Pathology of the Northern Fur Seal

Mark C. Keyes, D.V.M.

Summary

Nearly half a million fur seals (Callorhinus ursinus) are born each year on the Pribilof Islands, Alaska, but as few as 10% may survive to be harvested at age 2 to 5 years. The known or suspected causes of mortality at sea, where most deaths occur, are predation, starvation, weather, parasitism, food poisoning, and infectious diseases. The major known causes of the 5 to 20% mortality of pups on land are malnutrition, trauma, parasitism, and gastrointestinal and miscellaneous infections.

Marine mammals are divided into 3 orders: Carnivora, Pinnipedia, and Cetacea. The order Carnivora is represented by the sea otter; Pinnipedia by the seals, sea lions, and walrus; and Cetacea by whales, dolphins, and porpoises.17 These animals have become more frequent objects of research. For example, scientists are now trying to find out how the Weddell seal (Leptonychotes weddellii) can remain submerged as long as 40 minutes, and how it employs sonar to locate underwater objects for feeding and navigation.15 Scientists might well be interested in the diet of the fur seal and gray seal pups (Halichoerus grypus), because the fur seal’s diet consists of milk that is over 50% fat, and in the gray seal, the mother transfers about 60 lb. of blubber to her pup in only 18 days.18 How are such large quantities of fat handled without causing arterial disease? Space physicians might profit from a study of the walking seals, since the reaction of the marine mammalian heart to increased terrestrial activity without the assistance of buoyancy of sea water may parallel the reaction of an astronaut’s heart to normal activity after a long period of weightlessness.

Veterinarians in Marine Research

Few veterinarians are retained full-time for marine mammal research, but veterinary educational institutions and private practitioners are occasionally consulted. Because of the increasing number of marine mammal exhibits in zoos and aquariums, more veterinarians are becoming familiar with these animals.

The 120 species17 of marine mammals contribute to world economic wealth through a variety of products. If these species are to be successfully conserved and utilized, their population dynamics must be understood. A thorough knowledge of natural mortality is necessary to that understanding. The participation of a veterinarian in the program of conservation and maximum use of fur seals is part of one step into a coming field in veterinary medicine—wildlife conservation and marine research.

History of the Fur Sealing Industry

The fur sealing industry dates back nearly 200 years, when the Pribilof Islands were discovered by the Russian explorer Gerassim Pribilof. After the purchase of Alaska by the United States, the islands were leased by private companies for 40 years, during which time nearly 2½ million seals were killed on land.2 These harvests, combined with pelagic sealing, reduced the herd to a dangerous low of an

From the Marine Mammal Biological Laboratory, Division of Biological Research, Bureau of Commercial Fisheries, USDI, Seattle, Wash.

Adapted from a presentation given before the Section on Research, 102nd annual AVMA meeting, Portland, Ore., July 11-15, 1965.
estimated 216,000 animals. Under an international ban on pelagic sealing in 1911 and conservative harvesting by the U.S. Government, the fur seal population recovered by 1940 to an estimated 1/2 million. About 60,000 seals are now being taken annually. The most popular class of processed seal furs, determined by color, size, and grade, sold for an average of $122.03 per skin. The top price was $161 at the 1965 spring sale.

Nearly half a million fur seals are born each year on the Pribilof Islands; as few as 10% or less may survive to be harvested at ages 2 to 5 years. Causes of mortality and pathogenetic factors are of primary concern to wildlife management biologists. The U.S. Fish and Wildlife Service (and its predecessor agency) has sponsored or cooperated with several groups of investigators since the late 1800's.

**History of Research on Fur Seal Mortality**

Causes of death in fur seals were studied in 1896-1897 when most pup mortality was attributed to trampling by bulls. After discovery of the hookworm (*Uncinaria lucasi*) in late 1896, the primary blame was shifted to uncinariasis; starvation was rated second and trampling third. Only gross postmortem examinations of dead pups were conducted.

According to results of postmortem examinations in 1906, a high incidence of asphyxia neonatorum was reported among newborn pups. Mortality studies after 1906 were limited to annual counts of dead pups on land in 1941 and 1948 to 1950, until 1951, when the first of 9 summers of hookworm investigations was begun. It was discovered that infective hookworm larvae reside in the blubber until parturition and are transmitted to the pup in the milk during the 1st nursing.

Also in 1951, investigators isolated *Salmonella enteriditis* from 5 of 12 fur seal pups and from the sucking lice on 1 pup.

In 1957, it was reported that 98.6% of 1,727 deaths in pups were caused by hookworms or starvation.

Psittacosis-group antibodies were found in fur seal sera in 1960 and 1961, but an associated clinical syndrome was not recognized.

**Mortality of Fur Seals at Sea**

The principal known or suspected causes of mortality in seals at sea are predation, starvation, weather, parasitism, food poisoning, and infectious diseases. The relative importance of mortality at sea is unknown, but it is believed to have the greatest impact on recently weaned pups as they begin their adaptation to a strictly pelagic existence in November.

*Predators.*—Known predators of fur seals are the killer whale (*Orcinus Orca*) and the white shark (*Carcharodon carcharias*). It is possible that other sharks prey on fur seals, particularly pups. The number of fur seals killed by predators is not known.

*Starvation and Weather.*—Scarcity of food, physical impairment from injury, old age, infection, and storms are factors which may contribute to starvation. Prolonged storms may kill weaker seals through exposure, fatigue, drowning, and interruption of feeding.

*Parasitism.*—As soon as pups leave the rookeries and change their diet from milk to fish, they begin to accumulate the ascarids, *Phocanema decipiens* and *Contracaeum osculatum*, which attach primarily to the gastric mucosae. A typical lesion consists of a small ulcer, 1 to 5 mm. in diameter, surrounded by a swelling to form a crater in which the anterior ends of one to several immature worms are buried. As many as 400 worms may be distributed in this fashion throughout the stomach. Occasionally, nests of larvae may be found within thick-walled gastric caruncles up to 40 mm. across and 10 mm. thick. The larvae may also penetrate the stomach wall and cause peritonitis. Eighty-five larvae were found free in the abdominal cavity of an 8-month-old fur seal. The extent of mortality from ascarid infection is not known but it may be great, since the incidence of ascarids in fur seals approaches 100%. Of 1,355 seals taken at sea in 1963, all but 4 were infected.

Other fish-borne parasites include ces-
toxoids, trematodes, and acanthocephalans. The cestodes, *Diphyllobothrium pacificum* and *Diplacogonporus sp.*, and the acanthocephalan, *Corynomastrum strumosum*, can often be found in greatest numbers at the ileocecal junction. The trematodes, *Pristrema zalophi*, *Phocotrema fusiforme*, and *Cryptocotyle jejuna*, inhabit the small intestine. More than 1,000 *P. zalophi* were found in 1 seal. It is of particular interest that, although fur seals are known to feed on salmon to some extent, the fluke of salmon poisoning, *Troglocrema salmincola*, has not been demonstrated. The importance of cestodes, trematodes, and acanthocephalans in mortality of seals at sea has not been evaluated.

Only 2 of the 4 known ectoparasites of fur seals are a factor at sea: the nasal mites, *Orthohalarachne diminuata* and *Orthohalarachne attenuata*. The 2 species of sucking lice are primarily a problem on land. Infestation of the nasal turbinate with mites is frequently massive in pre-adult and adult seals. It is possible that breathing (especially at sea) could be critically impaired.

**Food Poisoning.**—From time to time, large numbers of seals are reported dead, floating in the water or washing ashore, with no obvious lesions or cause of death apparent. In September, 1962, for example, approximately 275 seals and numerous birds and foxes were found dead along the beaches of St. George Island. The circumstances pointed to a toxin in food common to seals and birds and also affecting foxes scavenging the recently dead animals. Remnants of sand lance (Ammodites hexapterus), a food fish of seals and sea birds, were found in the intestines of dead seals and birds. The shells of small pelagic snails were found in the intestines of seals and in the intestines of sand lances regurgitated by a sea bird. These findings suggested the possibility that pelagic snails contaminated with a toxin (dinoflagellate) were ingested by sand lance; and that the fish, in turn, were consumed by seals and sea birds in the vicinity of St. George Island; and the dead seals and sea birds were scavenged by the foxes.

Parts of fish, seals, and foxes were fed to white mice, and seal stomach contents were injected into other white mice, with negative results. If there had been a toxin, however, it could have been inactivated by a change in pH prior to freezing the carcasses or by the 5 months of cold storage in transit from the isolated island.

**Infectious Disease.**—It is unlikely that an epizootic, dependent on transmission from seal to seal, could occur in the ocean, since fur seals do not congregate there, nor do they come ashore except at the breeding grounds. Epizootics at sea must therefore be a result of either a long incubation period of an agent contracted on the breeding grounds or an agent transmitted in the food. The agent of salmon poisoning disease qualifies for the latter mode of infection, but it is not known if fur seals are susceptible.

**Mortality of Fur Seals on Land**

The cause and spread of disease among fur seals on land is intricately involved with their biologic processes and life cycle. Fur seals spend most of the fall, winter, and early spring in the water of the northern Pacific ocean, ranging from 50 to 100 miles offshore as far south as southern California. They return to the Pribilof Islands in the order of decreasing age, starting with the mature harem bulls in May and ending with the youngest females in October. Some bulls are killed in battles over territories, and some females are killed by bulls trying to retain them. The percentage of females that die from complications of dystocia is not known. Mortality of pre-adults from natural causes is slight on land. Most fur seals that die on land are pups. In 1956, 120,000 dead pups were counted. This mortality represented 12% of an estimated 992,000 pups, from birth to the age of approximately 2 months. Fewer than 19,000 males were harvested from this year class during the ensuing 5 years. If a male escapement of 10% and a 1 to 1 sex ratio are assumed, the total natural mortality of the year class to age 5 years was 96%. In 1958, the count of dead pups was 38,000, of an estimated 729,000 born—a land mortality of 5.2%. Correspondingly, over 80,000 males were harvested from this year’s class,
suggesting a combined land and sea mortality of 75% to age 5. Such wide fluctuations in mortality are not unusual for a wild animal population of this size. The combinations and magnitudes of variables contributing to these fluctuations are many and great.

However, mortality of the newborn is one area that can be scrutinized, although it presents many problems. Rookeries where pups die are usually inaccessible except from catwalks, because of the belligerent attitude of both adult males and females congregated in contiguous harems. Idle bulls, equal in number to harem bulls, surround the harem areas waiting for the opportunity to acquire a harem, and further impede access to the rookeries.

**Mortality of Fur Seal Pups**

An understanding of the environment of pups is necessary for an accurate interpretation of postmortem findings. Although the bulls confine their movements to territories established before the females arrive, their patrolling of boundaries, along with movement of females and pups to and from the water, results in continuous chaos. Consequently, the pups are frequently trampled accidentally by the bulls and are treated roughly by all but their own mothers.

To avoid contact with adult seals, pups congregate in pods, where there is a free exchange of ectoparasites and other potential disease agents.

The rookeries serve not only as a place for parturition and copulation, but also as summer graveyards and “sewage disposal areas” for a breeding population of about a million seals. During the breeding season in July and August, the weather ranges from occasional warm sunshine to chilling wind-driven rains and is otherwise foggy or misty. There are many areas of poor drainage which become contaminated with excrement and dead seals, and through which large number of seals, particularly pups, may flounder.

When pups nurse for the first time they are likely to ingest hookworm larvae in the milk. When nursing periods become increasingly less frequent, up to an average of 8 days apart, pups must shift for themselves while their mothers swim hundreds of miles in search of food. It is common for a pup to miss one or more nursing opportunities if he has wandered too far from the site to which the mother customarily returns.

During the past 3 seasons, 226 fur seal pups have been necropsied, but the findings most likely representative of the pup population were from 109 pups collected throughout the 1964 season from the same zone of 1 rookery. Pup mortality was complex; 18 primary and 30 secondary and tertiary causes of death were found. The major categories of primary causes were malnutrition, trauma, parasitism, miscellaneous infection, and gastrointestinal infection.

**Malnutrition.**—Malnutrition was the primary cause of death in 37.6% of the 109 pups and secondary cause in 5.5%. The condition was characterized by a paucity of subcutaneous blubber; atrophic, dark red muscles and liver; atrophy of the thymus and lymph nodes; empty gastrointestinal tract; and often saccular areas in the jejunum and ileum. The saccular areas ranged from thin and atrophic, containing yellowish brown fluid, to distended and necrotic, containing black tarry material. The blood was dark, viscous, and poorly coagulated. The skin lacked resiliency, and all the tissues had less fluid than normal. The adrenal cortices were very thin and depleted of lipid.

The major cause of malnutrition is probably prolonged separation of mother and offspring. Other possibilities are galactia, mastitis, starvation, or other diseases in the mother which inhibit milk production, and diseases in the pup which prevent or inhibit nursing. Malnutrition occurred most frequently in combination with gastrointestinal infection, often with trauma or uncinariasis, and sometimes with all 3. General and pulmonary passive congestion and respiratory failure were the terminal events, but infection, trauma, and parasitism hastened the process.

**Trauma.**—Traumatic lesions were found in 36.7% of the pups and were the primary cause of death in 17.4%. The lesions con-
sisted of fractures, contusions, and bite wounds, usually of the head and neck. Bite wounds frequently penetrated the skull, causing meningoencephalitis and hemorrhage. Bites of the thorax, abdomen, or limbs resulted in pleuritis peritonitis, and cellulitis, respectively. The bacteria associated with these infections were *Streptococcus faecalis*, *Escherichia coli*, *Aerobacter aero-
genese*, *Clostridium perfringens*, and *Proteus mirabilis*. Another organism tentatively identified as *Actinomyces sp.* and an unidentified anaerobic, gram-negative filamentous rod were also isolated. Trauma seemed less prevalent when the majority of pups began congregating in pods away from adult seals.

**Parasitism.**—The hookworm, *U. lucasi*, an important cause of death in fur seal pups, is the only nematode known transmitted in the milk. Pups acquire infective larvae the 1st day of nursing but not subsequently. The prepatent period is 13 to 14 days, and the eggs take about 25 days to hatch. New-generation larvae appear in the belly blubber of pups about mid-August, and the adult worms are gone from the intestine about mid-September.

Uncinariasis was the primary cause of death from hemorrhagic anemia in 13 (12%) pups and a secondary or tertiary cause in 13 others. Altogether, hookworms were detected in 42 pups (38.5%). By mid-August, when the prepatent period of the larvae has passed for most of the pups, the incidence of hookworms may be higher. Acute uncinariasis was characterized by extremely pale organs, watery blood, and usually over 100 worms and free blood in the small intestine and colon. The liver was often fatty, and the small intestines had a nodular appearance. The victims were frequently large, heavy with blubber, and in good condition, except for appearing like freshly slaughtered and well-bled animals.

Pups were also parasitized by the sucking lice, *Antarctophthirus callorhini* and *Proechinophthirus fluctus*, and the nasal mites, *O. diminuata* and *O. attenuata*. Infestations were usually mild and probably unrelated to serious illness or death; however, some severe louse infestations have been noticed (15 lice per square inch of body surface). These parasites are capable of carrying infectious agents such as *Salmonella* and perhaps endoparasites such as the microfilariae of the tunic worm, *Dipetalonema spirocauda*. The adult filariids are in the subcutaneous tissue, particularly of the scrotum, in immature and adult seals. Microfilariae were found in the serums of 35 of 40 harvested males.

**Miscellaneous Infection.**—Infections of several types were prevalent in fur seal pups; omphalophlebitis, peritonitis, pleuritis, abscesses, and phlegmons were the most numerous. These infections were usually sequels to bite wounds and were the primary cause of death in 11.0% of the pups and a secondary cause in 16.5%. Bronchopneumonia was surprisingly rare—only 1 case in 109 pups.

**Gastrointestinal Infection.**—The morbidity of gastrointestinal infection (44.0%) was much higher than the mortality from that cause (4.6%). Necrotic enteritis was the most common form, making up half the cases, followed by catarhal enteritis and hemorrhagic enterocolitis. The bacteria cultured from small intestines were *E. coli*, *P. mirabilis*, and *S. faecalis*. Organisms isolated from heart blood were *E. coli*, *C. perfringens*, and an anaerobic, gram-negative filamentous rod not yet identified. In addition, *Paracolobactrum inter-
medium* was isolated from a specimen of focal necrotic hepatitis.

**Need for Further Research**

Further progress in understanding fur seal pathology must be based on a diversified program. This program includes developing a method of holding normal seal pups under controlled conditions for observation and experimental inoculation, physiologic and anatomical studies of seals of various ages to establish a basis for recognizing and understanding the abnormal, and postmortem examinations to recognize disease syndromes and determine their cause.

**References**


Mycosis in a Manatee

A captive manatee (sea cow) had raw-appearing erosions develop on the skin of its nose, face, flippers, and tail. Skin scrapings revealed *Epidermophyton floccosum*.

The manatee was removed from its pool and cleaned by brushing. A mixture of vaseline and mycostatin ointment was spread over the lesions. One gram of griseofulvin wrapped in lettuce leaves was given orally twice a day (10 mg./lb. per day) for 21 days. Recovery was satisfactory.—Robert P. Dilbone, D.V.M., Naples, Fla.