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Leptonychotes weddelli. By Ian Stirling

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Leptonychotes Gill, 1872

Leptonyx Gray, 1837:582. Type species *Otaria weddellii* Lesson, 1826, by monotypy. Preoccupied by *Leptonyx* Swainson, 1821, Aves.

Leptonychotes Gill, 1872:70. Replacement name for *Leptonyx* Gray.

Peocilophoca Lydekker, 1891:605, a renaming of *Leptonyx* Gray, 1837.

CONTEXT AND CONTENT. Order Pinnipedia, Family Phocidae, Subfamily Monachinae, Tribe Lobodontini. The genus *Leptonychotes* has only one species, *L. weddelli*, as treated below.

Leptonychotes weddelli Lesson, 1826

Otaria weddellii Lesson, 1826:437 (spelled *weddelii* on p. 438). Type locality South Orkney Islands. The author chooses to disregard the requirement of the International Code of Zoological Nomenclature that the original spelling, in this case *weddellii*, be used and to use the simpler spelling *weddelli*.

Leptonychotes weddelli Allen, 1880:467, first use of current name combination.

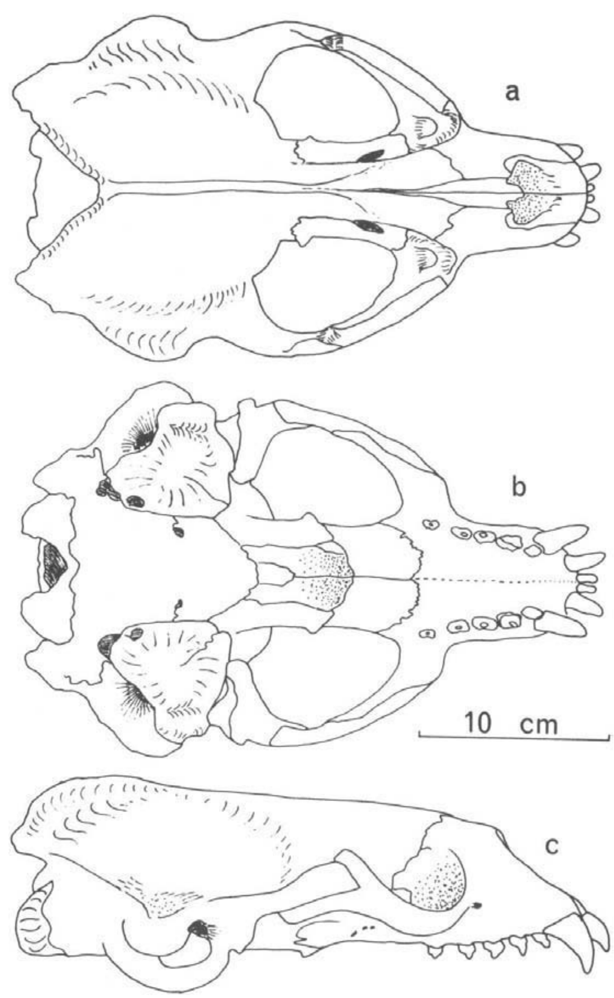

FIGURE 1. Drawings of the skull of *Leptonychotes weddelli*: a. dorsal view, b. ventral view, c. lateral view.

CONTEXT AND CONTENT. Context noted above in generic summary, based on Turner (1888) and Scheffer (1958). No subspecies are recognized.

DIAGNOSIS. The genus is monotypic and the following diagnosis applies to genus and species. To quote the generic description from Turner (1888:64–65): "Premaxilla reaching the side of the nasal. Cranial width greater than the interzygomatic width, nasals ankylosing together early and the interfrontal part laterally much constricted; anterior nares oblique, superior maxilla with a moderate articulation with the nasal. Hard palate emarginate, posterior border of vomer visible in cleft and articulating with vomerine crest at anterior part of palate bone. No postorbital process; hamular process and pterygoid everted, basi-occipital perforated mesially. Tympanic bulla not ridged and with antero-internal angle truncated . . . . Humerus without a supracondyloid foramen. Postcanines small, with one moderately prominent cusp, though in the 3rd and 4th a rudiment of a posterior cusp is also visible; the last postcanine distinctly smaller than the rest. Mandible with a faint, incurved tubercle to represent the subcondyloid process and with no angle; symphysis moderate, the halves of the body widely diverging." The upper canines and upper outer incisors procumbent (see Fig. 1), which character will separate *L. weddelli* from any other living pinniped; outer upper incisor about four times size of inner; interorbital width less than 18% of condylobasal length; low saggital crest in both sexes. Lateral and medial views of the mandible are shown in Figure 2. For general use, see key in Scheffer (1958).

GENERAL CHARACTERS. Adult seals are dark dorsally and mottled laterally and ventrally where white predominates. Females are larger than males, the maximum recorded lengths being 329 cm. and 297 cm., respectively (King, 1964). Like other lobodontines, Weddell seals grow faster, mature earlier, and live fewer years than do phocines (Laws, 1959). Dentition is i 2/2, c 1/1, p 3/3, m 2/2. A longer description is in Wilson (1907); photographs of the skull, including X-rays of the development of the milk dentition, are in Bertram (1940); and a good series of general photographs are included in Brown (1915), Wilson (1907), and Bertram (1940).

DISTRIBUTION. This species has a circumpolar range and inhabits the fast ice areas of the Antarctic continent and adjacent islands as shown in Figure 3. South Georgia is the usual northern limit. Limital records are also mapped (details in Scheffer, 1958; Vaughan, 1968). Scheffer (1958) estimated the total population to be 200,000 to 500,000. Laws (1953) estimated 800,000 in the Falkland Islands and Dependencies alone, and Stirling (1969b) estimated the popula-

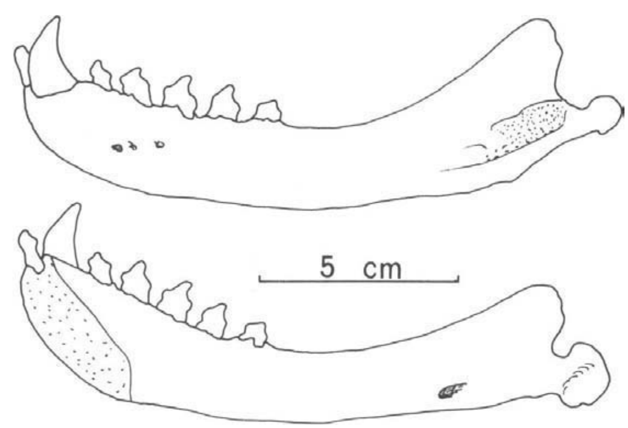

FIGURE 2. Lateral and medial views of the mandible.

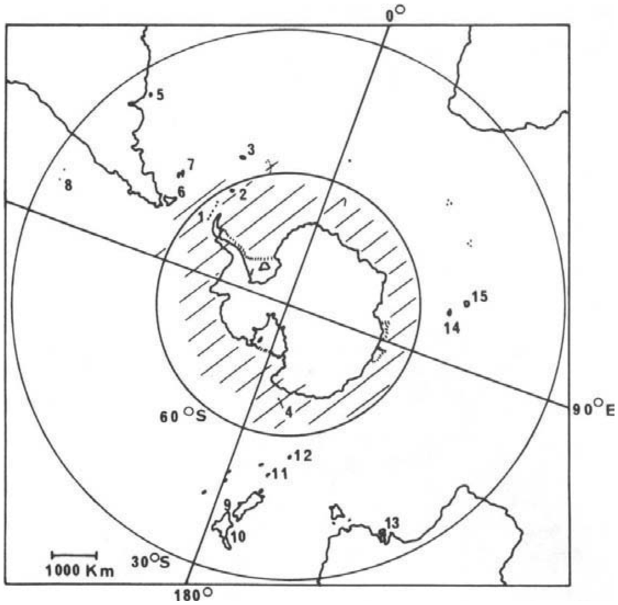

FIGURE. 3. Map showing geographic range of the Weddell seal. Diagonal lines indicate normal breeding distribution about the Antarctic continent and associated islands as follows: 1. south Shetland Islands, 2. South Orkney Islands, 3. South Georgia, 4. Balleny Islands. Sites of limital records are: 5. Islas de Lobos, Uruguay, 6. Patagonia, 7. Falkland Islands, 8. Islas Juan Fernández, 9. Wellington, New Zealand, 10. Auckland, New Zealand, 11. Auckland Islands, 12. Macquarie Island, 13. South Australia, 14. Heard Island, and 15. Kerguelen Island.

tion in the Western Ross Sea to be about 50,000, indicating that the total population may be higher than Scheffer's original estimate. Hopefully, a broad population study of Antarctic seals currently underway by the University of Minnesota (Erickson *et al.*, 1969; and Siniff, Cline, and Erickson, 1970) will provide a more accurate estimate. No fossil of the genus is known although a monachine seal has recently been found in Pliocene deposits in South Africa (Q. B. Hendy, personal communication).

FORM. The integument has not been studied. There are two mammae. The milk teeth are shed during pregnancy and Bertram (1940) gave further details of dental development and skull morphology. Turner (1888) gave an excellent description of the skull by comparing it with the leopard seal (*Hydrurga leptonyx* Blainville, 1820; although Turner called it *Stenorhynchus leptonyx*) and gave much detail about the skeleton, including the following: vertebral formula, 7 cervical, 15 thoracic, 5 lumbar, 2 sacral, and 11 caudal for a total of 40; 15 pairs of ribs of which 10 are articulated with the sternum; sternum of 10 segments and connected to a broad plate-like cartilaginous xiphisternum; scapula falciform with no acromion and a weak coracoid; manus pentadactyl, only seven carpals owing to coalescence of scaphoid and lunare (further fusing and articulation described); pes also pentadactyl and first and fifth toes longer than the rest. A recent detailed study of the osteology and myology (Piérard, 1970) indicated a predictably close relationship between *Leptonychotes* and other phocids and described the following adaptive modifications: a shortened cervical vertebral segment, a musculo-aponeurotic mechanism acting on the trachea and the esophagus, and better adaptation of the limbs for propulsion. Hepburn (1915a) gave a good general description of the brain and Haig (1915) described the histology of sections from the spinal cord, medulla oblongata, pons variolii, mesencephalon, optic thalamus, precentral gyrus, vermis of the cerebellum, and the pituitary. A more recent histological examination of the ephiphysis cerebri (Cuello, 1970) has shown that the Weddell seal has the largest pineal gland known in polar animals, with a structural pattern different from that known in other animals, enervation from orthosympathetic ganglia, and an annual variation in lipid content. Hepburn (1915b, 1915c, 1915d) gave general descriptions of the respiratory, digestive and urogenital systems.

FUNCTION. The composition of milk constituents shows wide variation from 72.8% to 42.5% solids and the milk apparently becomes more concentrated as lactation progresses which may be a mechanism of water conservation (Kooyman and Drabek, 1968). Milk fatty acid values are similar to those reported for the gray seal and the blood fatty acids seem to be fairly evenly distributed between the shorter and longer chain molecules (Stull *et al.*, 1967).

Piérard (1969) found from a dissection of the larynx that the glottis is more adapted than in other pinnipeds for protective closure of the larynx and that the membranous part of the vocal cord contributes little to sound production although short howls may be produced by the intercartilaginous part. He suggested that the well known "trilling" sounds are made at the cricotracheal junction and that the rostral part of the trachea acts as a resonating chamber for these sounds.

Kooyman (1968) gave the following information on diving physiology: most rapid ascent from a dive was 120 m./min.; a significant difference in oxygen capacity and packed cell volume was found between samples collected from the hepatic sinus (O_2 cap. = 38.1 vol %; Hematocrit = 73% and the facial tributaries of the jugular (O_2 cap. 32.5 vol %; Hct = 58 %); post dive heart and respiratory rates were about double the resting rates; and the mean body temperature was 36.7°C.

This species appears to have a higher relative O_2 store than other phocids, which may be related to its effective diving performance (Lenfant *et al.*, 1970). Elsner, Hammond, and Parker (1970) demonstrated that under experimental asphyxia pregnant animals reduced renal flow while maintaining uterine artery flow, blood flow from the abdominal aorta to the fetus was reduced, bradycardia occurred, and fetal heart slowing and restoration were delayed when compared to maternal heart rates. Elsner, Shurley, Hammond, and Brooks (1970) also monitored eye movements, muscle tonus, heart rate, electrical activity of the brain, and respiratory efforts during experimental asphyxia. They gave the intriguing suggestion that Weddell seals have a greater cerebral tolerance for low oxygen than terrestrial species for which data are available; electroencephalogram slowing occurred when arterial oxygen tension was reduced below 10 mm. Hg and changes in P_{aCO_2} and pH appeared to have little influence on this endpoint.

The Weddell seal eye in air has an astigmatism that varies from 4.5D to 1.2D; the meridian with the lowest error is vertical. While in water the eye shows low astigmatism (Wilson, 1970). It also has a reflecting structure, the tapetum (Kooyman, 1968; Wilson, 1970), which increases sensitivity under reduced light conditions. This is presumably an advantage to this seal, which feeds at great depths under sea ice and lives much of the year with limited available light.

Reproductive physiology has been detailed by Mansfield (1958) and Smith (1966a) and is similar to that of pinnipeds generally as covered in an excellent review by Harrison (1969). Urea and potassium levels in the urine of lactating females and pups are lower than in urine of males or non-lactating females but sodium values are greater, and even while losing large amounts of water through lactation, the adult female does not suffer dehydration to the extent that it responds with an appreciable increase in the urine concentration (Kooyman and Drabek, 1968).

ONTOGENY AND REPRODUCTION. In McMurdo Sound, active spermatogenesis occurs from mid-September to the end of December, females are impregnated in late November to mid-December and implantation occurs about mid-January (Smith, 1966a). Gestation is 9 to 10 months and young are born with their permanent dentition. Except for brief comments by Timms (1910) and Smith (1966a) the embryology has not been studied. Birth takes place straight onto the sea ice, often resulting in the newborn experiencing a change of external temperature in excess of 55°C. Births are described by Mansfield (1958), Stirling (1969d), and Ray and de Camp (1969). Normally only one pup is born although twins have been recorded in utero and born dead (Lindsey, 1937; Bertram, 1940; Smith and Burton, 1970). The sex ratio is not significantly different from unity. The time of birth varies with latitude from the first week of September at latitude 60°S (Mansfield, 1958) to the fourth week of October at latitude 78°S (Lindsey, 1937). Newborn pups weigh about 29 kg. at birth and have a soft gray lanugo, which is molted after 3 to 4 weeks to a dark coat similar to the adults coat. Pups are weaned at 6 weeks of age (Wilson, 1907; Lindsey, 1937; and Bertram, 1940) and become physiologically mature at 3 years (Smith, 1966a). Under some population conditions first breeding of females may be delayed 1 or 2 years (Stirling, 1970) and because of social pressures, males probably do not mate until they are at least 6 to 8 years of age. The females are probably monoestrus (Smith, 1966a). Senility, in the sense of becoming too old to breed, is probably rare although Smith and Burton (1970) record a female surviving, but without a pup, in her nineteenth and twentieth years. The average age of adult seals in McMurdo Sound in the years 1966 through 1968 was 8 to 9 years and annual survival of adult males and females was 76.1% and 82.8% respectively (Stirling, 1970). A life and fecundity table for adult females is also given by Stirling (1970).

ECOLOGY. Apart from occasional attacks by killer whales, the Weddel seal has no predators other than man. They are heavily infested with worms (Markowski, 1952; Featherston, 1965) and on some occasions regurgitate masses of them (Feltz, 1967). The louse, *Antarctophthirus ogmorhini*, occurs particularly about the hind quarters and occasionally in the penile orifice and axilla of the foreflipper (Murray *et al.*, 1965). Subadult animals have larger infestations of lice than do adults. The Weddell seal normally has no interspecific competition, but occasionally crabeater seals (*Lobodon carcinophagus*) utilize the same breathing holes (Bertram, 1940; Laws and Taylor, 1957; Stirling and Kooyman, 1971).

The Weddell seal lives in the fast ice areas and is nonmigratory; local movements may be stimulated by changes in ice conditions. During the winter, the seals use their canine teeth to abrade the sea ice and maintain breathing holes (Wilson, 1907; Lindsey, 1937) in areas where physical factors (glacial and tidal action) produce natural cracks (Stirling, 1969c). Breathing holes away from natural cracks are rare. The upper canines and incisors appear to be procumbent as a modification for abrading ice (Stirling, 1969a; Kooyman, 1969). Locating these breathing holes when surfacing from a dive during the polar night must present a serious navigational problem. The eyes are well developed for vision in conditions of minimal visibility (Kooyman, 1968; Wilson, 1970) and it has been suggested that a form of echolocation may be used (Poulter, 1965; Kooyman, 1968). The location of natural cracks determines the site of pupping colonies independent of biological considerations such as exposure or accumulation of drift snow (Stirling, 1969c). During the pupping season, seals on the sea ice are more widely spaced in the pupping colonies than they are later in the summer, and nonbreeding seals and subadults are excluded from these areas. In the water, adult males defend breathing holes from other males and harass subadults. Threat calls are used (Watkins and Schevill, 1968) and vigorous fighting may take place (see description in Kooyman, 1968) but underwater behavior has not yet been sufficiently observed to facilitate a detailed description. Smith (1966b) described wounds accrued by males in social fighting. No diseases have been described although R. East (personal communication) isolated several varieties of bacteria from festering wounds.

The diet is chiefly notothenid fishes and squids (Dearborn, 1965) although individuals of *Dissostichus mawsoni* up to 54 kg. in weight have been taken by seals (Kooyman, 1968). Mainly because of its inaccessibility, the Weddell seal has not been in danger of extinction. However, near some continental stations where seals are killed for dog food this species has been all but eliminated. A few young individuals have been kept in captivity but one problem has been that they continue to try to abrade the concrete of their tanks as though it was sea ice and wear their canine teeth badly (R. Elsner, personal communication). Drugs have been used to capture Weddell seals (Flyger *et al.*, 1965; Cline *et al.*, 1969) but a bag with ropes is the easiest and cheapest way of handling seals of any size with no physical after effects (Stirling, 1966a). Monel metal and plastic tags have been used (Stirling, 1966b; Kooyman, 1968) but both have suffered some loss. The best time to census is midafternoon when the maximum number of seals are out on the sea ice (Müller-Schwarze, 1965; Smith, 1965; Stirling, 1969b). Ray (1970) has pointed out the need for additional knowledge of behavior, particularly sub-ice, to augment aerial counts. Collecting specimens is simple because the animals have little fear of man. Detailed ecological discussions may be found in Lindsey (1937), Bertram (1940), Sapin-Jaloustre (1952), Mansfield (1958), Kooyman (1968), and Stirling (1969c).

BEHAVIOR. Most intraspecific behavior of the Weddell seal occurs in the water and no detailed study has been reported to date. In summer, a larger proportion of the seals are in the water "at night" than during the day and presumably most intraspecific behavior takes place then. Watkins and Schevill (1968) performed some interesting but inconclusive experiments that showed Weddell seals were interested in underwater playbacks of their own calls. Poulter (1965), Kooyman (1968), and Schevill and Watkins (1965) discussed vocalizations briefly as did Ray and de Camp (1969) in a popular account. Vocalization likely will be elaborated upon in the future. Reproductive behavior occurs in the water and was observed for the first time on 7 December 1969 (Cline *et al.*, 1971). The male mounted the female from behind, held her sides with his foreflippers, and sometimes bit at her neck while copulating.

On land or ice, Weddell seals move slowly in a humping fashion as described by O'Gorman (1963). In water they swim using both their fore and hind flippers and estimates of their speed are 7 knots (Bertram, 1940) and 5 knots (Kooyman, 1968). They can dive to depths of 600 m. (Kooyman, 1966) and can stay underwater for up to an hour (Elsner, Kooyman, and Drabeck, 1970). Kooyman (1968) demonstrated that seals under the sea ice were able to orient in a specific direction but the mechanism was not understood. They apparently devour their food under the ice and are probably able to meet their water requirements from their diet or by metabolizing sea water, but individuals have occasionally been observed eating snow.

When fighting, the hind quarters often are attacked (Smith and Burton, 1970), although Kooyman (1968) described a dramatic battle in which two males had their chests in continual contact except when striking at each other's chest, neck, or axillary areas. Ray (1967) suggested the males occupied territories but that females were dominant. When sleeping on the sea ice, seals may lie in the same position for hours, melting a depression in the sea ice with their body heat. They may be on the stomach or back but lying on the side appears commonest. When sleeping on sea ice on a sunny day, they often appear to lie with the long axis perpendicular to the sun, thus maximizing thermal benefit (Ray and Smith, 1968). They have also been observed sleeping under the sea ice for periods of 15 to 20 minutes at a time. Vocalizing while asleep is common. The only description of play is an observation of subadults play-fighting (Kooyman, 1968). The head, neck, chest, and upper sides may be groomed with the nails of the foreflippers. Other areas cannot be so reached although the hind flippers may be rubbed together and seals may rub the length of the body back and forth on the ice. Behavior on the surface of the sea ice may be observed directly and photographs may be used to assist. Underwater vocalizations may be tape recorded. Observations in the water may be made by looking down through holes, by diving with normal scuba gear (Dayton *et al.*, 1970), by use of an underwater observation chamber (Ray, 1965; Kooyman, 1968), and by use of underwater television cameras (Anonymous, 1970; Cline *et al.*, 1971). The latter technique appears to hold the most promise because cameras are more mobile, have no limit of time they can remain in the water, have the least chance of disturbing the seals, and several different locations can be watched at the same time. Kooyman (1965) described an instrument for measuring depth and pattern of dive. Telemetric methods of studying movements and diurnal rhythm are presently being developed by the University of Minnesota (see, for example, Siniff, Tester, and Kuechle, 1970).

GENETICS. Blood samples collected from four widely separated areas about the continent showed significant differences in transferrins (Shaughnessy, 1969). A study done with only 13 specimens (Seal *et al.*, 1970) indicated no hemoglobin or transferrin polymorphisms.

REMARKS. The name *Leptonychotes* is derived from the Greek *leptos* (small, slender), *onus* (claw) and *otes* (denoting possession) and refers to the small size of the claws on the hind digits. The species *L. weddelli* was named after Sir James Weddell, who commanded a British sealing expedition from 1822–24 into the Weddell Sea, which also is named after him.

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