amino acid determinations were made in a Beckman Amino Acid Analyzer.[1]

While Hill, quoted by Laurie (1933), was correlating the pressure conditions in the lungs of blue whales, *Balaenoptera musculus*, with the gaseous nitrogen content of urine, he also measured the specific gravity of the urine on 13 occasions and the sodium chloride (NaCl) content 43 times. The SG ranged from 1.029 to 1.038 with a mean of 1.034; the NaCl content ranged from 13.33 to 26.60 mg/ml with a mean of 21.30 mg/ml. This is 360 meq/l for both sodium and chloride ions. In the present instance an SG of 1.032 on the bowhead whale urine and sodium ion=183 meq/l and chloride ion=433 meq/l were obtained. Furuhashi (1927) obtained a mean chloride ion value of 318 meq/l on eight samples: Three from fin whales, *B. physalus*; four from sei whales, *B. borealis*; and one from a sperm whale, *Physeter macrocephalus*.

Laurie (1933) obtained chloride values on urine from blue and fin whales ranging from 120 to 455 mM/l with many values near the upper limits.

Lövenbach, quoted by Krogh (1939), obtained chloride values ranging from 75 to 820 mM/l (mainly on *Megoptera boops*)[2]. He stated that the usual range is between 280 and 520 mM/l. Schmidt-Nielsen and Holmsen (1921) obtained values of 266 mM/l and 362 mM/l of sodium and chloride, respectively, on urine from both crustacean-eating whales, *B. borealis*, and from mainly fish-eating whales, *B. physalus*. They also reported on the examination of fresh urine from one *B. borealis* that had a specific gravity of 1.027 and a freezing point depression of −2.46°C. This represents an osmolality of 1,323 mo/l. The chloride ion content of this urine was 181 meq/l.

[1]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

[2]Present scientific name is *Megaptera novaeangliae*

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The cooperation of P. F. Jezyk, Veterinary Medical Genetics, University of Pennsylvania, Philadelphia, Pa., in the urine amino acid analysis is appreciated. The cooperation of Harry Brower, Sr., Barrow, Alaska, the personnel of the National Marine Fisheries Service, as well as the Naval Arctic Research Laboratory is also appreciated in the collection and submission of the urine sample.

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Healed Penetrating Injury of a Bowhead Whale

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The bowhead whale has been successfully hunted by the Eskimos of Arctic Alaska for centuries. In recent years increasing concern has been expressed over the rising number of animals taken or struck and lost (Marquette, 1979). The fate of those that are struck and lost is not known; however, it is reasonable to assume that many succumb to their wounds.

An instance of a bowhead whale evidencing a healed penetrating injury is described in this report. Although positive proof is lacking, a reasonable explanation is that the penetration was due either to a harpoon or a bomb fired from a shoulder gun. The whale was taken during the fall 1978 whaling season in the Beaufort Sea off Kaktovik, Barter Island, on the northeastern coast of Arctic Alaska. The animal was struck on 15 September 1978 and lost in an approaching storm. On 21 September, with aircraft support, the animal was found floating approximately 28 km to the west and 4 km from shore. The whalers then beached the animal at that point.

The animal was a male, approximately 10.6 m in length, and was designated as whale #78KK1 by the National Marine Fisheries Service. As the butchering proceeded, large sections (approximately 0.9 m × 0.6 m × 0.2 m) of skin with underlying blubber were removed and placed upon the beach. During collection of tissue specimens from the sections, what appeared to be a scar was noted extending from the skin and through the blubber. The area of suspected scar tissue was a whitish tract that extended through the blubber at an angle; it was 2.5 cm in diameter, 11 cm long, and firmer than the surrounding blubber (Fig. 1). The whitish tract in the blubber, hypodermis, and dermis was continuous externally with an area of white skin, slightly

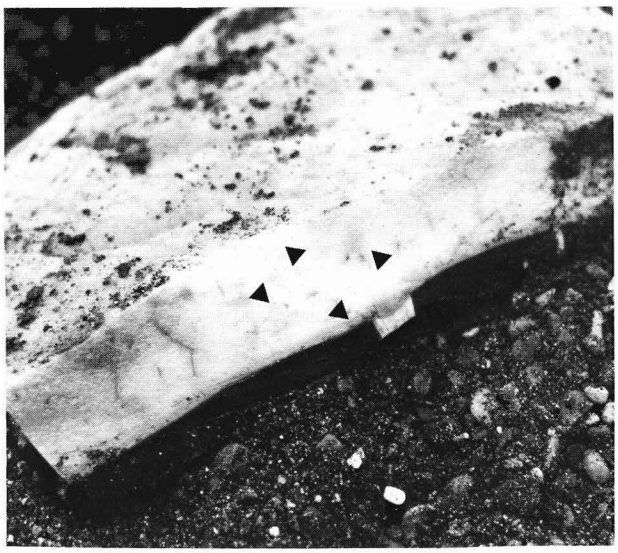

Figure 1. —Large section of skin with attached blubber. Note locus of white epidermis with scar tissue (closed triangles) extending through blubber.

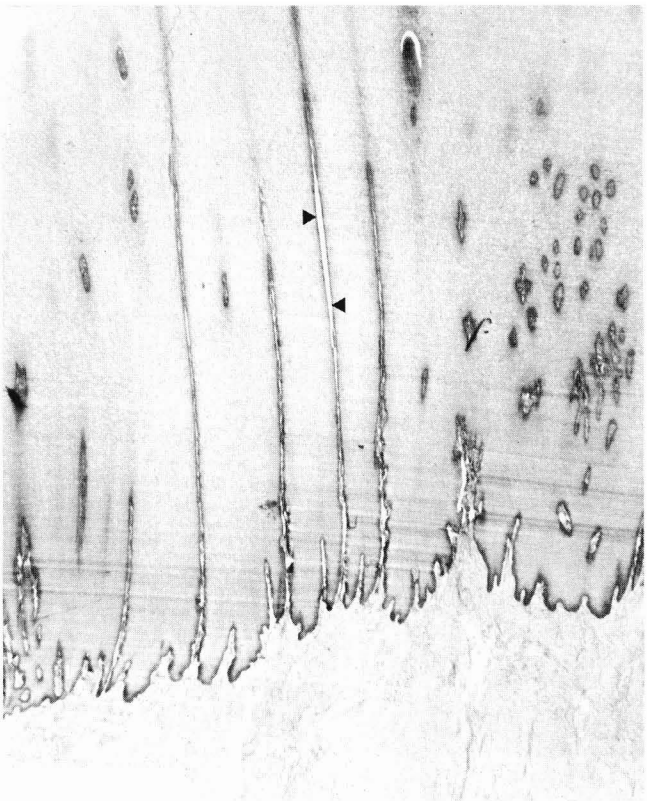

Figure 2. —Photomicrograph of skin with epidermis above and dermis below. Note dermal papillae (closed triangles) extending well into the epidermis. Hematoxylin and eosin; × 11. Armed Forces Institute of Pathology photograph.

depressed from the surrounding black skin. This locus of white skin was somewhat irregular in shape, approximately 2.5 cm long, 1 cm wide, and 0.8 cm thick. Since the suspected scar was noticed in tissue removed from the animal it was neither possible to localize its position upon the animal nor to determine the full extent of the penetration. This and other materials were placed into 10 percent buffered Formalin[1] and prepared for histological examination.

Histological Findings and Discussion

The epidermis of cetaceans is divided into three separate layers or strata (Harrison and Thurley, 1974). The stratum germinativum or the basal cell layer forms the junction between the dermis and epidermis and is comprised of columnar-type epithelial cells and melanocytes containing brownish-black melanin pigments. The presence of these pigments accounts for the black appearance of the skin. The stratum externus or the outer cell layer is comprised of flattened cells each containing an elongated nucleus. Because all of the cells in the epidermis contain a nucleus, no true stratum corneum is recognized.

The normal skin of this bowhead whale was comprised of a thick epidermis and a relatively thin dermis which merged with a thick underlying hypodermis or blubber. The epidermis was black and about 18 mm thick. The rete ridges were uniform in size and shape and extended deep into the dermis. The dermal papillae containing small blood vessels were found more than half way up the epidermis (Fig. 2). The dermal papillae were comparatively wide; this would account for the visible parallel vertical lines which resulted in the striated appearance of the epidermis on the cut surface (Fig. 3).

The dermis measured about 3 mm in thickness and was comprised almost entirely of collagenous fibers with lesser amounts of elastic fibers. The dermis was divided into an outer papillary layer containing the dermal papillae and an inner reticular layer which merged with the hypodermis. The fibers were arranged in bundles of uniform size and could be found extending in different directions, especially in the reticular layer. Blood and lymph vessels as well as nerve bundles were evident.

The blubber was continuous with the dermis and was comprised almost entirely of mature fat cells which were supported by thin bundles of collagenous fibers.

Histologically, some differences were noted between the white epidermis external to the fibrous tract and the adjacent black epidermis (Fig. 4). In this white epidermis, the cells did not contain melanin pigments and the rete ridges were very irregular in shape and

[1]Reference to trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

Figure 3. — Cut surface of skin with underlying blubber (A) Note vertical striations in black epidermis due to dermal papillae. Armed Forces Institute of Pathology photograph.

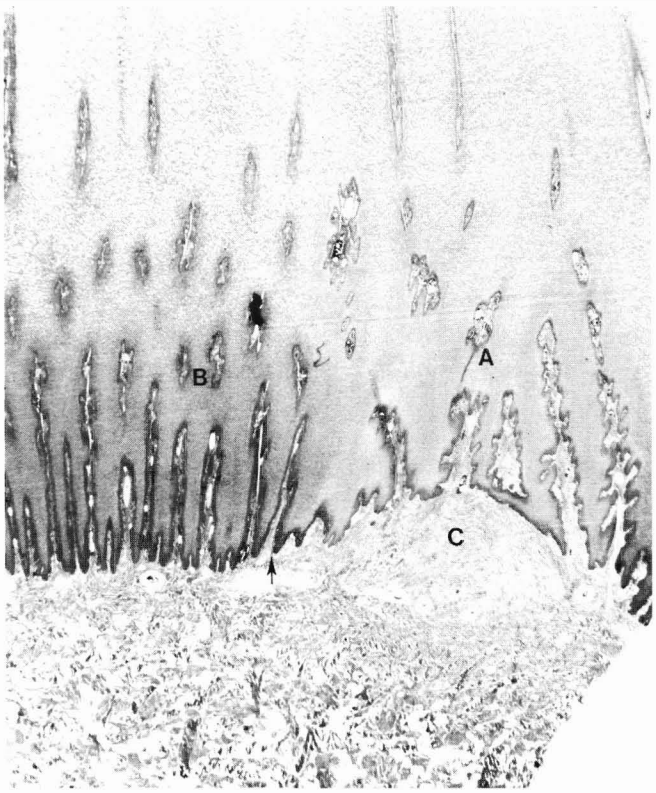

Figure 4. — Photomicrograph of skin at the junction (arrow) between white epidermis (A) and black epidermis (B). Note discrete areas of fibrosis in the dermis (C). Hematoxylin and eosin; × 11. Armed Forces Institute of Pathology photograph.

appeared to be much wider and shorter (Fig. 5) than those of the black epidermis (Fig. 6). In the dermis beneath the white epidermis, the whitish tract was comprised of mature collagenous fibers arranged haphazardly and in smaller bundles (Fig. 7) than those seen in the normal dermis (Fig. 8). Evidence of granulation tissue was lacking and occasional foci of mononuclear leukocytic infiltrate were noted (Fig. 9). In the blubber the whitish tract was comprised of mature collagenous fibers arranged in bundles which were oriented in many different directions (Fig. 10).

The fact that the animal's skin was in contact with near freezing water undoubtedly contributed to the maintenance of the skin's histological structure following death.

The morphology of the white epidermis and the discrete whitish masses in the dermis and blubber are suggestive of repair following a deep penetrating traumatic wound. The presence of mature collagenous tissue with little or no leukocytic response and the absence of vascularity are indicative of a chronic lesion of long duration. It is apparent that melanocytes were destroyed in the injured epidermis and that regeneration was accomplished by epithelial cells, thus resulting in a white epidermis.

White scars on the skin of cetaceans have been reported as resulting from various causes (Greenwood et al., 1974; Harrison and Thurley, 1974; McCann, 1974). These include mechanical pressure necrosis of the skin resulting from nonaquatic transportation, intraspecific fighting, attack by the sea lamprey, trauma due to contact with ice floes, and freeze branding. It has been noted, however, that the skin of cetaceans inhabiting cold northern waters is generally without scars (Yablokov et al., 1972).

Penetrating injuries containing portions of the spearlike snout of a swordfish (Machida, 1970) and marlin, *Makaira* sp. (Ohsumi, 1973), have been noted in at least the sei whale, *Balaenoptera borealis*, and minke whale, *Balaenoptera acutorostrata*.

In the present instance it is not likely that the penetrating injury was due to a billfish, as their distribution (Klawe, 1977) does not overlap with what is suspected to be the southern limit of the bowhead whale's range. It would also seem unlikely that the wound was due to a pointed object that the animal encountered in the water during its travels. A reasonable explanation is that the animal had been struck by an Eskimo hunter during an earlier whaling season and survived the encounter. As can be seen in Figure 11, the wound in

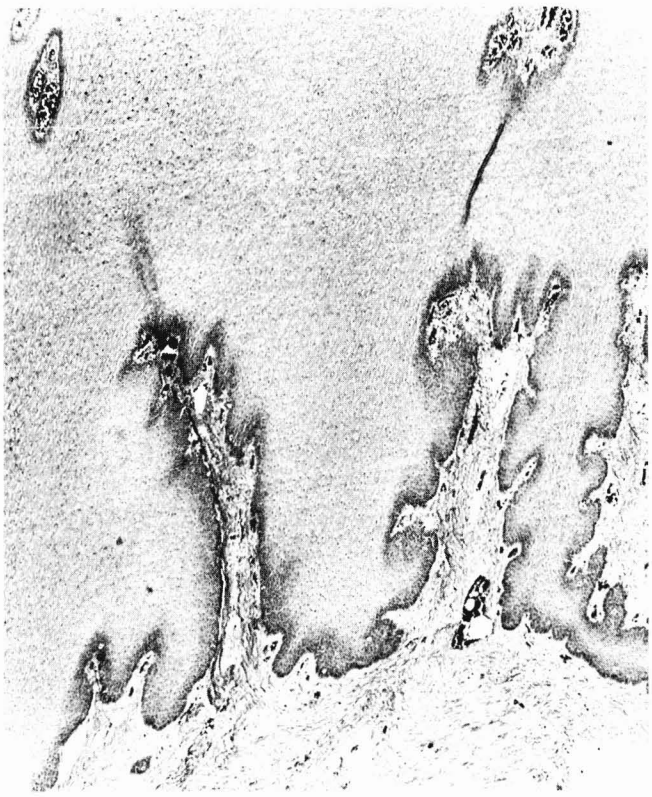

Figure 5. — Photomicrograph of the white epidermis Note the absence of melanin pigment, and the irregularly shaped and short blunt appearance of the rete ridges extending into the dermis below when compared with the normal black epidermis in Figure 6. Hematoxylin and eosin; × 45. Armed Forces Institute of Pathology photograph

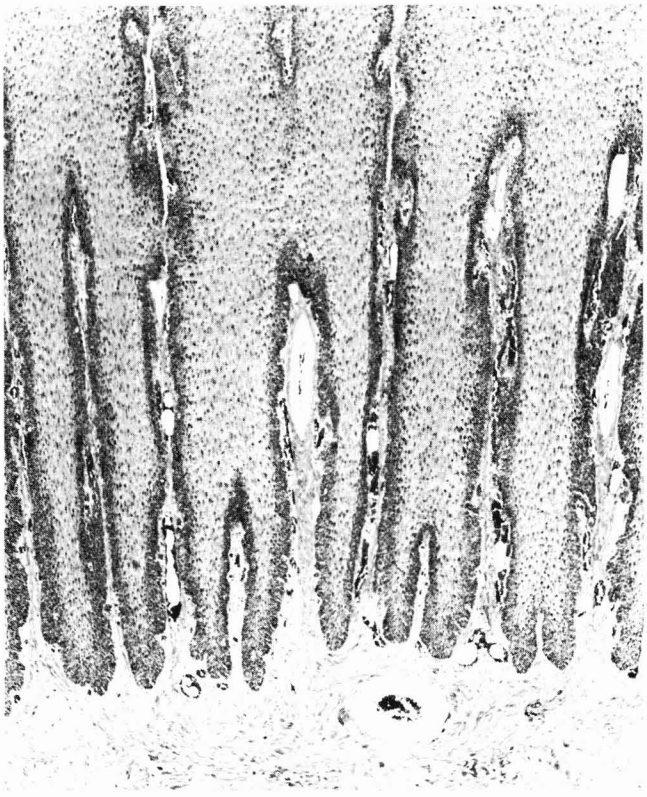

Figure 6. — For comparison with Figure 5. Photomicrograph of the normal black epidermis. Note the presence of melanin pigments and the uniform size and shape of the rete ridges extending into the dermis below. Hematoxylin and eosin; × 45. Armed Forces Institute of Pathology photograph.

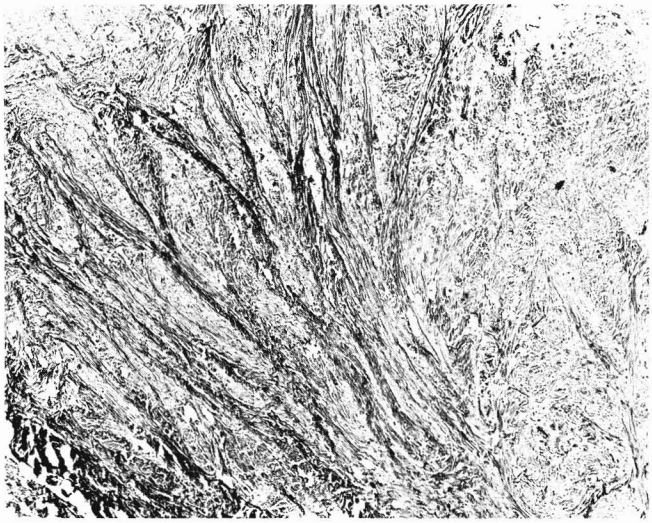

Figure 7. — Photomicrograph of the whitish tract in the dermis and blubber. Note the haphazard arrangement of the collagenous fibers which appear to be in smaller bundles than those found in the normal dermis (see Fig. 8) Mason trichrome; × 45. Armed Forces Institute of Pathology photograph.

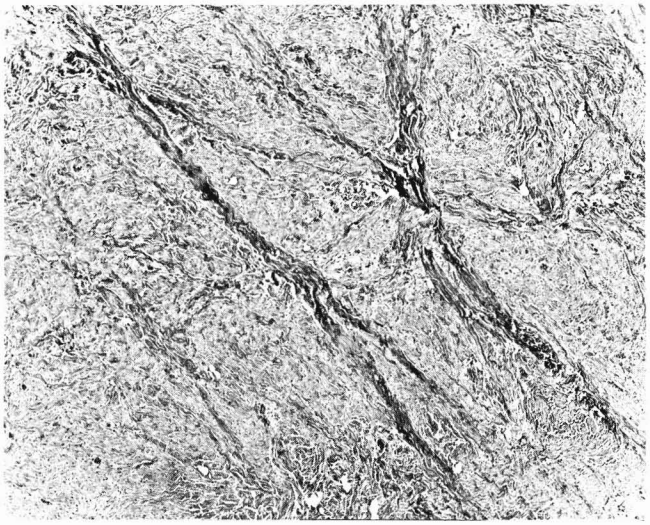

Figure 8. — For comparison with Figure 7. Photomicrograph of the normal dermis. Note the uniform size and appearance of the bundles of collagenous fibers. Mason trichrome; × 45. Armed Forces Institute of Pathology photograph.

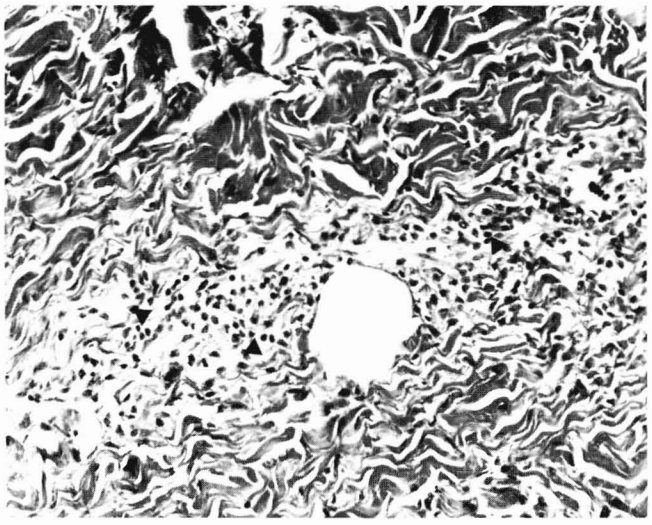

Figure 9.—Photomicrograph of the dermis beneath the white epidermis showing small foci (closed triangles) of lymphocytes and plasma cells. Hematoxylin and eosin; × 288. Armed Forces Institute of Pathology photograph.

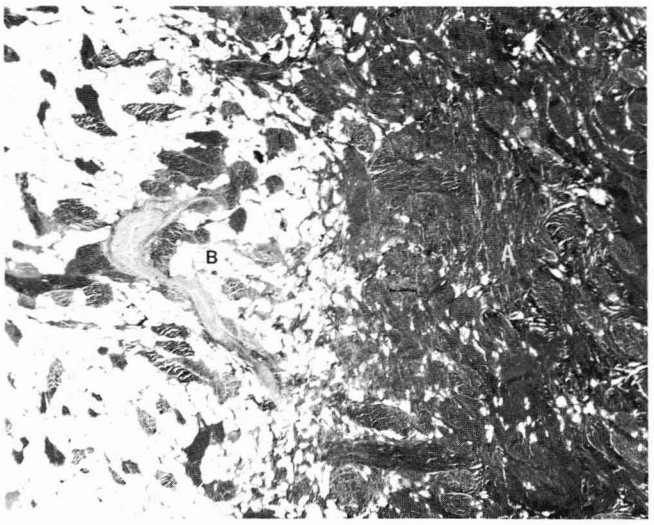

Figure 10.—Photomicrograph of the whitish tract (A) in the blubber (B). The whitish tract is composed almost entirely of mature collagenous fibers arranged in bundles. The blubber is largely composed of mature fat cells supported by thin bundles of collagenous fibers. Hematoxylin and eosin; × 11. Armed Forces Institute of Pathology photograph.

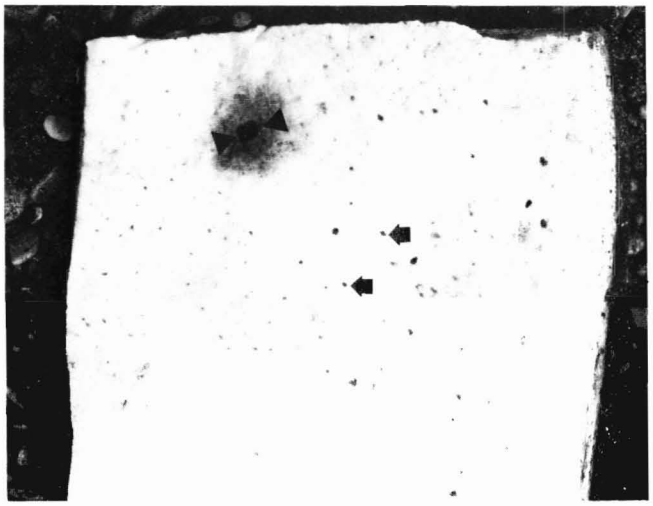

Figure 11.—Large piece of blubber lying on beach. Note fresh wound (closed triangle) caused by passage of one of the bombs used to kill the whale. Also apparent are numerous readily visible blood vessels (arrows).

the blubber caused by the passage of one of the bombs used to kill the animal is approximately the same diameter as that of the scar described above.

Acknowledgments

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