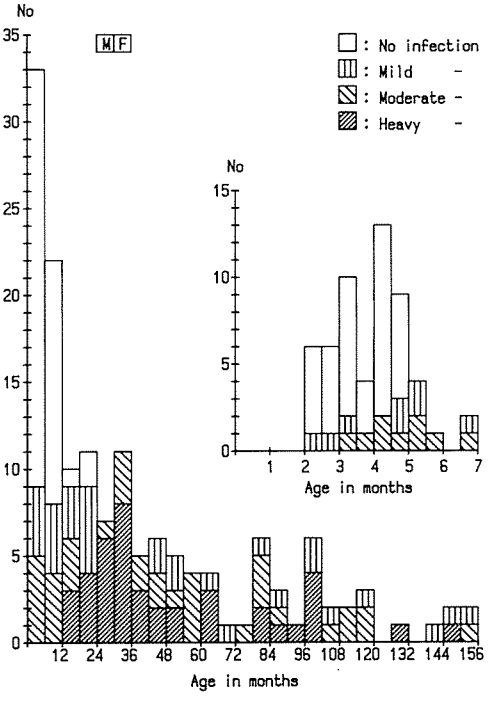

Fig. 7. Infection rate with lungworms (Pseudalius inflexus) in 149 harbour porpoises in relation to sex and age. Left column within each age group indicates males (M), and right column females (F).

older ones (97%). The rate of infection in relation to age and sex is given in Fig. 7. The animals become infected during the first 12 months of life and remain infected for the rest of their lives. Only a few worms were seen in the bronchii of animals less than one year old, whereas in older individuals moderate to large numbers of worms were usually found. Often the worms filled up the whole lumen of the bronchii, completely obstructing the function of the posterior part of the lung. In several cases, a local verminous bronchopneumonia was observed. No specific bacteria were found after aerobic culture of the parasitised lung tissue.

Mycoplasma was found in the lung tissue of 37 of the 88 harbour porpoises examined (42%). Colonies of isolated mycoplasmas showed the typical 'fried egg' morphology on solid medium, i.e. colour change in the added pH indicator to phenol red. During growth in broth, the mycoplasmas revealed a capacity of degrading arginine (N. FRIIS, pers. comm.).

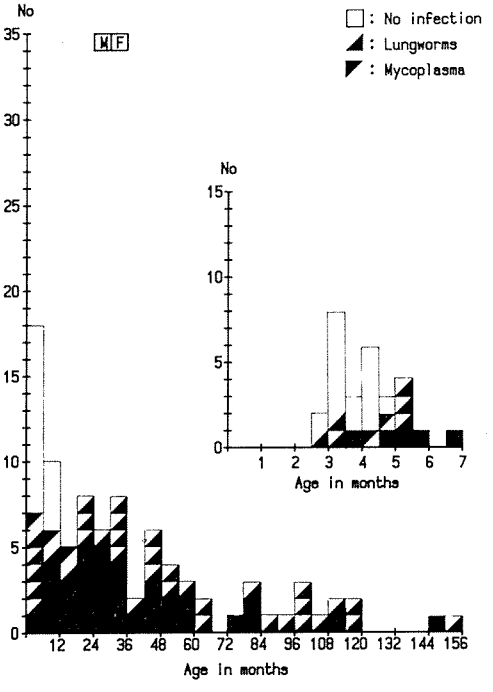

Fig. 8. Infection rate with lungworms and Mycoplasma in 88 harbour porpoises, in relation to age and sex. Left column within each age group indicates males (M), and right column females (F).

Serological examination, using the disc growth inhibition test of the isolated strains of mycoplasma, revealed that they were of two different groups, each differing from strain E62 isolated from harbour seals *(Phoca vitulina)* by MADOFF et al. (1980). By indirect immunofluorescence of colonies on solid medium, minor cross reactions between all three groups were registered. Further examinations are needed, however, for the final classification on the species level.

Findings of both types of mycoplasma are pooled and recorded in relation to the findings of lungworms in Fig. 8. While 15 of the 28 young harbour porpoises less than 12 months old (54%) were not infected at all, 6 were infected with lungworms, 2 with mycoplasma alone and 5 were infected with both lungworms and mycoplasma.

In the adult animals, up to ⅓ of the lung tissue may be out of function due to lungworm infection, but the general condition of these animals does not appear to be affected. At least those animals most heavily parasitised did not (cf. Fig. 3) differ in length or weight from the rest of the animals in the survey, nor was the amount of subcutaneous fat considerably smaller.

About 50 harbour porpoises were systematically examined for parasites in the survey from 1941-1943. Lungworms *(Pseudalius inflexus)* were seen in the majority of the animals. This parasite was further seen in the heart and in the large veins (WESENBERG-LUND 1947), sometimes in so large numbers that they might impede the flow of blood. In the present survey only a few worms were observed in the heart of a single animal.

Digestive system

Scars up to 3 × 5 cm were seen in the oesophagus of several harbour porpoises, probably caused by ulcerations similar to those previously reported in captive harbour porpoises from Denmark (ANDERSEN 1974 & 1978).

Stomach worms *(Anisakis simplex)* were found in 5 of the 55 harbour porpoises less than one year old (9%) and in 20 of the 94 older harbour porpoises (21%). The worms were found exclusively in the oesophageal part of the stomach lined with oesophageal epithelium. The rate of infection in relation to age and sex of the harbour porpoises is given in Fig. 9. Stomach worms were found in numbers of up to one hundred. In the stomach of 12 of these animals the worms were sitting in a volcano-like swelling up to 6-7 cm high with a proximal diameter of 5 cm and a distal one of 4 cm. Ten to fifteen worms of various sizes were attached to the bottom of the 'crater' with their 'tails' freely protruding into the lumen of the stomach. Pus and necrotic tissue were seen at the bottom of the swelling. The general body condition appeared normal, even in those animals with the largest ulcerations of the stomach. No parasites were demonstrated in the entire intestine except for a 99-month-old female from the North Sea, which carried hundreds of tapeworms *(Diphyllobothrium stemmacephalum)* in the jejunum.

Liver flukes *(Campula oblonga)* were found in the bile ducts in 8 of the 55 animals less than one year old (15%), and only in the form of mild infections. Sixty-four of the 94 animals more than one year old (68%) were infected. The rate of infection in relation to age and sex is given in Fig. 10. It is obvious that about ⅔ of the infected older harbour porpoises (more than 12 months old) showed infection rates characterised as moderate to heavy. Liver flukes are found less frequently (15%) than earworms (22%) and lungworms (31%) in harbour porpoises less than one year old.

The older harbour porpoises were often heavily infected with liver flukes. The walls of the bile ducts were thickened and the lumen small, but large numbers of flukes could also be seen in livers without pathological changes. Even though obstruction of bile duct seems likely to occur in heavily infected animals, icteric harbour porpoises were not seen in the survey.

In the reference material, similar lesions were seen in more than 90% of the livers from animals weighing more than 30 kg, whereas they were seldom seen in smaller animals. MØHL-HANSEN (1954) concluded that the lesions were probably caused by parasites, and there seems to be no doubt that the harbour porpoises taken 40 years ago also carried liver flukes.

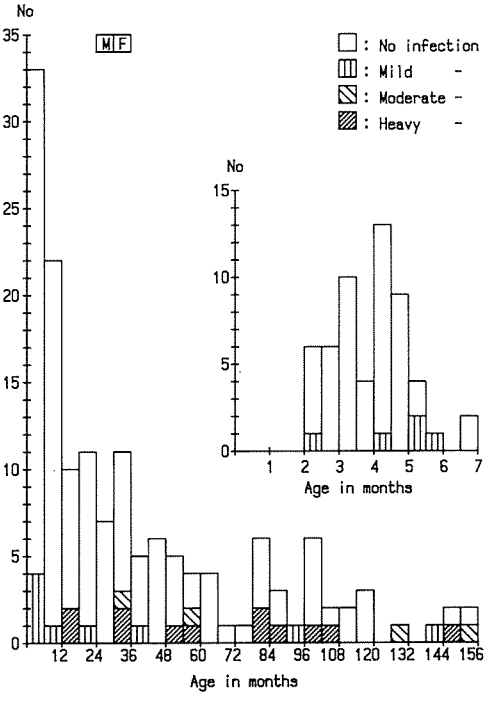

Fig. 9. Infection rate with stomach worms (Anisakis simplex) in 149 harbour porpoises, in relation to age and sex. Left column within each age group indicates males (M), and right column females (F).

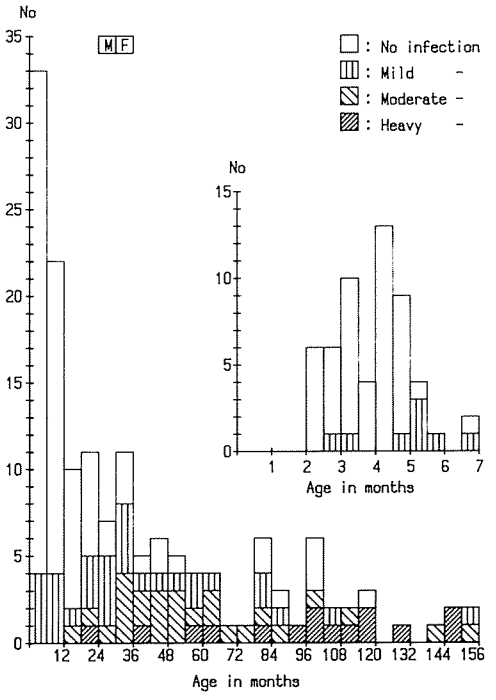

Fig. 10. Infection rate with liver flukes (Campula oblonga) of 149 harbour porpoises, in relation to sex and age. Left column within each group indicates males (M), and right column females (F).

Reproductive system and sexual maturity

It is evident that the females start breeding when about 140 cm in length and weighing about 40 kg (see Fig. 3), whereas the animals taken in November-December 1941-1943 were usually at least 150 cm long and weighing a minimum of 50 kg before pregnancy was recorded (see Fig. 4). In some females taken in September, only lactation from the previous birth was recorded, as a possible foetus was too small to be seen. The foetus was always found in the left horn of the uterus. Twins were not observed. The youngest pregnant harbour porpoise was, according to dental age determination, 29 months old and it was lactating!

Of the 27 females more than 3 years old, 3 were neither pregnant nor lactating (11%), 19 were pregnant (70%), and in 5 lactating harbour porpoises no foetus was recorded (19%).

Of the 42 females in the reference material more than 150 cm long, 5 were recorded as non-pregnant (12%).

Of the above-mentioned 3 animals older than 3 years which were found to be neither pregnant nor lactating, 2 were only 39 and 41 months old, respectively. These two may only recently have become sexually mature. One of these carried 18 and the other 69 mg PCB per kg blubber. The last reproductively inactive female was 53 months old, and the ovaries were developed like those found in juveniles. She carried 75 mg PCB and 10 mg DDT per kg blubber.

The weight of testicles related to age is given in Table 2. The weight did not differ much in the harbour porpoises less than one year old, while a higher weight of testicles was registered in some of the males less than 36 months old caught in September. A few spermatozoa were found in 5 animals all between 2 and 3 years old. In animals more than 3 years old, the testicles were large and during September they nearly all contained large numbers of apparently normal spermatozoa.

Table 2. The weight of the testicles of 77 harbour porpoises bycaught in 1980-81

Age groups (in months)	Mean weight (g)	Range (g)	No.	No. with spermatozoa
1 - 12	25	9 - 46	32	0
13 - 36	96	42 - 231	16	5
37 - 147	398	99 - 1,572	29	16

Table 3. Analyses for cadmium and mercury in the kidney. Results are in mg/kg wet weight (ww) in relation to age groups. Mean age is given in months.

	CADMIUM				MERCURY		
Age groups in months	No.	Mean age	Mean	Range	No.	Mean age	Mean
1 - 12	27	4	0.1	0.01 - 0.8	28	4	0.4
13 - 36	18	21	0.3	0.01 - 1.3	21	22	0.7
37 - 147	29	75	0.5	0.01 - 1.6	40	76	1.3

Chemical analyses

The animals are divided into 3 age groups: (1) animals less than one year old; (2) prematures up to 36 months old (which seems to be the age for sexual maturity); and (3) animals in the reproductive age.

In kidney tissue the dry matter percentage was 24 (range 18-32%). The amount of cadmium and total mercury in the kidney is given in Table 3 for the 3 age groups. The amount of both cadmium and mercury increases with the age of the animals. No difference was found in the load of cadmium and mercury between the sexes.

The amount of extractable fat averaged 89% (range 79-98%). The results of the DDT and PCB analyses in relation to age and sex are given in Table 4. It can be seen that only in males do the DDT and PCB contents increase with age.

Table 4. Analysis for DDT and PCB. Results are given in mg/kg blubber in relation to sex and age groups. Mean age is given in months. Standard deviation is given in brackets. (M: male; F: female)

				DDT		PCB	
Sex	Age groups in months	No.	Mean age	Mean (sd)	Range	Mean (sd)	Range
M	< 12	4	3	19 (17)	7.1 - 49	53 (39)	25.0 - 120
M	13 - 36	6	22	15 (5)	6.7 - 24	62 (25)	34.0 - 98
F		4	28	14 (4)	11.0 - 21	58 (12)	43.0 - 71
M	37 - 147	19	80	40 (41)	7.5 - 180	127 (83)	39.0 - 340
F		18	74	12 (8)	1.4 - 38	54 (29)	3.7 - 110

Discussion

This study has revealed the presence of a bycatch which has not previously been documented. Harbour porpoises are only occasionally seen in the ports, as they are usually cast adrift when caught in nets or in trawl fishery, where sorting of the catch takes place on board at sea.

It is difficult to estimate the size of the bycatch. It seems reasonable to believe that only a fraction of all animals actually caught during the collection period arrived at the National Veterinary Laboratory.

It will inevitably cause some problems for the fishermen to contribute to a collec-

tion of this type. They may imagine, for example, that documentation of a considerable bycatch of harbour porpoise might lead to some kind of restriction on their own fishery. Therefore the fishermen have no interest in revealing the actual bycatch.

There is an indication of the actual size of the bycatch from the wreck fishery based on information given by the fishery inspectors from the harbours mostly involved. Approximately one hundred boats join roughly 30 trips a year catching each about one animal per trip, so indicating that up to 3,000 porpoises might be caught each year in connection with this type of fishery. There is no indication of the size of the bycatch in other fisheries, but it might make up several thousands. From interviews with fishing inspectors in the harbours on the matter of bycatch there seems, however, to be no intentional catching of harbour porpoises, as the animal is of no commercial value to the fishermen. Furthermore, this bycatch sometimes creates considerable inconvenience by blocking the automatic unloading of trash fish.

The fact that harbour porpoises are taken in mid-water trawls has been mentioned sporadically in the literature (UTRECHT 1978), but the results of the present survey indicate that trawling plays a more important role than previously assumed. UTRECHT also stated that healthy harbour porpoises can easily avoid the trawls. The large number of animals (Fig. 2) caught in trawls in this material is contradictory to that statement, and from the results on health status there is no indication that the animals caught were diseased. Trawls or other nets do not seem to select for any particular age group (Fig. 2).

Figs. 3 and 4 show that reproduction starts when the females are about 10 kg lighter and about 10 cm shorter, and probably younger, than the females sampled 40 years ago. Furthermore, it was found that the larger animals in the population have disappeared as only 1% weighed more than 60 kg and only 2% were longer than 160 cm. The comparable figures in the reference material are 35% and 26%, respectively.

The presence of shorter and probably younger animals, and the disappearance of the larger individuals, could suggest that the bycatch causes an overexploitation of the population.

Intentional catching has no influence on the population of harbour porpoises in Danish waters as regular hunting of harbour porpoises in the Little Belt was suspended in 1892, and in this century intentional catching has only been carried out on a small scale during 1916-19 and 1941-44 (MØHL-HANSEN 1954).

KASUYA (1985) similarly observed a decrease in mean age when sexual maturity was reached among striped dolphins *(Stenella coeruleoalba)* suffering from exploitation.

The high frequency of pregnant animals both in the present material (min. 69%) and in the reference material (78%) indicates that some harbour porpoises breed every year. The high number of reproductively active females indicates a normal breeding population.

The finding of spermatozoa in the large testicles of harbour porpoises older than 3 years indicates that males become sexually mature when about 3 years of age (Table 1).

The levels of cadmium and mercury must be considered relatively low when compared with those found in another survey on marine mammals (KAYES 1985). The load of heavy metals is regarded as being without influence on the health of the harbour porpoises.

The levels of DDT seem relatively low and the PCB levels are not alarmingly high when compared with the results of studies on harbour porpoises and other marine mammals in European waters (KAYES 1985).

Swedish surveys suggest a reduced reproduction possibly associated with levels of more than 100 mg PCB/kg in blubber from female ringed seals *(Pusa hispida)* (HELLE et al. 1976; BERGMANN et al. 1981).

The levels of PCB in the blubber of harbour porpoises in the present survey are lower than those found for a seal population in the Baltic Sea (KAYES 1985). The harbour porpoises in Danish waters seem to breed well. Furthermore, the PCB levels in the few non-pregnant or non-lactating adult females examined do not seem to be above average. Therefore, there is no indication of decreased reproduction among Danish harbour porpoises due to PCB contamination.

The PCB/DDT ratio might indicate that the harbour porpoises examined were part of a population living in waters west of Sweden, as a much larger proportion of DDT is found in harbour porpoises and seals living in the Baltic Sea (OTTERLIND 1976; HELLE et al. 1976; JENSEN et al. 1979). In the present study levels of chlorinated hydrocarbons are more or less the same in males as in females up to 3 years of age, while adult males older than 3 years carry much more PCB and DDT than do females of the same age (Table 4).

It is well established that pregnancy and lactation result in a loss of organochlorine contaminants (KAYES 1985).

After the finding that the harbour porpoises are heavily parasitised, one might ask whether this study is dealing with mainly diseased animals or an unhealthy population.

For example those harbour porpoises heavily parasitised with earworms might not orientate themselves acoustically very well and could therefore easily be caught in the nets, thereby becoming over-represented in this survey. However a different catching technique was used for the reference material in 1941-1943, when all the harbour porpoises were driven into nets by people in boats. These animals were also heavily parasitised with earworms, nearly 100% of the adults carrying worms with a maximum of 1,500 worms registered in a single animal.

The large number of lungworms causing the corresponding pathological changes in the lung tissue in most of the animals and the high number of animals harbouring mycoplasmas might also indicate an unhealthy population. The mycoplasma is at least known to invade livestock, which for other reasons are already weakened. On the other hand, lungworm infestation seems to be of common occurrence in the population of harbour porpoises in Danish waters. In the reference material the infection rate was even higher.

The high number of liver flukes and the corresponding changes of bile ducts may cause obstruction of these ducts and in this way be fatal to the harbour porpoise, but no cases of icterus were observed in the present survey. In the reference material the infestation with liver flukes was even higher, as Møhl-Hansen found changes in the liver probably caused by liver flukes in 90% of the harbour porpoises weighing more than 30 kg. Large ulcerations in the stomach due to worms may probably cause pain and even result in penetration to the abdominal cavity.

These bycaught harbour porpoises do not seem to be more parasitised than those specimens taken in pond nets (ANDERSEN 1974) or harbour porpoises caught 40 years ago.

Harbour porpoises taken in 1970 in Swedish waters carry the same load of parasites (B. CLAUSEN unpubl.).

Altogether it is believed that the present sample of harbour porpoises is a random selection of free-ranging animals, assuming that the harbour porpoises do not detect acoustically or optically the nylon filaments of the nets and that they are facultative echolocators.

Experience from harbour porpoises taken into captivity from Danish waters indicates that the major cause of death of harbour porpoises shortly after they have been collected is diseases that are most often caused by parasites.

Similarly, the free living harbour porpoises might very well die due to parasitism under unfavourable conditions, such as shortage of food, disturbance, etc.

Further studies of harbour porpoises taken in European waters might reveal whether an apparently heavy load of parasites is normal for the population of harbour porpoises in western Europe. It is essential, however, to achieve counts or well-documented estimates of the total population of harbour porpoises in order to evaluate whether or not bycatch is a threat to the population. These studies should be combined with a more accurate record of the bycatch in West European waters and possible means of minimising or preventing this bycatch.

The results of the present survey which indicate a considerable bycatch support the statement given by GASKIN et al. (1984), that 'present, incidental net captures probably represent not only the major threat to several phocaenid species, but may also prove to be the most frustrating and unattractive obstacle to any successful management programmes for these animals'.

Dansk resumé

Vurdering af bifangst af marsvin *(Phocoena phocoena)* i danske farvande og status over deres helbredstilstand.

I perioden august 1980 til februar 1981 blev der indsamlet 149 marsvin. Dyrene blev taget som bifangst af danske fiskere og blev fra danske fiskerihavne indleveret til undersøgelse. Formålet med undersøgelsen var at vurdere størrelsen af bifangst af marsvin i danske farvande, sat i relation til forskellige typer af fiskeri. Desuden ønskedes en vurdering af sundhedstilstanden af bestanden, herunder parasitmængden, dyrenes reproduktionsforhold og belastningen med kviksølv, cadmium, PCB og DDT. Det indsamlede materiale er, hvor muligt, sammenlignet med informationer og resultater fra en undersøgelse af marsvin fanget i 1941-43.

Undersøgelsen viser, at der sker en betydelig bifangst af marsvin. Der synes ikke at foregå nogen selektion af marsvin ved bifangst. Dyrene, som er uønskede af fiskerne, synes ikke at blive fanget i én speciel nettype, idet de optræder i såvel bundgarn som i trawl og net sat for fladfisk og torsk.

Undersøgelsen antyder, at bestanden er ændret siden 1941-1943. De større og dermed ældre dyr optræder nu meget mere sparsomt. Hunnerne er ligeledes nu kortere og dermed sandsynligvis yngre, når de får unger første gang. Det kan ikke udelukkes, at dette er en følge af den store bifangst af marsvin.

Dyrene synes at have samme gode reproduktionskapacitet som i 1941-43. Marsvin fanget i 1980-81 synes ikke at være mere parasiterede end dyr fra tidligere undersøgelser.

Det foreslås, at der bør foretages en sammenligning med parasitbelastningen i marsvin fra andre vesteuropæiske bestande, og at yderligere studier bør koncentreres om en mere nøjagtig registrering af bifangsten af marsvin i Vesteuropa. Endelig påpeges nødvendigheden af en vurdering eller optælling af den totale bestand af marsvin og en belysning af de måder, hvorpå bifangsten kan formindskes eller forebygges.

Резюме на русском языке:
Оценка побочной ловли морских свиней (Phocoena phocoena) в датских водах, и статус состояния их здоровья.

В периоде с августа 1980 г. по февраль 1981 г. было собрано 149 морских свиней. Животные были пойманы датскими рыбаками в виде побочной ловли, и из датских рыбацких гаваней были посланы на обследование. Целью обследования была оценка величины побочной ловли морских свиней в датских водах по отношению к разным видам рыбной ловли. Кроме того желалась оценка состояния здоровья популяции, включая количество паразитов, условия размножения животных, и степень заражения ртутью, кадмием, PCB и DDT. Собранный материал, поскольку это было возможно, сличался с информацией и результатами, полученными исследованием морских свиней, пойманных в 1941-43 годах.

Исследование показывает, что происходит значительная побочная ловля морских свиней. Кажется, что при побочной ловле морских свиней не происходит никакого выбора, так как она рыбакам нежелательна. Животных повидимому не ловять сетями какого-нибудь определенного типа, побочная ловля их случается как в донных неводах, так и в траловых сетях и в сетях для плоской рыбы и трески.

По результатам исследования можно предполагать, что состав популяции с 1941-1943 годов изменился. Более крупные и, следовательно, старые животные встречаются менее многочисленно. Самки теперь также короче и, следовательно, моложе, когда они родят в первый раз. Возможно, что это является последствием значительной побочной ловли морских свиней.

Кажется, что условия размножения животных так же благоприятельны, как в 1941-1943 годах. Морские свиньи, пойманные в 1980-1981 годах, не кажутся сильнее зараженными паразитами, чем животные при прежних исследованиях.

Предлагается произвести сравнение со степенью заражения паразитами морских свиней других Западно-Европейских популяций, и сосредоточить дальнейшие исследования на более точную регистрацию побочной ловли морских свиней в Западной Европе. Наконец указывается на необходимость оценки или подсчета общей популяции морских свиней и выяснения способов, которыми было-бы возможно сократить или предотвратить побочную ловлю.

References

ANDERSEN, S.H., 1974. A typical case history of the net-caught harbour porpoise, *Phocaena phocaena* from Danish waters. J. Aquatic Mammals, **2**(3): 1-6.

ANDERSEN, S. H., 1978. Experiences with harbour porpoises, *Ph. phocaena*, in captivity: Mortality, autopsy findings and influence of the captive environment. J. Aquatic Mammals, **6**(2): 39-49.

ANDERSEN, S. H., 1982. Change of occurrence of the harbour porpoise, *Ph. phocaena*, in Danish waters as illustrated by catch statistics from 1934 - 1970. FAO Fisheries Series **5**(IV), 131-133. Rome 1982.

BERGMANN, A., M. OLSSON, L. REUTERGARDH, 1981. Lowered reproductive rate in seal population and PCB: A discussion of comparability of Baltic seals. ICES L.M./N. **10**: 1-17 (Mimeo).

GASKIN, D. E., G. J. D. SMITH, A. P. WATSON, W. Y. YASUI & D. B. YURICK, 1984. Reproduction in the porpoises *(Phocaeni-*

dae): Implications for management. Rep. Int. Whal. Comm. (special iss.6.).

HAYFLICH, L., 1965. Tissue cultures and mycoplasmas. Tox. Rep. Biol. Med. **23**, suppl. 1: 285-303.

HELLE, E., M. OLSSON & S. JENSEN, 1976. DDT and PCB levels and reproduction in ringed seal from the Bothnian Bay. Ambio **5**: 188-189.

JENSEN, S., L. REUTERGARDH & B. JANSSON, 1979. Analytical methods for measuring organic chlorines and methylmercury by gas chromatography. Seventh FAO/SIPA workshop on aquatic pollution in relation to protection of living resources. FAO Tec. Paper FIR: TPLR/79/4.

KASUYA, T., 1985. Effect of exploitation on reproductive parameters of the spotted and striped dolphins off the Pacific coast of Japan. Scient. Rep. of the Whales Res. Inst. **36**: 107-138.

KAYES, R. J., 1985. The decline of porpoise and dolphin in the southern North Sea. Res. Rep. PR 14. Political Ecology Rec. Gr. Ltd., 34 Crowley Rd., Oxford OX4 1HZ, England.

KINZE, C.C., 1987. Hvad ved vi om marsvinet? Økologisk status over Danmarks truede ynglehval. Kaskelot **75**. pp. 14-23.

LINDSTEDT, G., 1970. A rapid method for the determination of mercury in urine. Analyst, **95**: 269-271.

MADOFF, S. SCHOOLEY, R.T., RUHNKE, H.L. DEL GIUDICE, R.A., BARKER, I.K., GERACI, J., BARKER, A.S. 1980. Mycoplasma pneumonia of phocid (harbour) seals. Third Conf. of the Int. Org. of Mycoplasmology. 3rd Sep. Custer, South Dakota, U.S.A.

MØHL-HANSEN, U., 1954. Investigations of reproduction and growth of the porpoise *(Phocaena phocaena)* (L.) *(cetacea)*. Vidensk. Medd. Dansk Naturh. Foren. **116**: 369-396.

NIELSEN, H.G., 1972. Age determination of the harbour porpoise *Phocoena phocoena* (L) *(cetacea)* Vidensk. Medd. Dansk Naturh. Foren. **135**: 61-84.

OTTERLIND, G., 1976. The harbour porpoise *(Phocaena phocaena)* endangered in Swedish waters. ICES CM 1976/N: **16**: 1-7.

UTRECHT VAN, W. L., 1978. Age and growth in *Ph. phocaena* L. 1758 *(Cetacea, Odontoceti)* from the North Sea. Bijdragen tot de Dierkunde **48**: 16-28.

WESENBERG-LUND, E., 1947. On three parasitic nematodes from *cetacea*. Vidensk. Medd. Dansk Naturh. Foren. **110**: 17-30.

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