

## The pineal organ (Epiphysis cerebri) of the harbour porpoise *Phocoena phocoena* (Linné, 1758)

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### Summary

The pineal organ (Epiphysis cerebri) of the harbour porpoise *Phocoena phocoena* (Linné, 1758).

As former reports about the pineal organ (which is important for the development of the genital organs) are vague, this is the first precise description of a functional cetacean pineal organ. The organ was found in a brain of a young male harbour porpoise. Morphological and histological examinations demonstrate that the pineal organ of this animal has been functional. The pineal organ of the harbour porpoise is comparable with those of horses, cattle and sheep.

### Introduction

The pineal organ, also named the parietal organ or epiphyse, is an appendage to the diencephalic roof (Lamina tecti), and is located in the centre of the brain, between the two hemispheres (Fig. 1). The pineal organ is situated on the tip of the posterior commissure, which emerges from the colliculus superior, a part of the diencephalon. The pineal organ floats in the cerebrospinal fluid of the third ventricle (Ventriculus tertius).

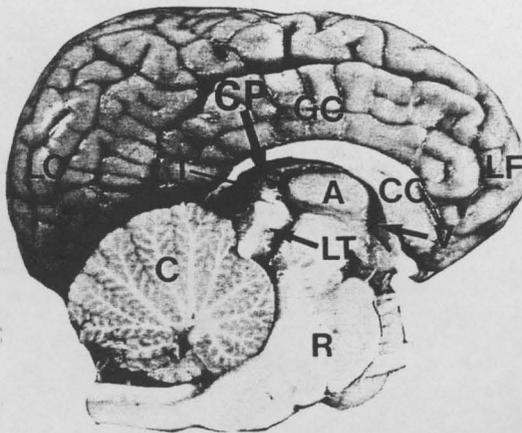


Figure 1. Sagittal section of the brain, view on the left side and the pineal organ.

The forms of the pineal organs of mammals are quite different. Some species of mammals lack a pineal organ. Sometimes in the past whales were added to the list of mammals which lack a pineal organ (von Hallerstein, 1934; Flanigan, 1972). But Gersch (1938) has described pineal organs of humpback whales.

However, these organs have an important function in animals, as they coordinate hormonal secretion in the hypothalamus (Leonhardt, 1985), and have an influence on genital maturity (Penzlin, 1980).

In 1979 Klinowska & Vollrath had a discussion about the existence of the pineal organs in cetaceans. Vollrath (1979) recommended that the cetaceans



Figure 2. The pineal organ of the harbour porpoise.

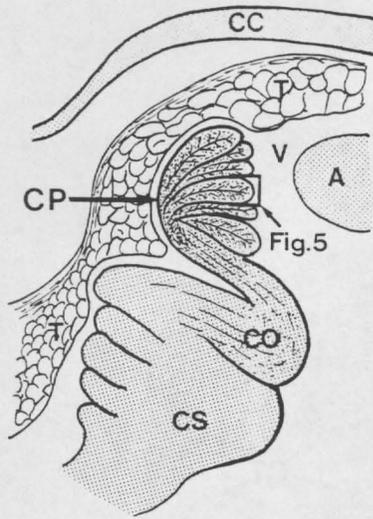


Figure 3. Model of a longitudinal section through the pineal organ.

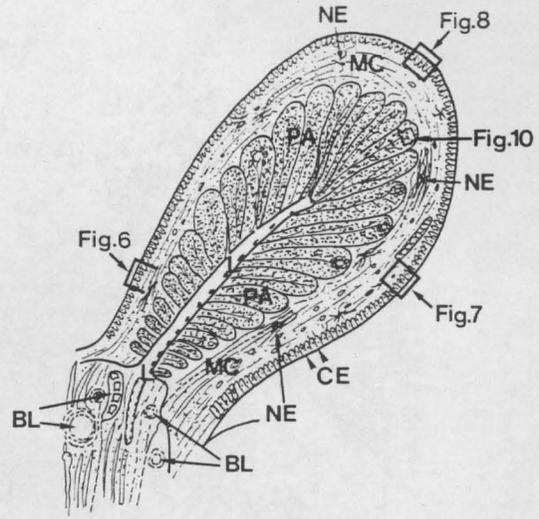


Figure 5. Model of a pineal segment.

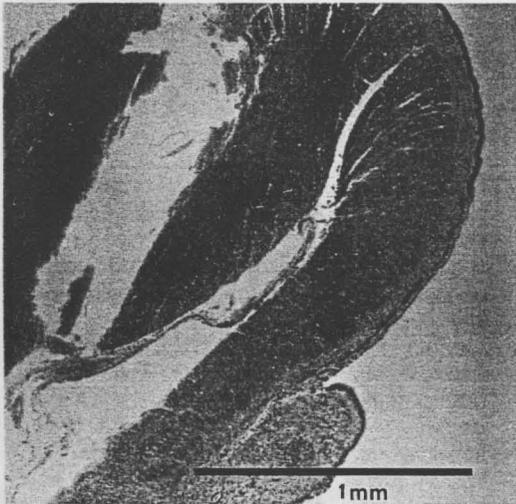


Figure 4. Longitudinal section through a pineal segment, staining 1.

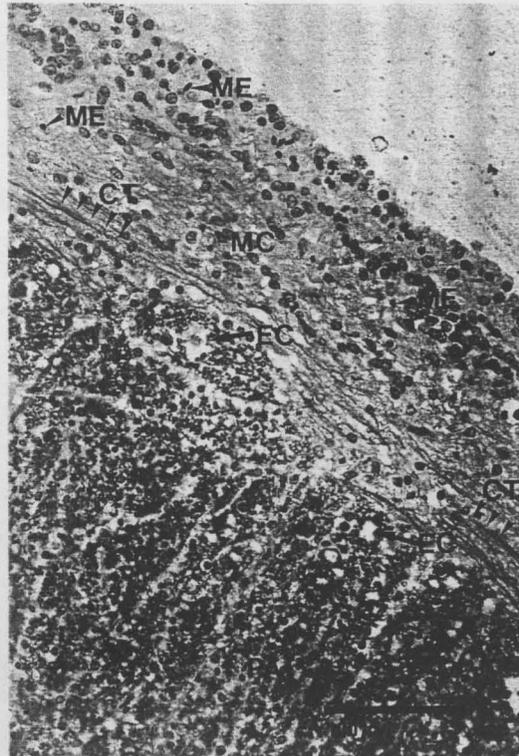


Figure 6. The peripheral region of the pineal segment, staining 3.

need to be better checked, so to make it absolutely clear whether these animals lack the pineal organ.

Following this recommendation I examined the brain of the harbour porpoise and definitely found the pineal organ.

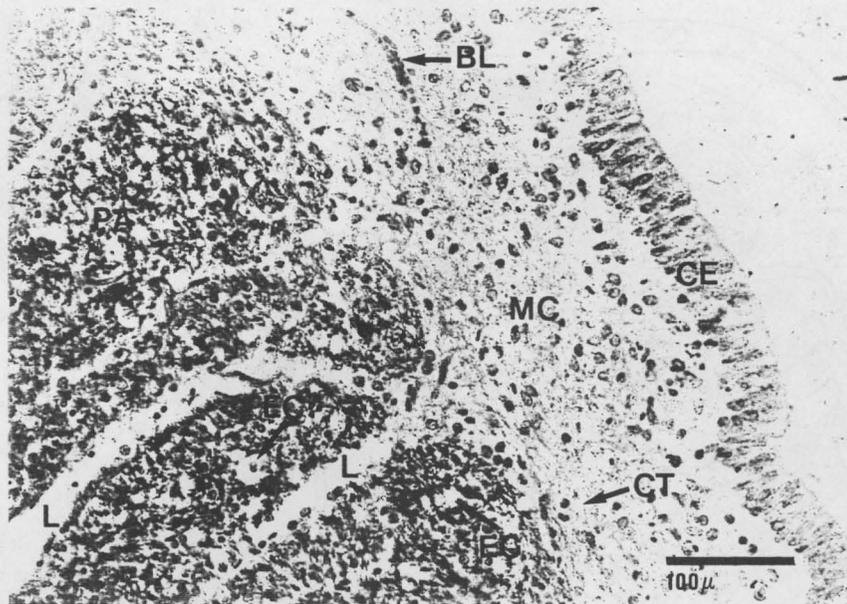


Figure 7. The peripheral region of the pineal segment with cylindrical cells, staining 4.

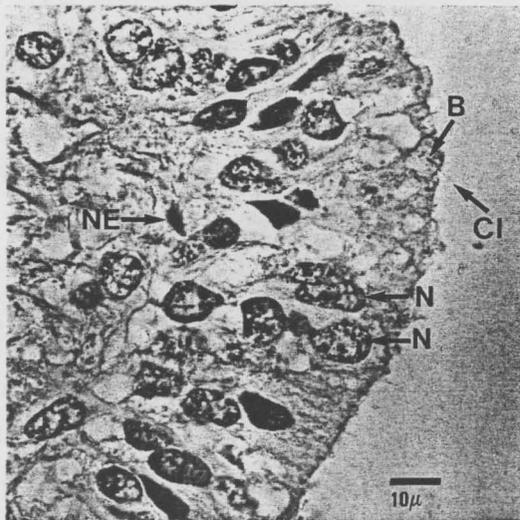


Figure 8. Cylindrical cells with cilia, staining 6.

#### Material and Methods

The pineal organ was taken from a young male. The animal was found in the bycatch while fishing in the Baltic Sea. The animal had a total length of 108.5 cm. The brain was removed 6 hours after death, and was immediately fixed in formalin (10%). After fixation the brain had a wet-weight of 535 g. After separation of the two brain hemispheres, the pineal organ

remained on the left side. Therefore the photographic documentation could be done in its natural environment (Figs 1 and 2). The whole pineal organ was removed together with small parts of the tela and the commissura, and prepared for histological examination.

The following staining methods were applied:

1. staining with haematoxylin, eosin and lithium carbonate, to show the morphology;
2. staining with haemalaun, method no. 648 (Romeis, 1968), for impregnation of cell tissue and reticular fibres;
3. staining with ferrous sulphate and calcium ferrocyanide, method no. 1163 (Romeis, 1968), to show pigment corpuscles;
4. staining with ferro-III-chloride and calcium ferrocyanide, method no. 1158 (Romeis, 1968), to show melanin;
5. staining with bleaching, method no. 1180 (Romeis, 1968), to point out tryptophan;
6. staining with toluidin blue (Gerrits, 1985) to ascertain nuclei, cytoplasm and glial cells.

The photographs were taken in using light-microscope, different colour filters and phase contrast objectives.

#### Results

The pineal organ (Figs 1 and 2) of the harbour porpoise is located in the central part of the brain,

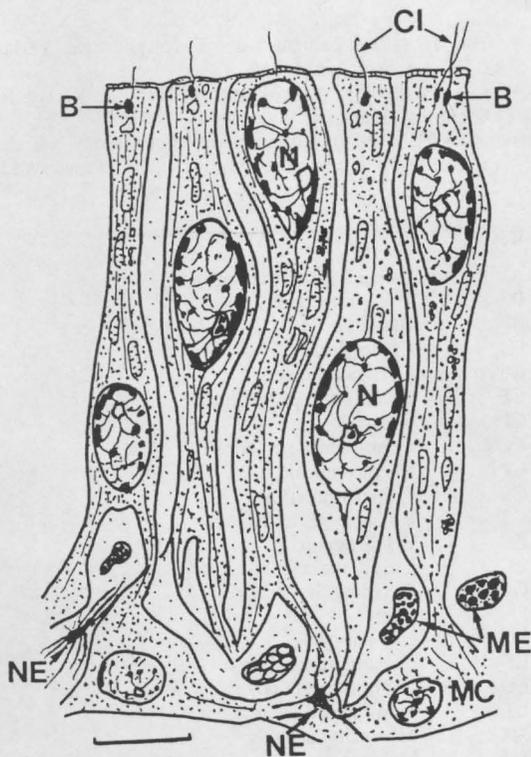


Figure 9. Model of the cylindrical cells.

below the splenium of corpus callosum (CC). It is combined through the commissura posterior (CO), with the collicus superior (CS), a part of the diencephalon. The pineal organ of this animal has a rosette-like shape and is shaggily divided. The small zottels have a common floor, which emerges from the commissura (Figs 2 and 3).

Caudodorsally the pineal organ is covered by, but not in union with the tela chorioidea (T). Rostrally the pineal zottels float in the cerebrospinal fluid of the third ventricle (V).

In each zottel three forms of cell layers can clearly be distinguished (Figs 4 and 5). Medially exists a branching lumen (L) surrounded by parenchymal cells (PA), which forms, together with ependymal cysts (EC), the pineal organ. It is covered by a layer of mesenchymal cells (MC), which is sporadically penetrated by collagenous tissue (CT), and mesenchymal cysts. The mesenchyma is covered by a layer of cylindrical cell epithelium (CE).

The large cell cylindrical cells contain very large oval nuclei and can have a length up to 60  $\mu\text{m}$  (Figs 8 and 9). Out of each cell extend, one or two cilia (CI) into the fluid of the third ventricle (V). The cilia, together with their kinotosome (B) have a length up to 10  $\mu\text{m}$ .

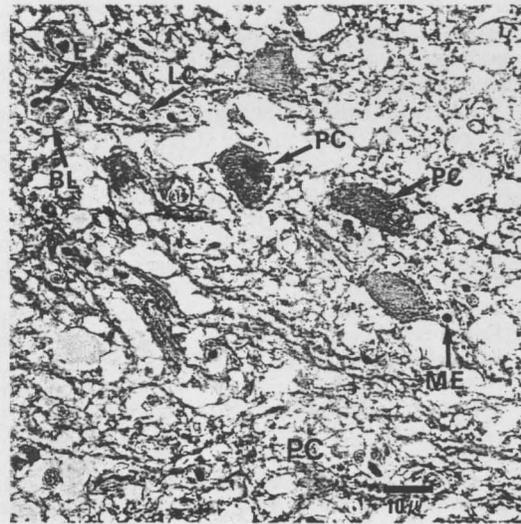


Figure 10. Section of the parenchyma with granulated pineal cells, staining 4.

The whole pineal organ is amply penetrated by nerves and glia cells (Fig. 8, NE). Astrocytes and the other nerve cells are strikingly large.

Chemicohistological examinations prove the existence of melanosomes (Figs 6 and 10, ME), lymphocytes (Fig. 10, LC), and large granulated pineal cells (Fig. 10, PC), which contain tryptophan, proven by staining method 5. The fluid in the lumen and the cysts of the parenchyma have differential consistencies, proven by the colour in staining method 2, as the fluid in the ependymal cysts and the blood vessels. This may be melatonin, produced by the pineal gland.

#### Discussion

Pineal glands produce the hormone melatonin, which controls the development of the genital organs and has neural connections with the brain, and therefore rhythmically influences sleep patterns, as well as other organs (Penzlin, 1980). The pineal organ of the harbour porpoise which had been examined, has its own shape, which differs in form and place from those of other mammals. Comparable is the situation only with the pineal organ of the humpback whales (Gersch, 1938). But the pineal organs of the humpback whales have another form.

Pineal organs have been detected in *Delphinus longirostris*, *Lagenorhynchus obliquens*, *Balaenoptera borealis* and *Hyperoodon rostralis* (Aroy, 1970).

It may be that after maturity the pineal organs of cetaceans are sacrificed, but it is also possible that in previous examinations they were simply overlooked. For the description of the morphology of the harbour

porpoise pineal organ, I finally used the publications about pineal organs in horses (Fassbender, 1962), cattle and sheep (Lang, 1959).

I believe that all cetaceans have pineal organs and the research has to be continued.

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### Key

A	Adhaesio interthalamica
B	Basal corpuscle
Bl	Blood vessel
C	Cerebellum
CC	Corpus callosum
CE	Cylindrical epithelium
CI	Cilia
CO	Commissura posterior
CP	Corpus pineale
CS	Collicus superior
CT	Collagenous tissue
E	Erythrocyte
EC	Ependymal cyst
GC	Gyri cingulii
L	Lumen
LC	Lymphocyte
LF	Lobus frontalis
LO	Lobus occipitalis
LT	Lamina tecti
MC	Mesenchymal cells
ME	Melanosome
N	Nucleus
NE	Nerve cell
PA	Parenchymal cell, pineal gland
PC	Granulated pineal cell
R	Thombencephalon
T	Tela chorioidea
V	Ventriculus tertius