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Gross pathology of the Weddell seal (*Leptonychotes weddelli*) in the Vestfold Hills, East Antarctica

R. A. McFarlane B.V.Sc., M.R.C.V.S.

Namina Road, Murrumbateman, N.S.W. 2582 Australia

Summary

A long term monitored population of Weddell seal (*Leptonychotes weddelli*) that hauls out on the fjord and coastal sea ice of the Vestfold Hills, near Davis (68°31'S, 78°12'E) Antarctica was monitored throughout the Antarctic summer of 1990–1991 for examples of morbidity and mortality concurrent to primary research projects of the Australian Antarctic Division. Ocular, skin and respiratory disease and postpartum discharges and diarrhoea were observed and pup mortality was investigated by post mortem investigation. Other literature describing pathology in the Weddel seal is reviewed.

Introduction

The Weddell seal is the most southerly breeding of the Antarctic seals and is rarely observed except when hauled out during lactation and moult during the Antarctic summer. Population studies of the Vestfold Hills group have illustrated the difficulty in assessing true numbers of adult seals by aerial and ground censusing and have questioned the significance of an apparent population decline from 1978–1984 as no supporting evidence was present in pupping records (Green *et al.*, 1992). Much of the information available on morbidity, mortality and reproductive success in the species was obtained by zoologists when hauled-out seals were slaughtered for feeding dogs at Antarctic bases (Bertram, 1940; Lindsey, 1937; Mansfield, 1958; Stirling, 1969; Stirling, 1971) and few specific reports of pathology have been recorded (Prathap *et al.*, 1966; Wilson, 1970) or summarised (King, 1963; King, 1983; Ridgway, 1972). More recently several studies have looked specifically for evidence of viruses or pollutants in Antarctic pinnipeds including the Weddell seal (Bengston *et al.*, 1991; Harder *et al.*, 1991; Hidaka *et al.*, 1983; Kawano *et al.*, 1984; Osterhaus *et al.*, 1988). This study observed and described the pathology of the Weddell seals of the Vestfold Hills and conducted post mortem examinations where possible. As the opportunity to make multiple observations of individuals in a reproductively healthy wild population (and during the most stressful period of the annual cycle) may provide clues to morbidity and mortality factors in the species, it was hoped that some understanding of the health status of the fluctuating adult population could be obtained.

Materials and methods

During annual population studies of Weddell seals during the pupping haul-out (November and December 1990) and the moulting haul-out (January to March 1991) records were made of all observed pathology. During the study period a maximum count of 715 seals and 137 pups was recorded although this does not represent all seals frequenting the site (Green *et al.*, 1992). Seven carcasses were observed over this period (six pups and one adult) and, of these carcasses, five pups were available for post mortem examination. Age of pups was estimated from measurements of standard length (Bryden *et al.*, 1984) as considerable distortion of the bodies after exposure to the weather (four pups were noted dead in situ a month prior to examination) and unknown feed intake made girth and body weight unreliable parameters. Post mortem examinations were made in situ and subsequent to the rapid freezing of tissues after opening carcasses no samples were collected for histopathology,.

The largest of the lactation haul out sites was situated in Shirokaya Bay, Long Fjord and regular monitoring of this group during lactation enabled multiple observations of tagged individuals. The majority of observations of pathology below are described from this group and the frequency of observations for this group are given under each section where relevant. A table summarising attendance of the site by seals over this period is used to describe the occurrence of external wounds. From 10 November until 31 December 1990 fifteen males,

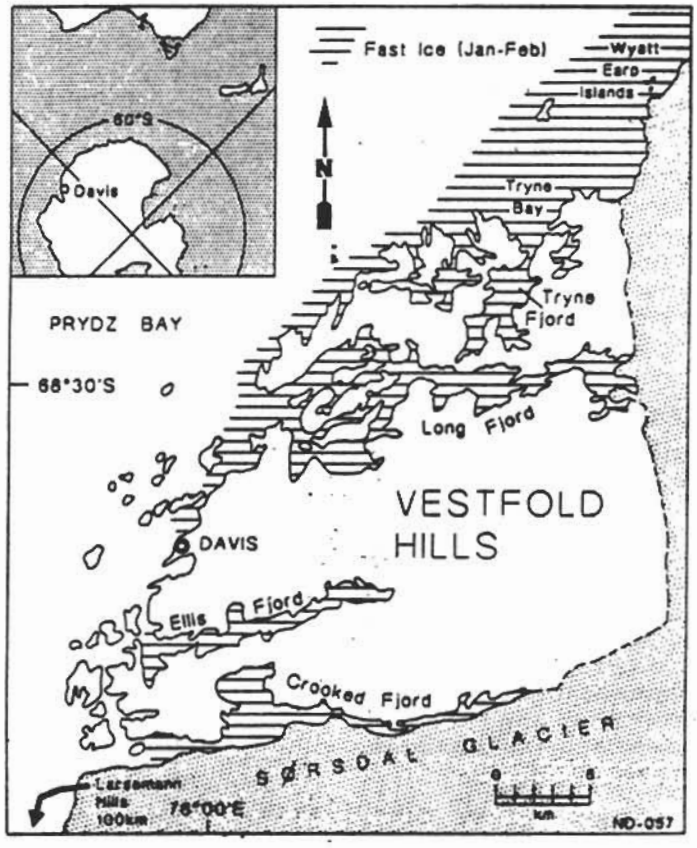

Figure 1. Map of the study area.

fifty lactating cows, twenty five non-lactating cows and fifty pups were recorded as separate individuals at the site.

Results

Mortality

Pup mortality Four of the six pup carcasses were associated with the Shirokaya Bay group (suggesting a mortality of 7.4%). A summary of findings is presented in Table 1.

Misadventure Three mummified Weddell seal carcasses of unknown age were identified by dentition at inland lakes some kilometres over rough terrain from the fjords and coast normally frequented. This aberrant migration is not restricted to the Weddell as carcasses of crabeater, southern elephant, and leopard seals were also found at these locations some of which have been recorded previously (Johnstone *et al.*, 1973).

Morbidity

Pup ill-health: 6 cases Two pups were observed to be under weight but were never retrieved as carcasses, one had a superficially infected tag puncture but no other suggestion of cause was evident from either cow or pup pair. Each pup was sighted together with its cow at each observation. In other pups, frothy, watery diarrhoea (1), fresh blood in tan diarrhoea (1), purulent nasal discharge (1) and nasal discharge and diarrhoea (1) were observed. Occasional wounds were also noted (as below).

Disease or retarded growth was recorded in 10% *of the Shirokaya Bay pups.*

Skin lesions Skin lesions related to aggression and trauma were observed frequently. Large open wounds possibly associated with killer whale (*Orcinus orcus*) attacks were noted on three seals. Two seals had wounds measuring approximately 20 cm × 20 cm × 4 cm dorsally on their caudal

Table 1. Summary of post mortem examinations of Weddell seal pups

Sex	Standard length (nose to tail)	Estimated age (days)	Appearance of lungs	Gastro-intestinal contents	Abdominal fat	Subcutaneous fat (measured at ventral midline)	Notable pathology
M	1.00 m	0–1	Aerated	Present	No	<2 mm	Marked enlarged spleen, pale carcass with small autolysed kidneys
F	1.17 m	0–1	Not aerated	No	Present	<2 mm	N.S.F.
F	1.28 m	3–4	Aerated	Present	Present	<2 mm	N.S.F.
M	1.24 m	3–4	Aerated	Present	Present	<2 mm	N.S.F.
M	1.33 m	14	Aerated	Present	Present	2–4 mm	Muscle bruising and subcutaneous emphysema evident over one shoulder; patchy congestion of lungs most notable in the cranial lobes; pockets of gas in hepatic serosa

body which were granulating without evidence of infection during the moulting haul-out. One of these seals had evidence of linear scarring around its girth continuous with the major lesion. A lactating cow was observed twice in five days with a hind fluke traumatically amputated distal to the tarsus healing and contracting rapidly without evidence of infection.

During lactation skin lesions were often multiple. Wounds on males (19) were recent and usually infected. They involved stab wounds around the penile opening (>9), lacerations above the fore-flukes (>5), flank (4), head (3) including one seal (denoted 'b' in the Table 2 below) with a crooked jaw, presumed fractured, with bloody saliva and multiple fresh injuries that was further attacked by females after hauling out exhausted. Other males with multiple wounds (8) were not specified.

Wounds on females (15) were more varied and include healed scars on the belly (3), head (1), dorsum (1), not stated (3) and recent wounds including puncture marks at the neck (1), lacerations above the fore-flukes (2), head (1), lacerations or stabs to the belly (3), puncture wound(s) to the flank (3), and multiple fight wounds (1). The cow with fresh puncture marks on the belly was accompanied by a pup with a laceration above a fore-fluke. Only three other pups were seen with lesions and include a healing laceration above a fore-fluke, punctures around the penile opening and an infected wound over a digit of a hind-fluke.

The majority of these observations (21) were made at Shirokaya Bay. These observations are tabulated below (Table 2) as they more accurately illustrate frequency of lesions in males (53%), lactating cows (6%), non-lactating cows (28%) and pups (8%) during the progress of lactation.

Ocular pathology: 12 cases The lachrymal duct is absent in Weddell seals (Wilson, 1970) and an overflow of tears onto the face is often accompanied by inflamed conjunctiva when out of water. Active and resolved corneal ulcers including herniated corneal stroma/desmetocoele (1), irregular dermal infiltration (1), complete and partial corneal opacity (4) with vascularisation (1), and blephrasphasm with purulent ocular discharge (3), hyphaema and corneal (and head) scarring (1) were observed. One female exhibited marked medial strabismus of the right eye.

Ocular disease was recorded in 4.4% of the adult seals at Shirokaya bay.

Respiratory disease: 9 cases A solitary subadult Weddell seal had a mass of frothy material attached to its nostril, mouth and face approximately 15 cm in diameter with purulent nasal discharge and dyspnoea. An adult female seal which produced approximately 200 ml of pink froth at its mouth after abdominal contractions also had purulent discharge at the nares. Purulent nasal discharge was also seen in two suckling pups. Four adult Weddell seals and a pup were observed to produce a similar frothy phlegm like substance after in-air singing (an aggressive vocalisation described by Terhune *et al.*, 1994), coughing or abdominal contractions. Multiple patches of this substance were present on the ice on the days of these observations and samples were collected from the ice. No parasites were grossly present.

Post partum vaginal or uterine discharge: 5 cases Cows affected appeared in good health with bright and active suckling pups. One pup was subsequently observed to develop watery diarrhoea

Table 2. Occurrence of wounds in seals at Shirokaya Bay

Date	Total seals	Males (lesions)	Females (lesions)	Pups (lesions)
13/10/90	21		2	2
14/10/90	33		5	5
10/11/90	80	3a	42	35
12/11/90	Not Counted		(1)a	
15/11/90	78	4 (3)b,c,d	39	35
18/11/90	72	2e,a	40	30
20/11/90	72	1e	39 (2)b*,c*	31
23/11/90	81	2 (2)e,f	43 (1)b*	33
25/11/90	89	4 (3)g,h,i	44 (3)d,e,f*	37 (2)a,b
28/11/90	81	2 (2)b,g	40 (2)g*,c	32
29/11/90	73	3 (1)b,	31	37
2/12/90	58	2 (1)b	25 (1)h*	31 (1)c
4/12/90	59	3 (2)b,e	23 (1)i*	32 (1)d
6/12/90	48	1	17 (1)i*	30
17/12/90	33	2 (2)h,e	4	27
24/12/90	12	2	2 (1)j*	8
31/12/90	0			

Individuals are indicated by letters and hence their resighting is distinguished from new seals, asterix denotes scars (ie. old lesions) which in this group were represented only by non-lactating females.

and nasal discharge but no further observations were made. Age of pups were estimated to be less than 1-week-old (1), 1–2-weeks-old (1) and 2–4-weeks-old (3). One cow was observed with purulent, pink discharge on three occasions over 10 days. Discharges observed varied from yellow, serous discharge (1) to purulent discharge (4). All observations were from the Shirokaya Bay group and account for 10% of lactating females.

Miscellaneous Two observations were made of cows with a transient watery diarrhoea during lactation. Faecal samples for dietary analysis of adults were sometimes noted to be fluid in nature and gross screening of two such samples revealed (a) a high quantity of undigested macroalgae and four nematodes (unidentified) and (b) two nematodes (unidentified) and the exoskeletons of decapod crustaceans. During near shore feeding when these crustaceans dominated the diet of lactating cows (Green & Burton, 1987) urine and 'phlegm' (see respiratory disease above) were stained pink or red. One cow with multiple lacerations produced green vomitus. On two occasions during the moulting period one or more seals in a small group had multiple circular areas of raised hair approximately 2–5 cm in diameter on the dorsal aspect of the neck and thorax. There was no associated alopecia, exudate or pruritis. Similar observations have been made of the grey seal (J. Baker, pers. comm.).

Discussion

The Weddell seal inhabits the coast and fast ice and depends on its teeth not only for feeding but for maintaining breathing holes in the sea and fjord ice. One contributing factor to natural population regulation in the species appears to be excessive teeth wear and subsequently an increase in the frequency of dental disease until an individual can no longer continue either of these activities and death follows due to predation, starvation or drowning (Bertram, 1940; Stirling, 1969; 1971). Stirling (1971) recorded an average age of adult Weddell seals of 8–9 years, maximum of 18 years and concluded after comparing population replacement rates with the scarcity of carcasses during the more concentrated on-ice distribution of summer that the heaviest mortality probably occurs underwater or during winter.

The Weddell seals of the Vestfold Hills region have been observed for over 37 years and no major disease outbreaks or population crashes have been recorded over this time. Pup production has remained relatively stable over the periods studied: 1957–1964 (Lugg, 1966) and 1977–1989 although numbers of adults were more variable (Green *et al.*, 1992). The pup mortality of approximately 4.4% of total (and 7.4% of the Shirokaya Bay group) in the 1990 pupping season cannot account for any carcasses lost through predation and ice melt-through but would seem to be representative of annual losses (Green *et al.*, 1992) recorded minimal

difference between total numbers born and those counted and tagged and Lugg (1966) recorded one abortion, one still birth and one death due to crush injuries in pups in 1964 during a study of the seal's annual cycle. Stirling (1971) also recorded a minimum mortality of pups at McMurdo Sound of 4.68% (1966) and 5.08% (1967) with deaths occurring within the first week of life due to crush injuries and being caught in tide cracks and minimum pup survival rates to one year of 76.1% males and 82.8% females. Lindsey (1937) estimated a pup mortality of up to 18% and recorded two pairs of stillborn twins, a frozen and flattened pup, and eight pups lost due to refreezing of swimming holes or being caught in ice.

The distribution of loose groups of pupping Weddell seals in the Vestfold Hills is influenced by the location of tide cracks and haul out holes across a large area of thinning spring sea and fjord ice. Overcrowding of suitable sites in most years does not appear to be a problem. Although the greater social spacing contributes to a much lower perinatal mortality rate due to aggression and crushing in the Weddell than in densely population pupping rookeries of many other seal species (Doidge *et al.*, 1984), debilitating cow-calf aggression and abandonment of underweight pups has been observed (Lindsey, 1937; Mansfield, 1958). Quality of ice is also a factor and Mansfield (1958) recorded a pup mortality of 30–50% following early break up of spring ice.

Stirling (1971) examined 19 pups internally: over half had umbilical stumps, 15 had 0.6–2.5 cm of subcutaneous fat and 2 had 3.8–5.0 cm of fat. This sample of dead pups measured between 83.5–145 cm in length and only two had milk in their stomachs. The neonatal pups examined by post-mortem examination in this study had much smaller quantities of subcutaneous fat and this was taken to suggest starvation and exposure. The presence of a milk-like substance in the stomach and/or presence of fatty lacteals in the omentum was interpreted as evidence for suckling having taken place. However, caution must be taken in interpreting the post-mortem findings of pups in this study due to the affects of prolonged periods of freezing and thawing. One pup would appear to have been stillborn, three neonatal deaths are probably due to starvation/exposure and mismothering but include one pup with splenic enlargement. One pup with internal pathology suggestive of a primary or post-mortem bacterial infection (possibly secondary to a crushing injury to the thorax) was probably two weeks old but appeared to have less than 0.5 cm of subcutaneous fat.

The skin lesions seen on males during the lactation haul-out appear to be due to territorial fighting. Some of the wounds on cows and pups would also appear to be due to intraspecific aggression and others such as scars and lacerations on the belly are possibly due to ice haul-out as suggested by Bertram (1940) and Lindsey (1937). Direct female to female aggression has been observed (Bertram, 1940; Lindsey, 1937) and the occurrence of wounds at the fore-fluke and the genital opening (the most common sites of male wounds in this study and that of Bertram, 1940) in the injured pups of this study further suggests that intraspecific aggression is also directed occasionally towards pups.

The presence of infection of fighting wounds is commonly reported and other wounds such as branding burns, some unhealed two years later (Stirling, 1971) and ill fitting tags also became infected. Bertram, (1940) described fist sized abscesses, both draining and non-draining, in the axillae and between tail and hind-flukes in slaughtered Weddell seals some of which were low in body condition and blubber thickness. He also records a female seal with distal body paralysis and multiple draining suppurating abscesses which could apparently still swim. It is likely that intraspecific fight wounds account for some mortality in the Weddell seal particularly in males competing for mating territories but death, post hauling out onto ice, was not observed in this group or others (Bertram, 1940; Lugg, 1966; Stirling, 1971) although Lindsey (1937) recorded bulls "bleeding to death" post fighting. Baker (1987) has described death due to wound sepsis in a grey seal and from the reports of Bertram (1940) it would seem unlikely that this does not occur in the Weddell.

Although Lugg (1966) recorded two male Weddell seals with large suppurating wounds 'similar to those seen in crabeater seals' (i.e. probably due to killer whale or leopard seal attacks) the observations of this study suggest rapid and healthy granulation of large open wounds in spite of the drain on body heat and fluid in such an extreme environment. Carrick & Ingram (1962) describe a wound on a southern elephant seal (*Mirounga leonina*) measuring 12 × 10 × 3 inches, attributed to a killer whale, that healed completely in three months. The lower reported incidence of cetacean scars on Weddell seals compared with crabeater seals probably reflects the former's more inshore distribution.

Ocular lesions are commonly recorded in pinnipeds both captive and free living (Fowler, 1978). Although visual and tactile sensations are most imporant to the Weddell seal for catching prey items partial blindness appeared to be well tolerated. All lesions were unilateral and a primary infectious cause was not suspected. Direct trauma or excessive corneal irritation and subsequent bacterial infection were the most likely causes of the

ocular pathology in this group and various stages of normal corneal repair were observed.

The observations made of apparently healthy Weddell seals producing milky phlegm or froth after in-air singing was suggestive of a pre-existing airway irritation possibly demonstrated more dramatically in the two adult seals which also had purulent nasal discharge with and without dyspnoea. The German Weddell Seal Expedition, Spring 1986 and Summer 1990, observed large numbers of Weddell seal adults and pups at Drescher Inlet coughing and bringing up phlegm with nostrils surrounded by 'whitish coloured foamy layers' without evidence of generalised ill-health (Harder *et al.*, 1991). They speculated that these were clinical signs of respiratory disease possibly associated with phocine herpes virus (PhHV) as their serological studies demonstrated the presence of herpes viruses related to European PhHV in both crabeater and Weddell seals, the latter often demonstrating high titres. A mass dying of crabeater seals (mortality 85–97%) in 1955 was characterised by pulmonary congestion, abortion and nephritis and although a viral aetiology was suspected none of the Weddell seals (or dogs or humans) present demonstrated morbidity or mortality (Laws & Taylor, 1957). Bengtson *et al.* (1991) suggested that this 1955 epidemic may be attributable to a phocine distemper virus and was able to demonstrate antibodies to canine distemper virus in crabeater and leopard seals but not Weddell seals (thus confirming the results of Osterhaus *et al.*, 1988). Excess respiratory mucous and productive cough due to a parasitic inflammatory or obstructive airway disease has been recorded in other pinnipeds (Fowler 1978) due to upper and lower respiratory mites (*Orthohalarachne* spp.) and true lungworms (*Otostrongylus* spp. and *Parafilaroides* spp.). Halarachne mites were recorded for the Weddell seal by King (1964) and although King (1983) describes the Parafilaroides hydrurgae seen in the leopard seal as the only incidence of lungworm in Antarctic seals, evidence from northern pinnipeds suggests a low degree of host specificity. Halarachne mites alone could be responsible for the signs of respiratory irritation seen in this group of Weddell seals although further research may clarify the possible involvement of lungworm or viral agents.

Post partum genital discharges are uncommonly recorded in wild seals. Little mention of cow ill-health has been made in reports of pup mortality or breeding success in the Weddell although multiple uterine fibroids were recorded in a non pregnant cow with a large apparently functional corpus luteum by Bertram (1940). Mansfield (1958) recorded several Weddell seal cows dying shortly postpartum without elucidation of cause of death, and Stirling (1971) also recorded a dead female in a lactating group and thin pups attempting to suckle other cows. Abortion and still birth has been recorded (Lugg, 1966; Lindsey, 1937). Necrotic retained foetal membranes (and foetus) and purulent endometritis were recorded in grey seals and ringed seals (*Phoca hispida botnica*) with a high proportion of uterine occlusions and stenoses by Bergmann & Olsson (1985) in the Baltic Sea where high levels of organochlorines and polychlorinated biphenyls (PCB) were suspected to be a contributing factor. Baker (1987) also described endometritis and fatal acute bacterial metritis in grey seals. Post partum uterine and vaginal infections can result in reproductive tract pathology, ill health or decreased future breeding success. In this study there was no immediate evidence of further disease although the suckling pup of a cow with post partum discharge developed respiratory disease and diarrhoea. Retention of foetal membranes was not noted but these are usually consumed by south polar skuas (*Catharacta maccormicki*) as soon as exteriorised. Low levels of organochlorine and PCB residues have been recorded in the Weddell seal (Hidaka *et al.*, 1983; Kawano *et al.*, 1984) but have not been associated with pathological changes.

As mating takes place towards the end of lactation (on average 6–7 weeks post partum), one would presume that the presence of infection would compromise successful early conception and hence parturition before break up of fast ice in the following year. Mansfield's 1958 study of the reproductive cycle of the Weddell Seal found that 16% of all females over 90 inches in length (nose–tail) had missed pregnancies based on number of corpora albicantia present in ovaries of slaughtered cows and noted that this was similar to other seals. Stirling (1971) found that of female Weddell seals over 3 years of age 97% had ovulated and 80.5% were pregnant, with young seals having the lowest pregnancy rates. It would be reasonable to assume that disease as well as social factors could account for missed pregnancies.

Although the Weddell seal provides the opportunity to make detailed and repeated observations of evidence of health and disease during haul-out the significance of observed pathology in the absence of fatalities available for post-mortem examination is difficult to qualify. The impression of this study is that with the exception of the dyspnoeic subadult seal described above, the ocular, respiratory, reproductive, gastrointestinal and skin diseases observed did not represent an important challenge to the overall health of the individuals concerned. The post-mortem examinations by Stirling (1969) and Bertram (1940) of slaughtered Weddell seals, where chronic abscesses of fight wounds and of worn teeth were demonstrated,

suggest more likely stressors to the health of adult seals. Green *et al.* (1992) argued that apparent declines in the Weddell seal numbers in the Vestfold Hills were the result of limitations of current censusing techniques and that increased foraging times due to changes in feed availability would dramatically decrease the numbers of seals hauled out at any one time. In the absence of a decline in pup production or the suggestion of suboptimal population health this would provide adequate explanation.

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