Pacific Science (1975), Vol. 29, No. 2, p. 153–157
Printed in Great Britain

# Skin Structure of the Hawaiian Monk Seal (*Monachus schauinslandi*)[1]

G. C. Whittow,[2] J. Szekerczes,[2] E. Kridler,[3] and D. L. Olsen[3]

ABSTRACT: Skin samples from the dorsal region of the torsos of Hawaiian Monk Seals were examined histologically to determine if there were any features of the structure of the skin that might explain the reputed heat tolerance of these seals. The skin structure was compatible with an animal exposed to strong solar radiation, in which nonevaporative heat loss was promoted, but little could be discerned to suggest the existence of functional evaporative cooling mechanisms.

Data collected from Hawaiian Monk Seals, hauled out on the sand, in their natural habitat in the Hawaiian Islands National Wildlife Refuge, indicated that they were not hyperthermic during the day (Kridler, Olsen, and Whittow 1971). Substantially similar results were obtained in a more extensive study of a single specimen of Monk Seal at the Waikiki Aquarium in Honolulu (Ohata et al. 1972). These findings are consistent with reports that Hawaiian Monk Seals are able to tolerate very hot conditions for prolonged periods of time (Kenyon and Rice 1959), but they are difficult to explain in the light of the demonstrable heat intolerance of other species of pinnipeds (Whittow, Ohata, and Matsuura 1971; Whittow, Matsuura, and Lin 1972). One possible explanation for the apparent heat tolerance of Hawaiian Monk Seals is that they are able to lose heat by evaporation of moisture from the skin. A significant amount of heat can be dissipated in this way only by the active participation of the sweat glands. The present study was undertaken to determine whether any evidence for the functional activity of the sweat glands, or any explanation for the reputed heat tolerance of Monk Seals, could be obtained by a histological examination of their skins.

## METHODS

Specimens of skin were obtained in April 1970 from two live seals on Southeast Island, Pearl and Hermes Reef, in the Hawaiian Islands National Wildlife Refuge. The skin samples were obtained from the dorsal surface of the torso of the animals, approximately 45 cm rostral to the base of the tail. The seals were hauled out on the sand, asleep, before the samples were taken. The skin was fixed in 10-percent formalin solution and washed in running tap water for 2 hours. The samples were then dehydrated in three changes of acetone for 8–16 hr, and subsequently cleared in three changes of benzene for 8–16 hr. Following this treatment, the specimens were infiltrated with, and embedded in, paraplast (melting point, 56°–58° C). Sections, 10 $\mu$ thick, were cut and stained with hematoxylin (Delafield) and eosin. The sections were examined with a light microscope and photographed with a Zeiss camera attachment.

## RESULTS

The epidermis of the skin was pigmented in its basal layers; it did not appear to be extensively invaginated by the papillary layer of the dermis. The dermis was highly vascularized. Only separate hair follicles were seen (Figure 1); there appeared to be no secondary follicles, confirming previous work by Scheffer (1964). A sweat gland and a simple, rather elongated, sebaceous gland were associated with each hair follicle. The duct of the sweat gland was a straight, slender, tubular structure, leading into

[1] This work was supported by National Science Foundation grant no. GB-29287X. Manuscript received 25 June 1974.

[2] University of Hawaii, School of Medicine, Department of Physiology, Honolulu, Hawaii, 96822.

[3] United States Department of the Interior, Fish and Wildlife Service, Bureau of Sports Fisheries and Wildlife, Kailua, Hawaii 96734.


FIGURE 1. General view of the skin showing separate hair follicles (h), ($h_1$), and ($h_2$). Photomicrograph. Tissues were stained with hematoxylin and eosin.

the rather long body of the gland. The body of the gland was convoluted (Figure 2), the lumen was small, and the wall of the gland was made up of a single layer of cuboidal cells surrounded by a single layer of myoepithelial cells. The body of the sweat gland was at approximately the level of the hair papilla. The entry of the sebaceous gland into the hair follicle was more superficial than that of the sweat gland (Figure 3). No arrectores pilorum muscles were evident.

## DISCUSSION

Several features of the histology of the skin of the Monk Seal are consistent with an animal exposed to a hot environment. The pigmentation of the epidermis is to be expected in an animal exposed to intense solar radiation. Presumably it serves to reduce the penetration of short-wave radiation into the skin (Mount 1968). The short, bristly, hair coat, without secondary hairs, would permit maximal heat loss to the air from the skin surface, and possibly would reflect environmental thermal radiation at the same time. Unfortunately, nothing is known about the reflectance of the Monk Seal's hair coat. In the Harp Seal, an Arctic species, the hair coat is believed to promote the absorption of thermal radiation by the skin (Oritsland 1971). However, the hair structure of the Harp Seal differs from that of the Monk Seal (Whittow, Szekerczes, and Ronald, unpublished data), and there may well be functional differences in the coats of the two species, related to their very different thermal environments.

The marked vascularity of the skin of the Hawaiian Monk Seal would be expected to facilitate the transfer of heat from the deep tissues to the periphery. Although information on the function of glands cannot be unequivocally deduced from their structure, it seems permissible to suggest that the sweat glands of the Hawaiian Monk Seal are not active. The only sweat glands known to be functional in

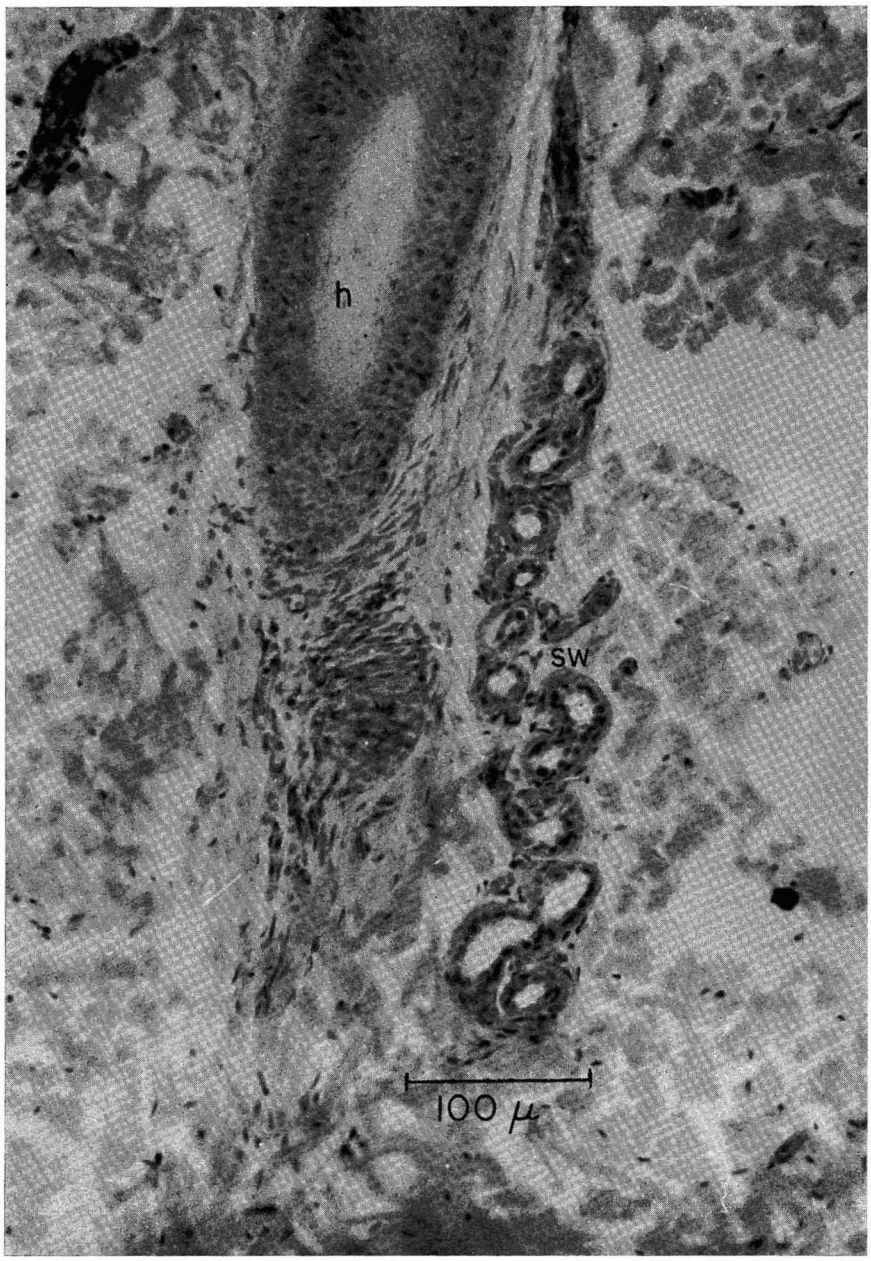


FIGURE 2. The body of the sweat gland (sw) in relation to a hair follicle (h). Photomicrograph. Tissues were stained with hematoxylin and eosin.

pinnipeds are in the flippers of the Northern Fur Seal and the California Sea Lion (Bartholomew and Wilke 1956, Matsuura and Whittow 1974). These glands are considerably larger than those of the Hawaiian Monk Seal. It is possible, however, that the sweat glands of the Hawaiian Monk Seal vary in size and functional activity at different times of the year. The entry of the sweat gland duct into the pilary canal below the opening of the sebaceous gland con-

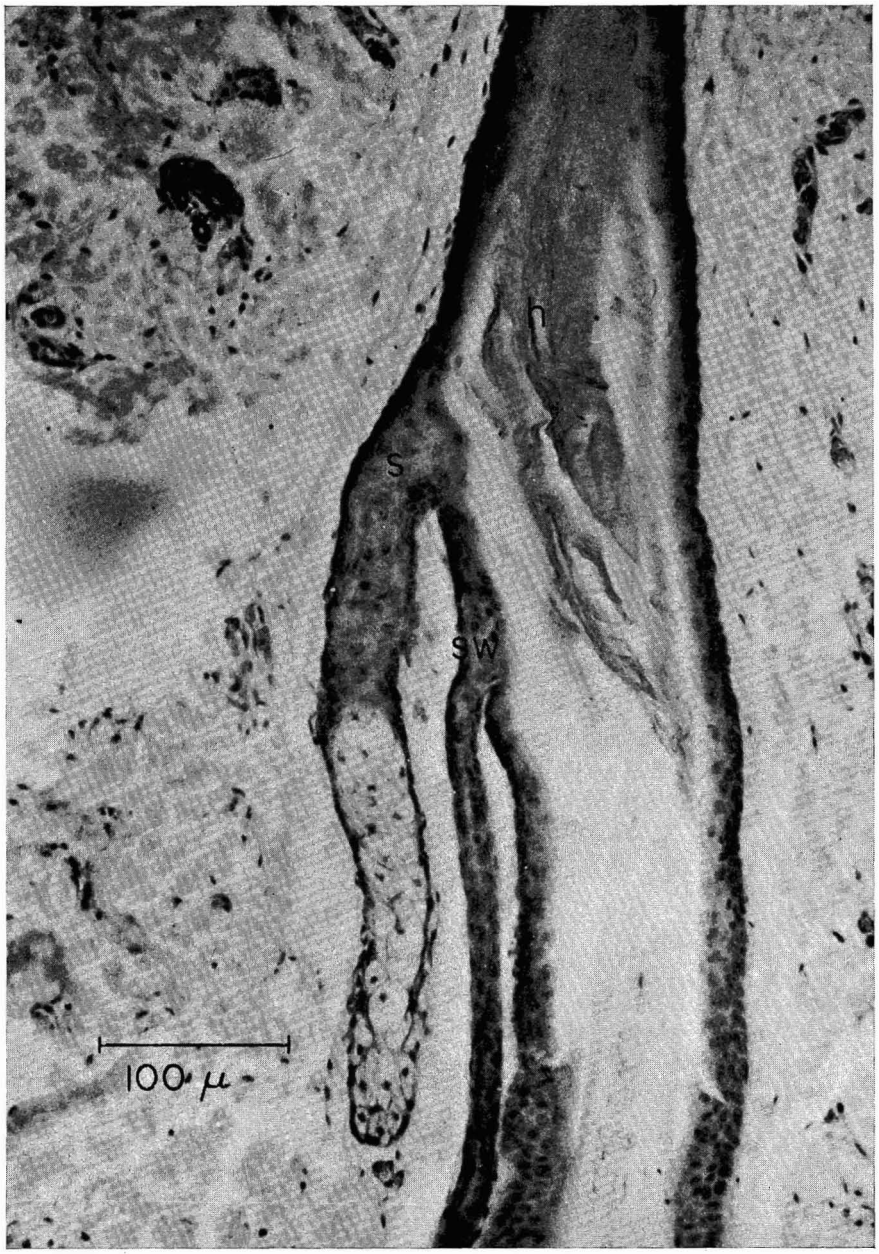


FIGURE 3. Entry of the ducts of the sebaceous gland (s) and the sweat gland (sw) into the hair follicle (h). Photomicrograph. Tissues were stained with hematoxylin and eosin.

forms with the situation in other Phocidae (Montagna and Harrison 1957, Ling 1965, Harrison and Kooyman 1968). According to Montagna and Harrison (1957), the secretions of the sweat glands and sebaceous glands are relatively immiscible in the Harbor Seal. If this is true for the Monk Seal, then any secretion from the sweat glands is likely to emerge onto the surface of the skin beneath a layer of oily sebum, an arrangement not con-

ducive to evaporation. However, the sebaceous gland was a relatively small, simple structure, suggesting the possibility that it also is not very active.

## LITERATURE CITED


BARTHOLOMEW, G. A., and F. WILKE. 1956. Body temperature in the Northern Fur Seal (*Callorhinus ursinus*). J. Mammal. 37: 327–337.

HARRISON, R. J., and G. L. KOOYMAN. 1968. General physiology of the Pinnipedia. Pages 211–296 *in* R. J. Harrison, R. C. Hubbard, R. S. Peterson, C. E. Rice, and R. J. Schusterman, eds. The behavior and physiology of pinnipeds. Appleton-Century-Crofts, New York.

KENYON, K. W., and D. W. RICE. 1959. Life history of the Hawaiian Monk Seal. Pacif. Sci. 13: 215–252.

KRIDLER, E., D. L. OLSEN, and G. C. WHITTOW. 1971. Body temperature of the Hawaiian Monk Seal (*Monachus schauinslandi*). J. Mammal. 52: 476.

LING, J. K. 1965. Functional significance of sweat glands and sebaceous glands in seals. Nature 208: 560–562.

MATSUURA, D. T., and G. C. WHITTOW. 1974. Evaporative heat loss in the California Sea Lion and Harbor Seal. Comp. Biochem. Physiol. 48A: 9–20.

MONTAGNA, W., and R. J. HARRISON. 1957. Specializations in the skin of the seal (*Phoca vitulina*). Amer. J. Anat. 100: 81–113.

MOUNT, L. E. 1968. The climatic physiology of the pig. Edward Arnold, London.

OHATA, C. A., D. T. MATSUURA, G. C. WHITTOW, and S. W. TINKER. 1972. Diurnal rhythm of body temperature in the Hawaiian Monk Seal (*Monachus schauinslandi*). Pacif. Sci. 26: 117–120.

ORITSLAND, N. A. 1971. Wavelength-dependent solar heating of Harp Seals (*Pagophilus groenlandicus*). Comp. Biochem. Physiol: 40A: 359–361.

SCHEFFER, V. B. 1964. Hair patterns in seals (Pinnipedia). J. Morph. 115: 291–304.

WHITTOW, G. C., D. T. MATSUURA, and Y. C. LIN. 1972. Temperature regulation in the California Sea Lion (*Zalophus californianus*). Physiol. Zoöl. 45: 68–77.

WHITTOW, G. C., C. A. OHATA, and D. T. MATSUURA. 1971. Behavioral control of body temperature in the unrestrained California Sea Lion. Commun. behav. Biol. 6: 87–91.