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Cystophora cristata.

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Cystophora Nilsson, 1820

Cystophora Nilsson, 1820:382. Type species, *Cystophora borealis* Nilsson. [*Phoca cristata* Erxleben].

Stemmatope Cuvier, 1824:196. Type species, *Phoca cristata* Erxleben.

Stemmatopus Cuvier, 1826:551. Type species, *Phoca cristata* Erxleben.

CONTEXT AND CONTENT. Order Carnivora, Suborder Pinnipedia (see REMARKS), Family Phocidae, Subfamily Phocinae (King, 1966), Tribe Cystophorini (Burns and Fay, 1970). This genus is monotypic; Gray's (1848, 1850) suggestion that *C. antillarum* from the West Indies was a member of the genus generally was not accepted (Allen 1880:454).

Cystophora cristata Erxleben, 1777

Hooded Seal

Phoca cristata Erxleben, 1777:590. Type locality southern Greenland and Newfoundland.

Phoca cucullata Boddaert, 1785:170–171. Type locality unknown.

Cystophora borealis Nilsson, 1820:383. Type locality southern Greenland and Newfoundland.

Phoca leucopla Thienemann, 1824:83. Type locality Iceland.

Phoca mitrata Cuvier (ex. Milbert. MS.), 1825:206. Type locality unknown.

Cystophora cristata Nilsson, 1837:326; first use of current name combination.

Phoca isidorei Lesson, 1843:228. Type locality Isle d'Oleron, France.

CONTEXT AND CONTENT. Context noted in generic summary. No subspecies are recognized. ISIS (International Species Inventory System) number 5301413002001001001 (Honacki et al., 1982).

DIAGNOSIS. *Cystophora* is distinguished from most other phocid seals by its incisor formula (2/1), the possession of an inflatable proboscis (Fig. 1a), and the general shape and appearance of the postcanine teeth (King, 1966). In all these characteristics it resembles *Mirounga*. However, the structure and mechanism of inflation of the proboscis of these two seals is different (Allen, 1880; Berland, 1958, 1966; Gray, 1866; Merriam, 1884). In addition to the inflatable hood (Fig. 1b), male *Cystophora* possess the unique ability to blow from one nostril, usually the left, a red, balloon-shaped, nasal septum (Fig. 1c, d).

Diagnostic skull characteristics (Figs. 2 and 3), associated primarily with the inflatable nasal appendage, are described from King (1972): the cranium is short with a long, wide snout; the interorbital area is toward the back of the skull; the dorsal junction of the maxilla and jugal projects laterally and forms a shoulder rather than a smooth outline; the orbit proper occurs anterior to the jugal; frontonasal area is elevated; nasal openings are wider than in any other phocid; premaxillae, which have a distinct dorsal ridge, do not meet the nasals; the narial basin is "key-hole shaped"; nasals project beyond the anterior edge of the maxilla by about a third of their length; the maxilla is reduced between the preorbital process and the rear edge of the narial basin; the palate is elongate posteriorly, more so than other phocids; the hamular process of the pterygoid is closer to the anterior border of the tympanic bulla than to the front edge of the zygomatic arch; mastoid region is visible on the dorsal aspect of the skull; ventrally the petrosal is visible projecting into the foramen lacerum posterius.

GENERAL CHARACTERISTICS. Adults (Figs. 1, 4b, 4c) are bluish gray overlain with irregular black spots and tend to be lighter ventrally (Dunbar, 1949). The face is black to behind the eyes (King, 1964). Average standard length is 2.5 m and body mass is approximately 300 kg in adult males and 2.2 m and 160 kg in adult females (Fig. 4c; Food and Agriculture Organization of the United Nations 1979, 1982; Mansfield, 1967).

DISTRIBUTION. Hooded seals occur throughout the central and western North Atlantic Ocean (Fig. 5). They range mainly from Bear Island west of Norway to Spitsbergen and south to Jan Mayen, Iceland and the Denmark Strait (King, 1964, 1983); they are common in south (Kapel, 1975) and northeast Greenland, north as far as Cape York (Vibe, 1950), and are a regular inclusion in the seal catch by West Greenlanders (Kapel, 1975, 1981; Rasmussen, 1960). Additionally, whelping areas in the Davis Strait (64°N), off Labrador (the "Front"), and inside of the Gulf of St. Lawrence are occupied at least seasonally (Sergeant, 1974).

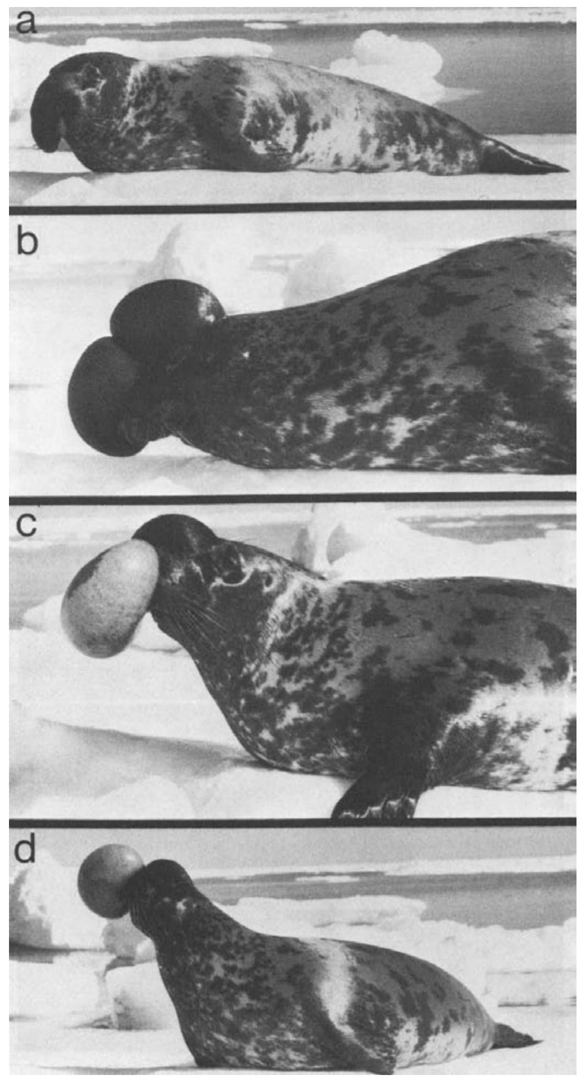

FIG. 1. Male *Cystophora cristata* showing (a) proboscis, (b) inflated proboscis (hood), (c) extruded nasal septum, and (d) nasal septum held in threat display (photographs by N. Lightfoot).

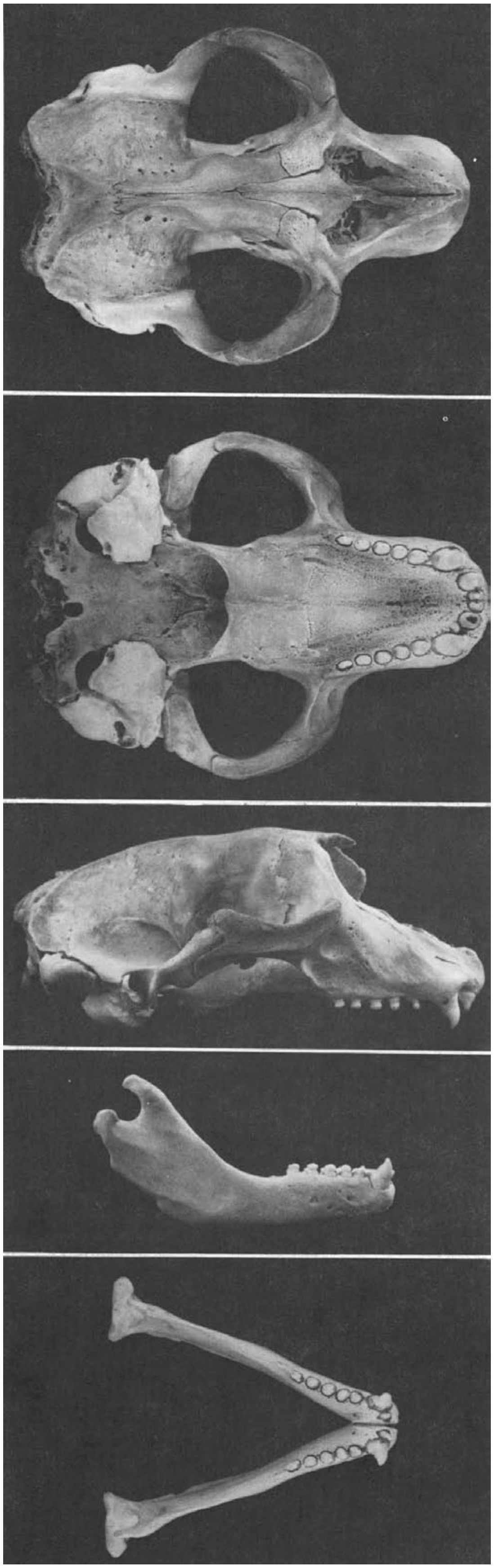

FIG. 2. Cranium of male *Cystophora cristata* (total length 28.1 cm) in dorsal, ventral, and lateral views, and lateral and dorsal views of the lower jaw.

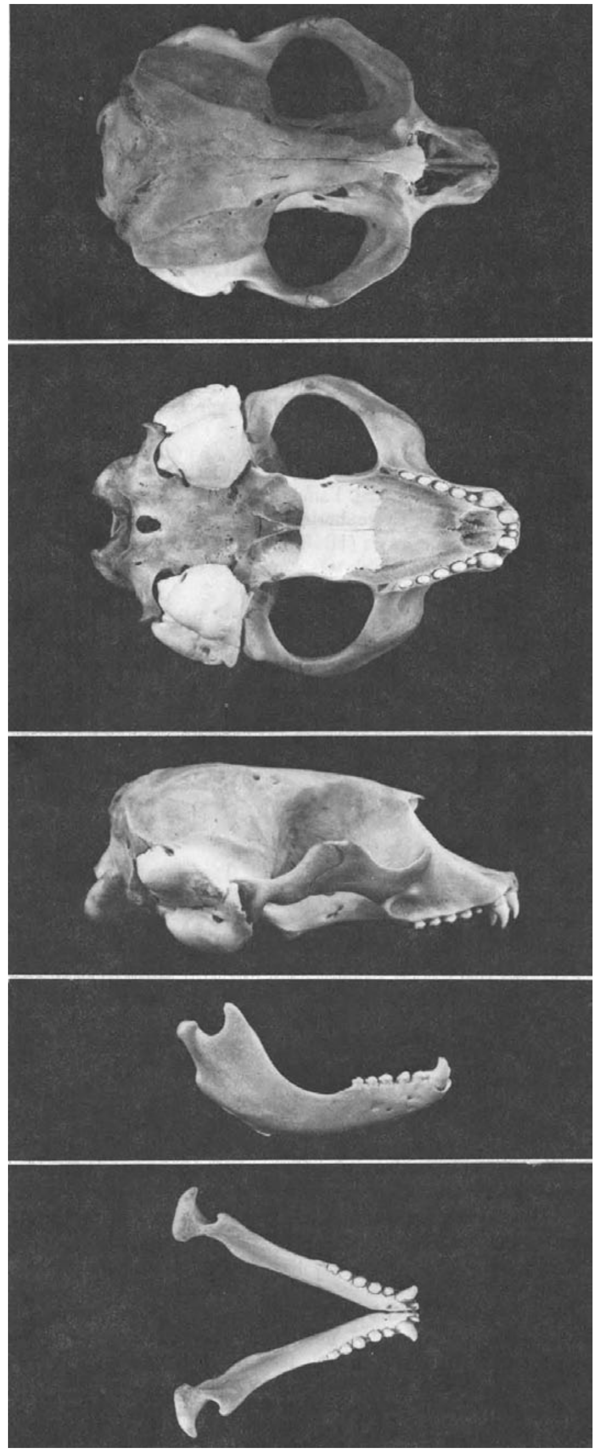

FIG. 3. Cranium of female *Cystophora cristata* (total length 21.8 cm) in dorsal, ventral, and lateral views, and lateral and dorsal views of the lower jaw.

The limits of hooded seal distribution in the North Atlantic are correlated with the seasonal limits of Arctic pack ice (Baird, 1964), and are essentially contiguous with subarctic waters (Dunbar, 1968), east to Bear Island. Both range and relative abundance apparently vary dramatically with changes in climate and ice cover (Sergeant, 1974, 1976*a*).

Hooded seals, particularly juveniles, are frequently sighted in the St. Lawrence River west to Montreal and along the eastern seaboard of Canada (Sergeant, 1974) and the United States south to Cape Canaveral, Florida (Goodwin, 1954; Mansueti, 1950; Mil-

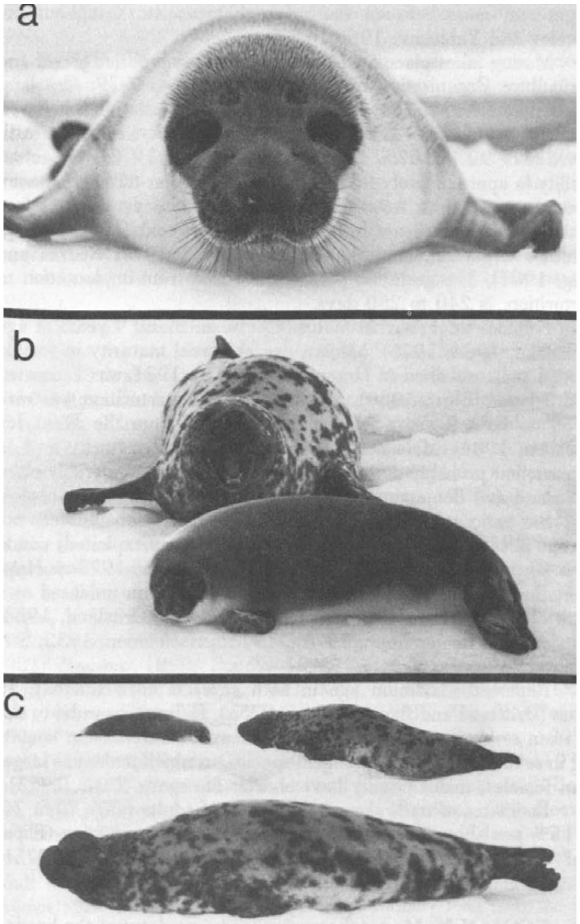

FIG. 4. *Cystophora cristata* (a) neonate or "blueback" (photograph by N. Lightfoot), (b) female defending pup, and (c) male-female-pup trio ("family" group).

ler, 1917; Norton, 1930; Richardson, 1975). There are summer records from the Canadian side of Baffin Bay (Anderson, 1934; Degerbol and Freuchen, 1935; Low, 1906; Miller, 1955; Tuck, 1957) including Cumberland Sound (Kumlien, 1879), Jones Sound (Riewe, 1977), Lancaster Sound (Greendale and Brousseau-Greendale, 1976), and off eastern Ellesmere Island (Vibe, 1950). Others have been sighted from southwest Devon Island (Stirling and Archibald, 1977), in east and southwest Hudson Bay (Mansfield, 1968), near Sachs Harbour (Usher, 1966), off southwest Victoria Island (Smith and Taylor, 1977), from Herschel Island (Porslid, 1945), and in the Beaufort Sea (Burns and Gavin, 1980).

Occasionally, hooded seals are sighted in the Barents Sea and rarely in northern Siberia at the mouth of the Yenesei River and in Novaya Zemlya (Ognev, 1935; Scheffer, 1958). The Food and Agriculture Organization of the United Nations (1979) makes reference to hooded seals whelping in small numbers "near" the White Sea, but this has not been well documented. Infrequent strays are known from the British Isles, and the European coast (King, 1964; Mohr, 1963; Øritsland and Bondø, 1980; Pouvreau et al., 1980; Thorburn, 1920) south to Portugal (Reiner, 1980).

FOSSIL RECORD. *Cystophora cristata* is not well represented in the fossil record. Specimens described by Van Beneden (1876) under the name *Mesotaria ambigua*, found in the vicinity of Anvers, Belgium, and believed to be Pliocene in origin, were thought to be those of *Cystophora cristata*, or at least allied to the Cystophorinae (hooded and elephant [sic] seals). Recently, Ray (1983) reviewed the three existing fossil records of the hooded seal in North America. The first, a tooth (Lyell, 1884) was discounted because of its probable loss and the limited diagnostic value of phocid canines. The second record, based on two scapulae, two humeri, and several other bones (Norton, 1930), was accepted by Ray (1983). Nonetheless, as this record also has been lost or discarded, its veracity remains equivocal. The third record consists of an incomplete diaphysis of a juvenile left tibia (Bishop, 1921). Ray (1983), after studying the original specimen, concluded that this fossil is that of *P. vitulina*.

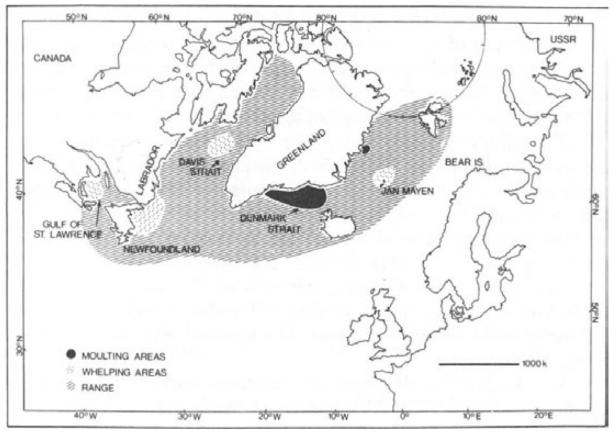

FIG. 5. Geographic distribution of *Cystophora cristata*.

FORM AND FUNCTION. The skin contains sweat and sebaceous glands; the fibrous structures of the reticulate layer are arranged "fairly densely"; between them pass numerous blood vessels and connective tissue cells; the skin-muscle layer of the dermis is substantial (King, 1983; Shepeleva, 1973). Arteriovenous anastomoses are present in hooded seal skin, especially in extremities; they are thought to play a role in themoregulation (Bryden, 1978). Mystacial and superciliary tufts of vibrissae are represented by well-developed stiff bristles (Pocock, 1914).

At birth, hooded seals bear a layer of subcutaneous fat, generally 2.5 cm thick (Shepeleva, 1973). This heat-insulating layer is maintained year round, varying in thickness with age, season, and reproductive condition. The layer is thinnest during breeding and molting, although Scheffer (1958) considered that fat always accounts for more than 25% of the mass of weaned animals. Fat also serves as a rich energy reserve and provides a storage site for vitamins A and D (Kuznetsov, 1962). Lipid samples from hooded seals had low iodine values (107–127 Wiys) and a correspondingly low concentration of highly unsaturated fatty acids (Jangaard and Ke, 1968). Pups and adults maintained body temperatures ranging from 35.4 to 37.6°C (Shepeleva, 1973).

There are two mammae. Development of the mammary glands in female hooded seals from birth until the beginning of pregnancy is similar to mammogenesis in other mammals (Belov, 1971). During lactation, the entire alveolar apparatus takes part in secretory activity. The alveoli become distended and their epithelial lining flattens. As lactation proceeds, defects appear in the epithelial lining of the alveoli to such a degree that, by the end of nursing, epithelial tissue is absent in many alveoli. After lactation, profound involution of the alveolar apparatus takes place, with desquamation of the epithelial lining and fibrosis of the interalveolar spaces (Belov, 1971).

The milk of hooded seals is extremely rich in fat, 40 to 65% (Potelov and Yablokov, 1966; Shepeleva, 1973; Shergin et al., 1967). Available estimates of fat content are for samples taken at unknown stages during lactation. Changes in milk composition such as those observed in other phocid seals during lactation (Kooyman and Drabec, 1968; Lavigne et al., 1982; Riedman and Ortiz, 1979) have yet to be documented in hooded seals.

King (1966) described the skeletal characteristics of *Cystophora* (compared with *Mirounga*) as follows: the vertebrarterial foramen faces posteriorly; the atlantal facet of the axis vertebra tends to form one continuous surface with the two anterior articulating surfaces; a well-formed spine occurs along the entire length of the scapula; a supracondylar foramen is present on the humerus that tends to develop a supinator ridge; the palmar side of the cuneiform has a distally projecting ledge; metacarpals of digits 1 and 2 are of almost equal size (69:62 mm); size of the intermediate phalanx of digit 5 is not reduced; the heads of the metacarpals have a longitudinal ridge that extends onto the palmar surface where it separates the articulations of the two sesamoid bones; the proximal surfaces of the proximal phalanges have a deep indentation on their palmar border and a deep articular surface corresponding with the ridge on the metacarpal heads; interphalangeal articulations are trochlear.

The ilium is everted, with a deep lateral excavation; the femur has a pronounced pit for the origin of the popliteus muscle, a distinct trochanteric fossa, and the greater trochanter is generally higher than the head; the post-tibial fossa tends to be pronounced. The terminal phalangeal joint of the pes can be flexed to provide a better grip on ice. Claws are large on fore- and hindflippers.

The structure of the auditory ossicles (Doran, 1876; King, 1966) and the larynx (King, 1966; Schneider, 1963) are similar to those of other northern phocids. The tracheal rings are complete (King, 1966).

The teeth of hooded seals are relatively small and the toothrow short (King, 1972). The postcanine teeth are tubercular and closely and strongly plaited on the crown; the fourth and fifth postcanines are usually double-rooted (Gray, 1848). The dental formula is i 2/1, c 1/1, pc (postcanines) 5/5, total 30.

Age determination in pinnipeds frequently is based on the annual production of light and dark bands of dentine in the canine teeth (Laws, 1953). Hooded seals also have clear, narrow bands of cementum formed annually (Khuzin and Yakovenko, 1963) that may be used in determining age.

Most physiological and anatomical investigations of musculature, circulation, and respiration of hooded seals have been conducted in conjunction with studies of their diving capabilities. Pronounced bradycardia with heart rate declining from approximately 100 to 10 beats/min occurs during forced submersion of restrained pups (Påsche and Krog, 1980; Scholander, 1940). Oxygen consumption during such submersions dropped to one-third the resting rate and the lungs practically collapsed without losing contact with the chest wall (Scholander, 1940).

A blood volume of 9 to 10% of body mass was determined by direct bleeding of two hooded seal pups (Scholander, 1940); Elsner (1969) "believed" it to be nearer 12% of body weight. The erythrocyte count appears similar to that of other seals, 4.8×10^6/mm. Hematocrit and hemoglobin content are 63% and 26.4 g/100 ml, respectively (Clausen and Ersland, 1969). Clausen and Ersland (1969) concluded that the elevated O_2 capacity, Haldane effect, and buffering capacity of *Cystophora* blood may be regarded as adaptations to deep diving. Additionally, hooded seals seem able to tolerate elevated levels of CO_2 (Påsche, 1976).

The anatomy of the reproductive system does not differ appreciably from that described for other phocid seals (King, 1983; Øritsland, 1964; Øritsland and Benjaminsen, 1975*a*).

ONTOGENY AND REPRODUCTION. Females give birth to a single 10- to 30-kg (average approximately 20 kg), 90- to 105-cm pup in mid to late March (Beloborodov and Potelov, 1966; Mansfield, 1967; Olds, 1950; Popov, 1976; Potelov and Yablokov, 1966; Shepeleva, 1973). Unlike most phocids that breed on ice, hooded seal fetuses shed their light grey lanugo in utero (Brown, 1868*a*). It is then swallowed by the foetus and defecated into the amniotic fluid as compact discs measuring 4.0 by 0.5 cm (Mansfield, 1967). Twinning has not been reported for this species. Neonates (bluebacks) are silver-blue-grey on the dorsum, shading abruptly to silver-grey on the sides and venter (Fig. 4).

Pups are extremely precocial, and are capable of coordinated movements, including swimming and crawling at birth (Shepeleva, 1973). They are reportedly nursed three to four times per day (Shepeleva, 1973) for 5 to 12 days (Food and Agriculture Organization of the United Nations, 1979; Shepeleva, 1973). Hooded seal pups like those of harp (*Phoca groenlandica*; Stewart and Lavigne, 1984) and northern elephant seals (*Mirounga angustirostris*; Ortiz et al., 1984) and probably other phocids are thought to have an unusually high degree of assimilation of mother's milk (Shepeleva, 1973). Khuzin and Yablokov (1963) suggested that a dense anal plug, formed at the time of embryonic molt, enhances assimilation of milk, but the existence of such a structure has not been confirmed.

Differences in mean length (but not mass) of male and female hooded seal fetuses (101.5 and 96.8 cm; Beloborodov and Potelov, 1966), neonates (98.9 and 96.2; Beloborodov and Potelov, 1966) and pups (104.8 and 101.7 cm; Potelov and Yablokov, 1966) have been reported. By 1 year of age there are distinct differences in length and mass between the sexes that persist throughout life (Potelov and Yablokov, 1966).

Mating takes place at the end of the nursing period (Food and Agriculture Organization of the United Nations, 1979; Øritsland and Benjaminsen, 1975*a*; Rasmussen, 1960). Copulation is believed to occur in the water (Øritsland, 1964). Ovulation rates are estimated to be 92% to 97% (Born, 1980; Øritsland, 1975), and actual fertility is approximately 93% (Born, 1980). Near-term pregnancy rates are not known. After fertilization, the blastocyst remains free in the reproductive tract for a period of 16 weeks (Food and Agriculture Organization of the United Nations, 1979; Reeves and Ling, 1981). The gestation period, measured from implantation to parturition, is 240 to 250 days.

Females attain sexual maturity between 2 and 9 years of age (Øritsland, 1964, 1975). Median age at sexual maturity in female hooded seals obtained in Greenland in 1970–1971 was estimated at 3.2 years (Born, 1980). Mean age of first parturition was estimated to be 4.9 years for females collected from the West Ice (Jacoben, 1984). Male hooded seals reach sexual maturity at 4 to 6 years, but probably do not breed until they are considerably older (Øritsland and Benjaminsen, 1975*a*).

Sex ratio at birth is close to 1:1. The ratio probably does not change greatly for adults under "natural" (i.e. unexploited) conditions (Øritsland, 1964; Øritsland and Benjaminsen, 1975*a*). However, there are no samples available that provide an unbiased estimate of the adult sex ratio (Kapel, 1972, 1974; Øritsland, 1964; Øritsland and Benjaminsen, 1975*a*, 1975*b*; Rasmussen, 1952; Sergeant, 1966).

Reported maximum age in both sexes is approximately 35 years (Øritsland and Benjaminsen, 1975*a*). Differences in body size between sexes frequently are correlated with differences in longevity; in sexually dimorphic pinniped species, in which males are larger than females, males usually have shorter life spans (Laws, 1953).

Estimates of natural mortality rates of adults range from 7% to 15% per annum depending on the method of estimation (Flipse and Veling, 1984; Øritsland and Benjaminsen, 1975*a*, 1975*b*; Winters and Bergflødt, 1978).

ECOLOGY. Man is the major known predator of the hooded seal. Additionally, polar bears (*Ursus maritimus*; King, 1983; Nansen, 1898) at whelping sites and Greenland sharks (*Somniosus microcephalus*; Reeves and Ling, 1981) in molting areas, probably prey at least on young and disabled animals. Killer whales (*Orcinus orca*) also may be a predator (Anon., 1979).

Although nursing pups seemingly are free of parasites, hooded seals become infected with helminths (Dailey, 1975) when they begin to feed independently (Deliamure and Treschew, 1966). Intensity of helminth invasion increases with age. Heartworm, *Dipetalonema spirocauda*, has been reported as a cause of death in hooded seals, but its prevalence is not well known (Food and Agriculture Organization of the United Stations, 1979).

Tuberculous lungs and cranial infections have caused death in captive animals (Blair, 1912; Ehlers et al., 1958). Salmonella infection was implicated in the death of one hooded seal caused by septicaemia (Ridgeway et al., 1975).

Hooded seals share much of their range with harp seals (*Phoca groenlandica*) and both species undertake almost parallel migrations. However, they differ in many biological characteristics that make competition unlikely. Hooded seals tend to remain farther offshore than harp seals (King, 1983; Robinson, 1897) and to occupy deeper water and thick drifting ice (Sergeant, 1974). They rarely frequent land or shore-fast ice except in the Gulf of St. Lawrence where limited numbers of hooded seals whelp in proximity to more numerous harp seals (Greene, 1933).

In February, adult hooded seals congregate near thick ice in preparation for whelping and mating (Sergeant, 1974, 1976*a*). Major whelping concentrations occur off the east coast of Labrador and Newfoundland (the "Front") and to a lesser extent in the Gulf of St. Lawrence, off the island of Jan Mayen in the Greenland Sea east of Greenland (the "West Ice"), and in the Davis Strait in an area known to whalers in the 19th century (Freuchen, 1935; Mosdell, 1923) but only recently rediscovered (Sergeant, 1974).

After breeding, adults from the Newfoundland and Gulf region migrate northward toward the Denmark Strait to molt in June, July (King, 1964; Øritsland and Bondø, 1980; Rasmussen, 1960) and possibly in August (Sergeant, 1974, 1976*a*). Small numbers are believed to move north into Davis Strait or Baffin Bay (Sergeant

1974, 1976*a*); others molt north of Denmark Strait (Rasmussen, 1960).

After molting, near the end of August, seals disperse widely. Some move south and west around Cape Farewell, then north along the coast of West Greenland as far as Thule (Kapel, 1975). Others move to the east and north and are found in pack ice between Greenland and Spitsbergen during late summer and early fall (Rasmussen, 1957).

Little else is known about hooded seal activities during the rest of the year. A few are killed during winter in fjords near Angmagssalik, West Greenland (Kapel, 1975); many reportedly feed on the Grand Banks off Newfoundland during winter (Rasmussen, 1960).

Although hooded seals whelp in three separate areas, stock delineations are not clear. Whether animals exhibit fidelity to their places of birth also is not known. Mixing of animals from Jan Mayen and Newfoundland and Gulf breeding areas takes place at the time of molting (King, 1964; Sergeant, 1974, 1976*a*; Øritsland and Bondø, 1980; Rasmussen, 1960). The similar timing of whelping among all three breeding groups has been cited as evidence of probable linkage between populations (Sergeant, 1976*a*).

Feeding behavior and the diet of hooded seals are not well known because they fast during breeding and molting, times when they are accessible to hunting and sampling. Hooded seals are pelagic feeders, capable of diving to great depths for food. Halibut (Kapel, 1981; King, 1983; Popov, 1976), Greenland cod (Bartlett, 1927; Kapel, 1981; Popov, 1976) redfish (*Sebastes* spp.; Kapel, 1981; Nansen, 1898; Popov, 1976; Sergeant, 1976*a*), capelin (*Mallotus villosus*; Bartlett, 1927; King, 1983; Reeves and Ling, 1981) herring (Bartlett, 1927; Whitney, 1912), flounder (Popov, 1976) "turbot" (*Reinhardtius hippoglossoides*; Bartlett, 1927), squid (*Gonatus fabricii*; Gray, 1935; Kapel, 1981; Popov, 1976; Sergeant, 1976*a*), octopus (Reeves and Ling, 1981), shrimp (Bartlett, 1927; Reeves and Ling, 1981), mussels (Bartlett, 1927; Reeves and Ling, 1981), starfish (Bartlett, 1927; Reeves and Ling, 1981), and cuttlefish (Brown, 1868*a*; Gray, 1935) have been found in adult stomachs (scientific names given only when individual prey species were identified in literature). Pups initially feed near the ice edge on crustaceans and squid (Food and Agriculture Organization of the United Nations, 1979; Popov, 1976).

Intensive commercial fishing occurs in parts of the range of hooded seals (Scarrett, 1982) and stocks of some known prey species (redfish, *Sebastes marinus*, in the Northwest Atlantic [Pinhorn, 1976] and caplin [Carscadden and Misra, 1980]) have been overfished and depleted in recent years. The effects of such reductions of prey populations on hooded seal are unknown.

Sealing as an industry began in the Northwest Atlantic in the early 18th century. Hooded seals have been hunted annually for at least 150 years (Barchard, 1978; Sergeant, 1976*a*). Such exploitation always has been linked to the hunt for the more numerous harp seal, and hooded seals were not differentiated in Newfoundland catch statistics until 1895 (Lavigne, 1979; Sergeant, 1976*a*). Initially, seals were hunted with a variety of gear including nets set from shore (Beck, 1965; Coleman, 1937, 1949) and small boats among loose ice floes (Sergeant, 1976*a*). By the beginning of the 19th century, schooners were used (Mosdell, 1923). Most northern European nations took part in the seal hunt at Jan Mayen in the late 18th and early 19th centuries (Sergeant, 1976*a*).

More than 500,000 seals (harp and hooded combined) commonly were landed annually between 1820 and 1860, the period of greatest harvest (Barchard, 1978; Fisher, 1955; Mosdell, 1923). Sailing ships were replaced with steam-powered vessels during the 1860's but seal catches continued to decline (Lavigne, 1979).

Before 1930, sealing was for oil and leather (Allen, 1880; Sergeant, 1976*a*; Whitney, 1912); hence, adults and pups were harvested (Brown, 1868*b*; Nansen, 1898; Whitney, 1912). Less demand for seal oil and improved techniques for converting pelts to fine furs placed financial reward on quality and quantity of pelts. Thus, young hooded seals were hunted intensively since the 1940's for their beautiful pelts (Sergeant, 1976*a*), which were three to four times more valuable than those of other phocid seals (Barzdo, 1980; Dunn, 1977). Seal oil still is used to a limited extent in industry, food, and medicine (Shepeleva, 1973) in some nations.

Scottish sealers attempted the first conservation measure in the 1870's, an opening date at Jan Mayen to protect animals until the young seals were a suitable size for catching (Sergeant, 1976*a*). Complete protection has been afforded molting hooded seals at Denmark Strait since 1961 (Sergeant, 1976*a*).

The regulation of hooded seal hunting by quotas occurred only when it became obvious that stocks were declining (Lavigne, 1979). At Jan Mayen, quota management was introduced in 1971 (Øritsland, 1976). The initial quota was set at 30,000 hooded seals for Norway; combined quotas for Norway and USSR rose to 46,000 in 1977, and declined to 20,400 by 1982. During this time, annual catches ranged from 30,250 (1971) to 7,296 (1976).

In 1972, hooded seals breeding in the Gulf of St. Lawrence were protected, although they continue to occur in catch statistics from that region in relatively small numbers. A quota of 15,000 was introduced for Northwest Atlantic hooded seals in 1974 (Sergeant, 1976*a*), since reduced to 12,000 for the 1983 and 1984 seal hunts (Anon., 1984). Between 1974 and 1982, catches ranged from 18,726 (1975) to 10,223 (1978). Catches in 1983 and 1984 were small because of a temporary trade ban on blueback skins by the European Economic Community introduced on 1 October 1983.

The percentage of adult female hooded seals killed annually became regulated in 1977 and was reduced progressively from 10% to 7.5% to 5% of the total catch off Newfoundland between 1977 and 1979 (Fish. Environ. Canada, in litt.).

World population estimates ranged between 300,000 and 500,000 for hooded seals in the 1950's (Scheffer, 1958; King, 1964), after the cessation of hunting during World War II and before the heavy exploitation of seals in the North Atlantic during the 1950's and 1960's (Fisher, 1955; Øritsland, 1971, 1976; Sergeant, 1976*a*). Popov (1976) later suggested that the population size of hooded seals was 500,000 to 600,000 animals. King (1983) provided estimates in excess of 300,000 animals aged 1 year and older. None of these estimates are well documented, hence, none should be accepted as reliable.

Population estimates by cohort analysis (Flipse and Veling, 1984; Winters and Bergflødt, 1978) and aerial survey (Khuzin and Yakovenko, 1963; Sergeant, 1974, 1976*b*) have been conducted for segments of the population, and estimates of pup production have been produced (Hay and Wakeham, 1983; Jacobsen, 1984; Winters and Bergflødt, 1978). Recent reviewers (e.g., Food and Agriculture Organization of the United Nations, 1979) have reported that there are insufficient data to permit adequate evaluation of current stock size, pup production, and sustainable yields.

Rasmussen (1960) demonstrated a significant decline in the number of hooded seals breeding off the coast of Newfoundland during the first part of this century. He concluded that this was related to an eastward relocation of animals because of a reduction in suitable whelping habitat. Sergeant (1974) suggested that the mechanism by which climatic change has affected the numbers of hooded seals arriving at Newfoundland is far from clear; he also provided evidence that intensive exploitation (including both pups and adults) also must have had an impact on the relative abundance of hooded seals in the Northwest Atlantic. Vibe (1967) attributed declines in density of hooded seals in the Davis Strait from 1860 to 1910 to climatic factors but did not consider the possible effects of exploitation during this period (Sergeant, 1974).

The first recorded captive hooded seal lived in the Berlin Zoo in 1902, the second was held at the Bremerhaven Zoo (Mohr, 1966). In 1912, an attempt was made to house hooded seals at the Bronx Zoological Park, but all of the animals died within weeks of their arrival (Blair, 1912). Since 1954, hooded seals have been successfully held in European zoos (Klos, 1966) and several research facilities (Blix et al., 1973).

Levels of DDE (3.5 ppm), PCB (3 ppm), and mercury levels (1 to 100 ppm in liver and 0.16 to 35 ppm in muscle) have been reported for tissues of hooded seals off eastern Canada (Pearce et al., 1973; Sergeant and Armstrong, 1973). Hooded seals sampled off Greenland during 1972–1976 were examined for DDD (0.086 mg/kg), DDT (2.1 to 6.5 mg/kg), PCB (2.2 to 8.2 mg/kg) and mercury (0.33 muscle; 16.7 mg/kg wet weight in liver tissue) (Johansen et al., 1980). From studies on ringed seals, it is believed that the mercury may be of natural origin and may not have adverse effects on seals (Smith and Armstrong, 1978).

Methods of marking individual hooded seals or cohorts have included metal tags, plastic roto tags, flash-branding, coke-brazier and hot-iron branding (Homestead et al., 1972; Rasmussen and Øritsland, 1964; Scheffer, 1950; Sergeant and Hoek, 1974). Adult hooded seals have been immobilized for tagging with fentanyl and etorphine (Haigh and Stewart, 1979).

BEHAVIOR. Hooded seals are solitary throughout most of the year (King, 1964), and little is known of their behavior. During the breeding season females disperse over the ice in loose aggregations spaced at approximately 50-m intervals (Olds, 1950). Females remain on the ice with their pups throughout the period of lactation. At this time, females are attended by one or more males that compete fiercely for proximity to the female and eventually for mating privileges (Brown, 1868*b*; Merriam, 1884). Males often are seen to expand their hoods and extrude their nasal septums during these encounters. The nasal appendage may act as part of the threat display or may serve as a secondary sexual character (Berland, 1966; Maxwell, 1967; Miller and Boness, 1979).

Scattered trios of male, female, and pup (Fig. 4c) are commonly referred to as "families" (Bartlett, 1927; Greene, 1933; Olds, 1950). Some workers have suggested that hooded seals are monogamous (King, 1964; Mansfield, 1967; Olds, 1950), but considering their summer distribution, sexual dimorphism, and the degree of competition among males on the breeding ice, it seems more likely that males are polygynous within a given year (Miller and Boness, 1979).

Female hooded seals are protective of their pups and actively defend them against intrusions by other seals and man. Greene (1933:81) stated that "the mother-seal especially displays a splendid courage that approaches the sublime in its fearless devotion, invariably dying by the side of her pup."

Males usually do not participate in the defense of the pup but at times may be extremely aggressive toward intruders. Hooded seals were feared and respected by early sealers, who made reference repeatedly to their fierce disposition and the difficulty involved in killing adult males (Bartlett, 1927; Brown, 1868*b*; Robinson, 1897; Southwell, 1884; Whitney, 1912).

The recorded vocal repertoire of hooded seals is limited to a few combinations of low-frequency, pulsed calls (Schevill et al., 1963; Terhune and Ronald, 1973).

GENETICS. The hooded seal has a chromosome number of 2n = 34 (Arnason, 1972; Hsu and Bernirschke, 1973; Pfitzer and Blessing, 1969); all chromosomes of the karyotype are identified easily and paired by their characteristic banding patterns (Arnason, 1974).

Genetic variability among hooded seals is low. Based on 10 animals from Greenland the proportion of polymorphic loci, at the 0.99 criterion level for the most frequent allele, was 0.048; individual heterozygosity was 0.009 (Simonsen et al., 1982). Little C-heterochromatin is present in the hooded seal, as in autosomes of 2n = 32 phocids (Arnason, 1981). Consistently, a study of late DNA-synthesis in hooded seal chomosomes revealed great similarities in the labelling pattern with the 32-chromosome form (Arnason, 1972).

Serological studies have detected no variation in transferrins among hooded seals. However, haptoglobin variations were conspicuous (Naevdal, 1966, 1969). Also, two unidentified serum proteins, II and III, appeared to occur at different frequencies in samples from Newfoundland, compared with samples from Jan Mayen and the Denmark Strait, but the available results are sufficiently ambiguous that no conclusions about stock identity are possible (Naevdal, 1966, 1969).

REMARKS. No classification scheme has been generally accepted for pinnipeds. Older authorities tended to elevate the Pinnipedia to ordinal rank, but most authors today consider the pinnipeds to be a suborder of the Carnivora (King, 1983) as indicated here. A number of other classification schemes have been proposed (for example, see Mitchell and Tedford, 1973). Most recently, Tedford (1976) included the pinnipeds in the Order Carnivora, Suborder Caniformia.

Several early descriptions using only vernacular names are important to the history of the nomenclature of the hooded seal: Egede (1741), Klapmuts; Ellis (1748), seal with a cawl, figure only; Cranz (1765), Neitersoak, also called Clapmutz; Pennant (1771), hooded seal, description based on Egede (1741) and Cranz (1765); Olafsen and Povelsen (1772), Blase-Seehund; Schreber (1776), Klappmuz, based on Pennant (1771); Buffon (1782), Le Phoque a capuchon. Other common names for the hooded seal are hood seal, crested seal, and bladdernose seal.

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