Aquatic Mammals 1990, **16.1**, 33–35

The tuberous organs of the harbour porpoise *Phocoena phocoena* (Linné, 1758)

Günther Behrmann

Alfred Wegener Institute for Polar and Marine Research, D-2850 Bremerhaven, Federal Republic of Germany

Introduction

Tuberous organs in the integument of the harbour porpoise were briefly described for the first time in connection with other nerve end corpuscles in the tongue (Behrmann, 1988). A new analysis of this organ, using improved light microscopy and new sections, has led to further insights into their morphology.

Materials and Methods

Samples of the integument covering the heads and tongues of two harbour porpoises were taken immediately after death, processed and systematically cut into 8 µm histological sections. A special staining technique (eosin and hematoxilin combined with lithium carbonate), provided an optimal view of the nerves and their end corpuscles. The sections were examined and photographs were taken by light microscopy, using different colour filters and a phase contrast objective (Neofluar 100 × 1.30).

Results

Numerous tuberous organs are found in the epidermal layer below the stratum corneum in the tip of the tongue. Some organs were located below the parakerotic layer of the lower jaw tip. This region is comparable with the lower lip in other animals. These organs were not detected in other integumental regions of the head.

Each tuberous organ consists of a roundish nerve terminal corpuscle located in the centre. This is surrounded by 5 to 8 roundish swellings. Each swelling has a pore at the tip and therefore looks like a secretory cell. The terminal corpuscle, and the swellings are covered by a membrane. The organs can have a diameter up to 20 µm (Fig. 1). Food cells are located outside the membrane. A blood corpuscle is frequently detected near this organ.

An axon leads into the organ, and from the underside this ramifies into neurits, which penetrate the nerve terminal corpuscle and the secretory cells. Some nerve bundles extend from this organ to other nervous organs. One undifferentiated nerve bundle leads, in a neuron channel, through the upper dermal layers—and in the tongue also through the mucosa—to the outside. The channel and the nerve measured 50 µm. The nerve ending raises the surface for nearly 5 µm and is covered with a gelatinous cupola (Fig. 2).

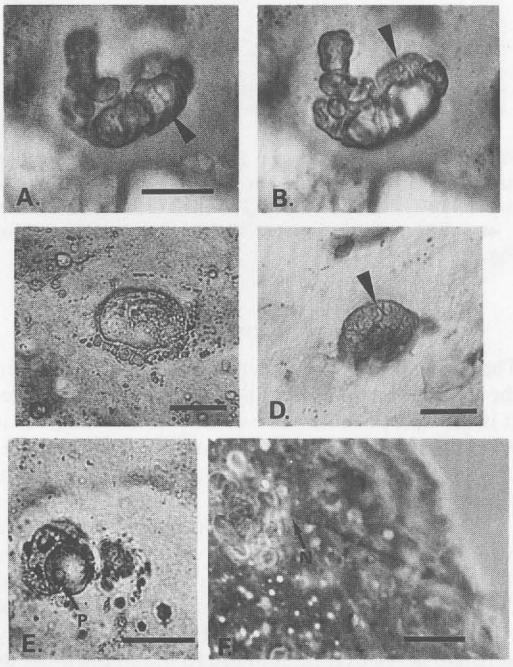

Figure 1. *Phocoena phocoena:* Details of the tuberous organ. Scale: 10 µm. A. Lateral view of the organ in the lower lip. Secretory cell in focus (◄). B. The same organ. Terminal corpuscle in focus (◄). C. Upperside of the tuberous organ in the tip of the tongue. D. Underside of the tuberous organ. Neurites of the secretory cell in focus (◄). E. A separate secretory cell with the pore. F. The nerve leaving the tuberous organ (◄). Key: A, Axon; C, Cupola; CA, Channel; F, Foodcell; M, Membrane; MU, Mucosa; N, Nerve; P, Pore; S, Secretory cell; SC, Stratum corneum; T, Terminal.

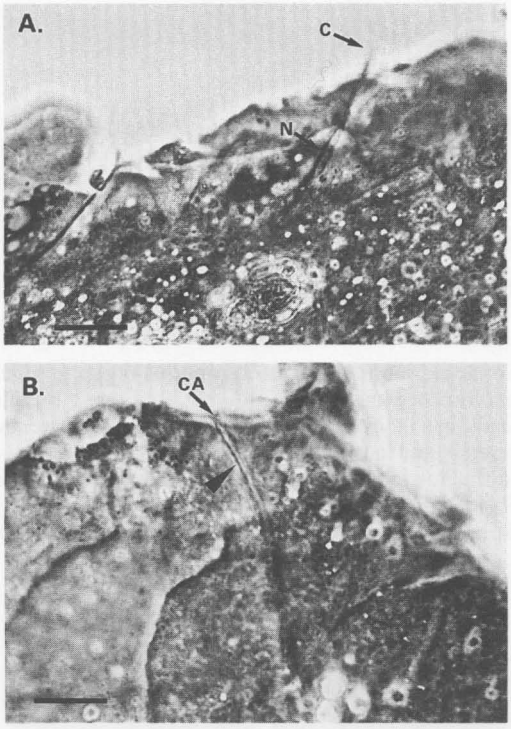

Figure 2. *Phocoena phocoena:* Horizontal sections through tuberous organs. Scale: 10 µm. A. The nerve ending in the cupola. B. The capillary. Focal point at the neuron channel (◄). The nerve is situated slightly deeper. (Key as for Fig. 1.)

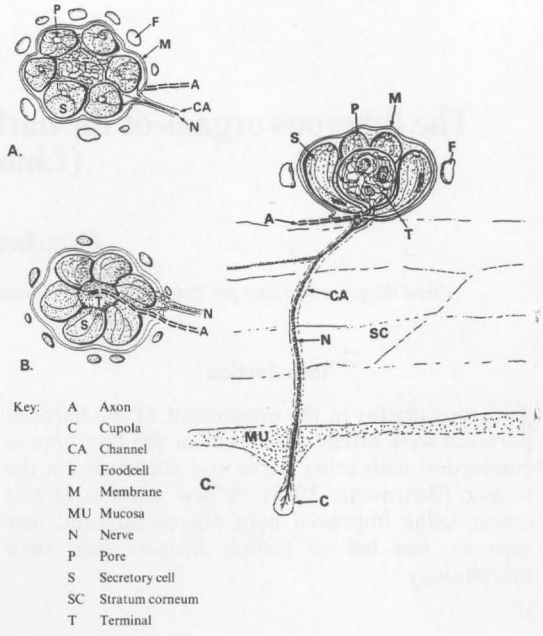

Figure 3. Model of the tuberous organ of the harbour porpoise *Phocoena phocoena*. A. Upperside, B. Underside, C. Horizontal Section.

Discussion

The existence of tuberous organs is now confirmed in the tongue and the lower lip of the harbour porpoise. It is the first proof of such organs in mammals. It is possible that they may also be located in other sensitive regions of the integument, and further studies are required.

The tuberous organs of the harbour porpoise are composed of two different nerve end-organs and a free nerve ending. The terminal nerve corpuscle of the tuberous organ looks like the corpuscle of Krause or like a genital nerve end-corpuscle. These are highly sensitive nerve organs, and are found in the mucous layers of the nose and mouth cavities, in the genitals and in other sensitive regions of mammals (Boeke, 1934, Kämpfe *et al.*, 1980).

Cells like the secretory cells of the harbour porpoise exist in fishes and amphibians. The combination of the tuberous organs of the harbour porpoise with the fine tube leading to the surface, leads us to the acceptance that the secretory cells may produce a secretion which would cover the free nerve ending at the outer surface. The position of the nerve bundles in the secretory cells in relation to the free nerve, indicates that they have also an effective function. Free unmyelinated nerves covered by a sheath of Schwann cells terminating in the cornea or in the mucosa, are common in mammals (Stark, 1982).

Combinations of nervous secretory cells with nerve terminals or other nerve end-corpuscles are also described (Kuhlenbeck, 1973; Andrew & Hickman, 1974). Combinations of sense organs, as seen in the harbour porpoise, do not appear to have been described in the literature.

Only the lateral line organ with its free nerve endings, and the tuberous organs of electroreception of fishes (Bennett, 1967) are nearly comparable to the tuberous organ of the harbour porpoise.

Tuberous organs with roundish swellings are found near the electric organs of mormyrid fish (Szabo, 1974). The tuberous organs of mormyrids are located in invaginations of the epidermal basement membrane. Photographs taken with the light microscope, and the complementary drawings by Szabo (1974) demonstrate that the forms of the organs in mormyrids and in harbour porpoise are comparable.

However the tuberous organs of the mormyrid have no connection to the outer medium (Szabo, 1974). The sensory cells of the tuberous organs of the harbour porpoises have, through the neuron channel

and the free nerve endings, a connection to the outside.

The free nerve endings of the lateral line organs of fish penetrate the epidermal layers and finish in a gelatinous cupola (Penzlin, 1980). The free nerve end of the harbour porpoise finishes also in a cupola. The lateral line or side organs are highly sensitive receptors.

Together with the nerve terminal, nervous secretory cells and free nerve end, harbour porpoises possess a highly sensitive nerve organ, the function of which is still unclear and requires further investigations.

It seems to be possible that the tuberous organs of the harbour porpoises have a function in perceiving electric or magnetic waves, which was already suggested by Klinowska (1985a,b; 1986).

References

Andrew W. & Hickman C. P. (1974). Histology of the vertebrates. Verlag: C. V. Mosby Company, Saint Louis. 439 pp.

Behrmann G. (1988). The peripheral nerve ends in the tongue of the harbour porpoise *Phocoena phocoena* (Linné, 1758). *Aquatic Mammals* **14.3,** 107–112.

Bennett M. (1967). Mechanisms of electroreception. In: *Lateral line detectors* (ed. P. Cahn). Indiana University Press, p. 313–393.

Boeke J. (1934). Niedere Sinnesorgane. Handbuch der vergleichenden Anatomie der Wirbeltiere, B.2/2. Verlag: Urban und Schwarzenberg, Berlin, Wien. p. 855–878.

Kämpfe L., Kittel R. & Klapperstück J. (1980) Leitfaden der Anatomie der Wirbeltiere. VEB Gustav Fischer Verlag: Jena. pp. 326.

Klinowska M. (1985a). Cetacean live strandings relate to geomagnetic topography. *Aquatic Mammals* **11,** 27–32.

Klinowska M. (1985b) Cetacean live stranding dates relate to geomagnetic disturbances. *Aquatic Mammals* **11,** 109–119.

Klinowska M. (1986). The cetacean magnetic sense—evidence from strandings. In: *Research on dolphins* (eds M. M. Bryden & R. Harrison) pp. 401–432. Clarendon Press, Oxford.

Kuhlenbeck H. (1973). The central nervous system of vertebrates. Vol. 3, Part II. Verlag: S. Karger, Basel, München. 950 pp.

Penzlin H. (1980). Lehrbuch der Tierphysiologie. Verlag: G. Fischer, Stuttgart. 569 pp.

Stark D. (1982). Vergleichende Anatomie der Wirbeltiere, Band 3. Springer-Verlag: Berlin, Heidelberg, New York. 1120 pp.

Szabo T. (1974). Anatomy of the specialized lateral line organs of electroreception. Handbook of sensory physiology (ed. Fassard). Springer-Verlag: Berlin, Heidelberg, New York. B. III/3: 14–58.