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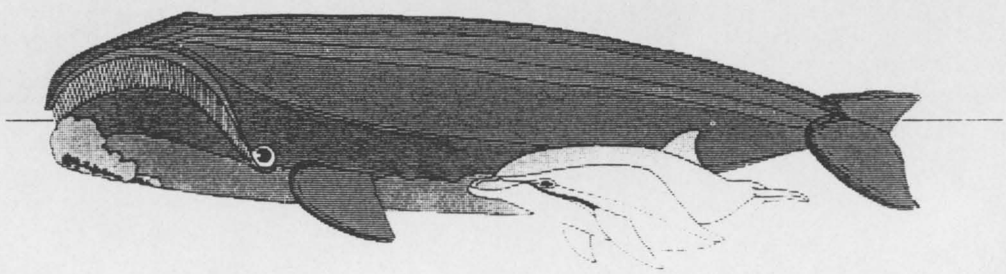

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CYTOARCHITECTURAL STUDIES OF THE CORTEX OF THE HARBOUR PORPOISE, *Phocoena phocoena* (LINNE, 1758)

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Whales are highly developed animals with a high intelligence. But nobody knows what intelligence is. At present it is not possible to draw a conclusion about intelligence from the archi- and cytoarchitecture of the brain. In spite of this fact, an attempt is made to compare human and harbour porpoise cortices.

The folding of the brain, and with it, the enlargement of the cortical surface, increased during evolution. A primitive brain contains only a few folds; highly developed mammal brains, however, have many folds. Cetacean brains have more folds than human brains. If we postulate that the folding of the brain is an indication of its phylogenetic development, we have to accept that the cetacean brain is the most advanced brain of all mammals. But it is also assumed that the configuration of a brain has no influence on its efficiency.

The efficiency of the brain depends firstly on the thickness of the cortex and the cortical lamination (Fig. 1). When comparing a human and a harbour porpoise brain, the cortex of the human brain is up to 5 mm. This is bigger than the cortex of the harbour porpoise which is up to 3.5 mm. But the porpoise's brain has more folds, and therefore the surface of the brain is two times larger than the surface of the human brain.

Generally the human cortex has six layers. The olfactory regions of the harbour porpoise (Fig. 1 A) have three or five layers only. By the packing of nine layers, the speaking centre in the brain of the harbour porpoise is much bigger than the comparable centre in the human brain with only seven layers (Fig. 1 E).

Secondly, the efficiency of the brain depends on the numerical density of the neurons and glia cells, the high density of the synapses of the neurons, and the nervous connection between the different nerve cells. The forms of the nerve cells are similar to those of human brains (Fig. 2).

The numerical density of nerve cells in the human cortex is 10,000 to 30,000 per cubic mm (Leonhardt, 1985). Studies of the packing density of neurones and glia cells in dolphin limbic cortices lead to an estimate in distinct parts of 5,600 to 105,000 per cubic mm (Garey and Leuba, 1986; Morgane *et al.*, 1986).

The ramification of the neurons, the connection between the cells, and the accumulation of synapses at the neurons, is comparable to the human nervous system (Fig. 3).

By comparison with the cyto-architecture of the human (Brodmann, 1909; Creuzfeld, 1983), and porpoise cortical fields, the olfactory system of the harbour porpoise is reduced but remains functional. The visual system of the harbour porpoise is poorly developed, and is inferior to the one of dolphins and human beings. However, the acoustic system is highly developed. With its equipment of the speaking centre, the harbour porpoise should be able to speak. The extension of motor areas demonstrates the high agility of the harbour porpoise. The cytoarchitecture of the motor fields demonstrate the high efficiency of the motor system, which is much better developed than the human motor system. By the important accumulation of free nerve endings, and the large collection of nervous end corpuscles, in the integument, the harbour porpoise has the highest sensory development of all mammals. This is not reflected in the somato-sensory areas. The equipment of the somato-sensory fields are comparable to those in dolphins and humans (Fig. 4).

However, at present it is not possible to make any statement about the efficiency of the brain by its neural equipment. All animals possess a central nervous system which is a necessity for life; this includes all whales.

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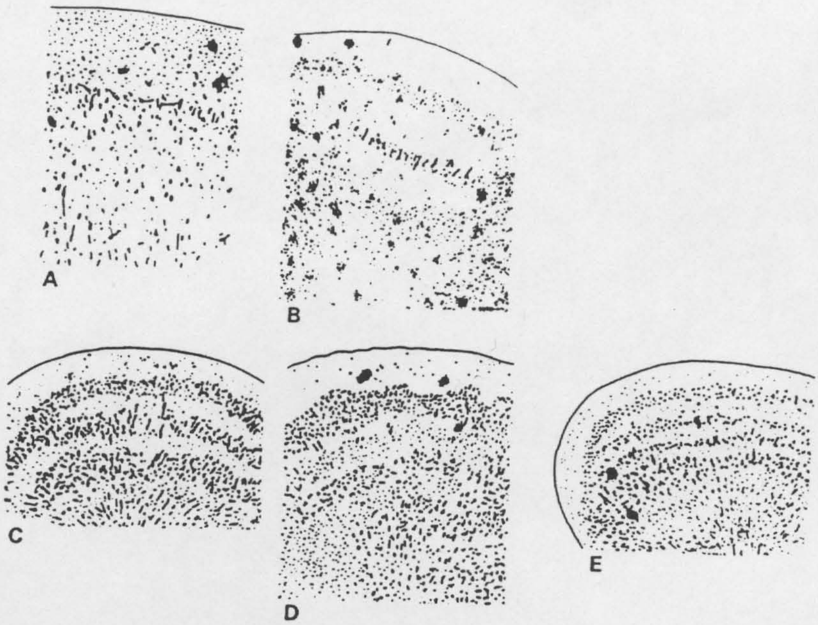

Fig. 1 Examples of the lamination of one olfactory area (A), an optic area (B), a motor area (C), the centre in the attenution area (D) and the motoric speaking area E).

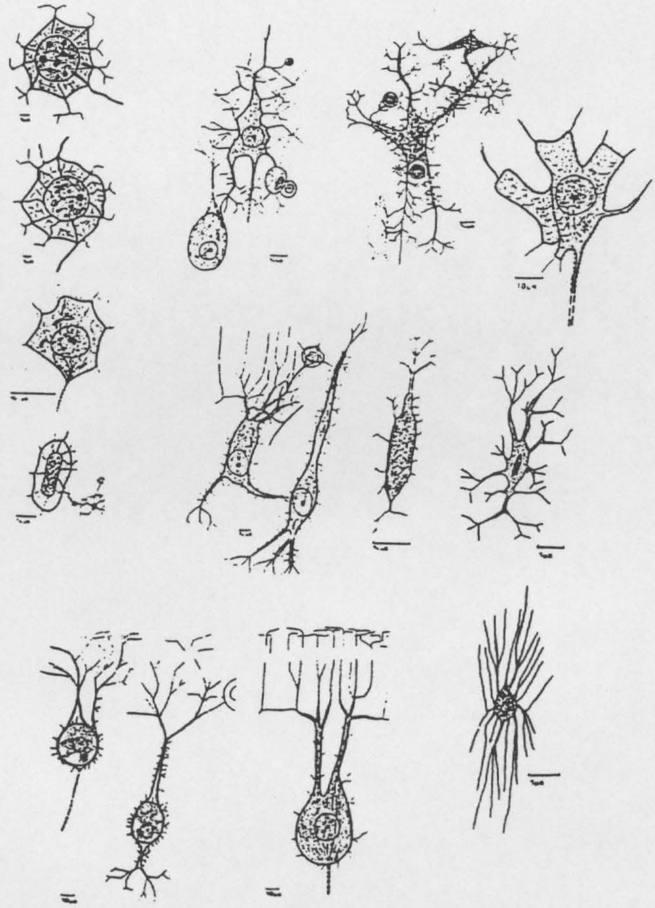

Fig 2 Various forms of neuron and ganglia cells of the harbour porpoise, *Phocoena phocoena*.

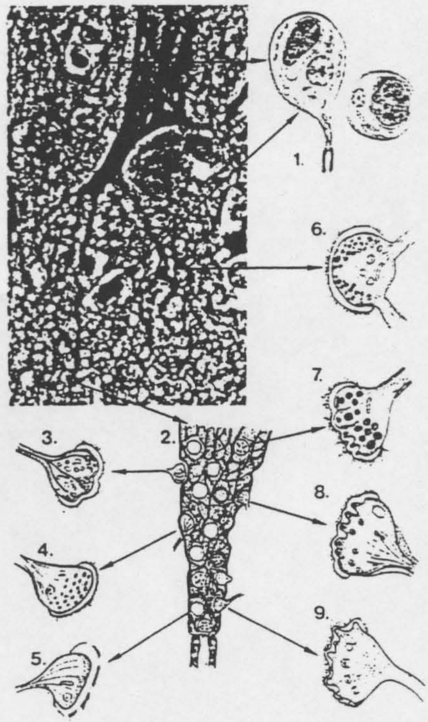

Fig 3 The foot of a large pyramidal cell, 1000 X, accompanied by blood-brain-barriers (1.), 3000 X . The axon hill of the pyramidal cell (2.) 7000 X, and its synapses (3.-9.).

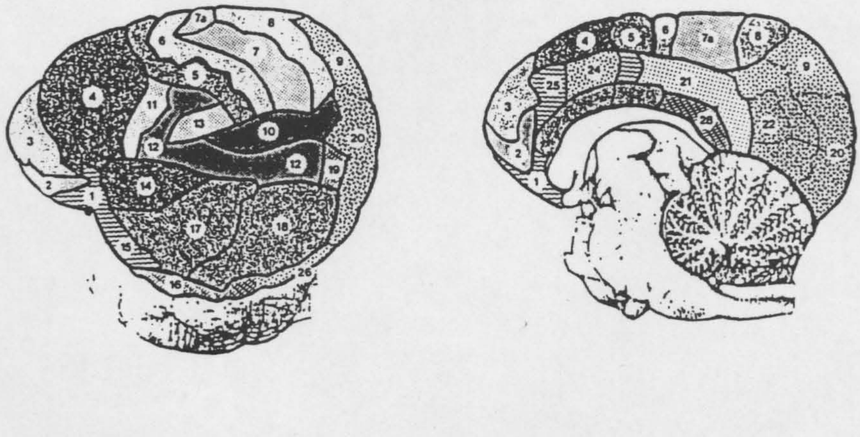

Fig. 4 The cyto-architectonic fields in the telencephalon of the harbour porpoise: the olfactory system, 1, 15, 23, 25; the optical system, 2, 9, 18, 20, 22, 26; the acoustical system, 7, 9, 10, 11, 12, 13, 16, 17, 18, 21; the somatosensory system, 2, 3, 6, 7, 8, 9, 11, 16, 28.