



THE PINEAL ORGAN

PHOTOBIOLOGY – BIOCHRONOMETRY – ENDOCRINOLOGY

A. Oksche and P. Pévet Editors

DEVELOPMENTS IN ENDOCRINOLOGY VOLUME 14

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THE PINEAL ORGAN

PHOTOBIOLOGY - BIOCHRONOMETRY - ENDOCRINOLOGY

Proceedings of the Second Colloquium of the European Pineal Study Group (EPSG) at the Department of Anatomy and Cytobiology, Justus Liebig University, Giessen, Federal Republic of Germany, July 1-4, 1981.

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PREFACE

The Second Colloquium of the European Pineal Study Group (EPSG) took place at the Justus Liebig University of Giessen (founded in 1607 as the Ludoviciana). This conference followed the first remarkable colloquium (Amsterdam, 1978) under the leadership of Professor J. Ariëns Kappers.

The pineal organ is a derivative and integral component of the brain. Phylogenetically it has changed from a "third eye" endowed with photoreceptor cells to an endocrine gland controlled by visual stimuli from the retina. The pineal organ has the capacity to translate photic (and apparently also other sensory and neural) information into a neuroendocrine response. In a further step this neuroendocrine message acts on various target organs and systems. The unique anatomical and physiological character of the pineal organ makes it a fascinating subject of analysis both in brain research and endocrinology. In evolutionary terms the pineal organ displays the capacity of a photoreceptor, biological clock, and endocrine gland. It is a member of the circumventricular organs and photoneuroendocrine systems. The pinealocyte can be considered a paraneuron originating from a special type of cerebrospinal fluid-contacting neuron, endowed with sensory and secretory properties (sensoneuroendocrine cell).

Current problems in pineal biology must be approached by interdisciplinary research, involving morphologists, physiologists, and biochemists. All of these disciplines are represented in the EPSG whose members have increasingly succeeded in overcoming the methodological and conceptual barriers among the traditional disciplines.

The present volume encompasses only the reviews presented by the 20 invited speakers. These reviews were focussed on current problems in pineal research. Particular emphasis was placed on comparative aspects. A special session of the conference was devoted to clinical problems. Unfortunately, it was impossible to include in this volume the short communications, poster presentations, and discussions. The complete series of the abstracts (Sessions I - X) has been published in EPSG Newsletter, Supplement 3 (P. Pévet and E. Trapp, Eds.), June 1981.

Giessen and Amsterdam,
August 1981

Andreas Oksche
Paul Pévet

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Finally, the editors of this volume are very much indebted to Dr. R.L. Snipes and Miss I. Lyncker for their invaluable editorial aid.

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PROLOGUE

EVOLUTION OF PINEAL CONCEPTS

J. ARIËNS KAPPERS

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This review deals with the development of our modern concept of the pineal organ. In writing this, I again became very much aware of the great debt we owe to our forerunners in this field of research. A choice of the many important recent investigations, specifically pertaining to pineal histology, cytochemistry and innervation, which contributed to modern views, will also be given. Some subjects which require closer investigation in the near future will, moreover, be mentioned.

Probably the earliest concept related to the pineal is found in the Indian Veda's, books on consecrated knowledge, which have been a source of Indian religion, philosophy and sanskrit literature. Here, seven chakras, literally wheels, or padmas, lotus flowers, or centres of vital energy are distinguished. They are all situated in the axis of the body. The most important and supreme chakra is the sahasrara chakra, which is located on the crown of the head. It was held to be related to the pineal organ and was characterized by thousand petals of the lotus flower and by utter silence, in contrast to the other chakras, which are symbolized by different and specific sounds. The sahasrara chakra represented the centre of supreme spiritual force. When functioning it bestows enlightenment on man enabling him to experience the deepest depths of his inner self and his direct union with the Godhead. In this state of bliss, man is lifted out of time and space by which his mind is imprisoned. As an outward sign of the activity of this chakra, Indian holy persons may show a protuberance on the crown of the head, mostly in the shape of a braid or a tuft of hair, or a small truncated cone, which is also found, but more rarely, in Byzantine art. The nimbus of Christian saints and the tonsure of Roman Catholic monks are also said to be reminiscent of the very ancient belief that man's supreme spiritual power is located on top of the head, in the pineal chakra.

This sahasrara chakra should not be confused with the ajna chakra, which is located on the forehead or between the eyebrows. According to some sources this chakra might be related to the pineal, while according to others, to the hypophysis. It was held to represent the centre of mental activity or thought. On Indian statues of Gods it is often depicted as a sculptured eye or represented by a jewel, indeed the third eye of God Shiva. This third eye had

and still has two opposite meanings: the power of devastation, the evil eye, but also its reverse, an apotropaic power. In the Mediterranean countries people still adhere to the belief in both meanings of the eye. In modern India, this ajna chakra is now often indicated, especially by women, by a dot of rouge or of another colour matching the colour of the lady's dress and considered a charm guaranteeing good luck. Formerly, it may have been a cast sign, but most Indian people whom I have interrogated on this subject did not have any idea of the original significance of this ancient symbol. In recent times the belief in the presence of the chakras and their functional importance has been revived by European occultists and parapsychologists.

The first more or less scientific concepts of the pineal were based on a mixture of philosophy and anatomical and physiological data available at that time. As examples, the concepts of Herophilos (325-280 B.C.) and Descartes (1596-1650) can be mentioned. Herophilos held the pineal to be a tap regulating the stream of the "pneuma psychikon", or "spiritus animalis" in Latin, from the third to the fourth brain ventricle. The soul was thought to be located in the brain ventricular system. Under the influence of the senses, this "pneuma psychikon" was considered the direct cause of the development of knowledge. It is not quite clear what Herophilos thought to be so important about the tap function of the pineal. He may already have had in mind the later theory according to which the fourth ventricle is the seat of memory, perhaps supposing that, if the tap is open, more "pneuma psychikon" could flow to this ventricle thus "loading up" memory. Galen (ca. 130-200), however, rightly observed that the pineal is located outside the brain ventricular system so that it cannot function as a tap in this system. According to him, the organ is just a "gland", like other structures of a similar nature filling the gap between branching vessels and supporting them, in this case the internal cerebral veins draining in the great cerebral vein, which still bears Galen's name. The function and structure of glands being unknown at that time, one cannot speak of a true pineal concept of Galen.

The systematically elaborated views of Descartes on the in- and output of the pineal organ of man are strongly based on the ancient ideas about the "spirits" and the functional significance of the brain ventricular system for somatic and mental activity. It seems that the main aim of Descartes was to explain, in a purely mechanistic-physiological way, the functioning of the soul. According to him, the soul exerts its function more particularly in the only unpaired organ of the brain, the pineal, which he considered a kind of

reflex centre (see Ariëns Kappers (1, 2) for a more extensive review of ancient theories and literature).

Modern pineal concepts owe much to research technologies introduced in the 17th century and developed increasingly in the 19th and 20th centuries. Since comparative anatomy, microscopic anatomy and embryology first developed more rapidly than physiology, pineal concepts were primarily based on morphological observations. De Graaf (3, 4) and Korschelt and Spencer (cit. Studnička (5)) were probably the first authors suggesting that the amphibian and reptilian pineals are photosensory organs. These authors were also of the opinion that the mammalian pineal is homologous to the pineal of non-mammalian vertebrates. However, during its phylogenetic development, the organ regresses, becoming quite vestigial in man.

Studnička (5) extensively described pineal cytology in a number of (primarily non-mammalian) vertebrates. He was the first to state that the pineal evolves from a purely photosensory organ into a gland of complex structure and enigmatical function, also pointing to the structural changes shown by the pineal during its phylogenetic development.

Due to the discovery in the second half of the 19th century of endocrine organs, physiologists and clinicians started to take interest in the pineal gland. Principally before the second world war, on the basis of clinical and pathological observations, the human pineal was already held to be an endocrine gland. In prepubertal youth it was supposed to normally exert an inhibiting influence on the hypothalamus and, probably via the hypothalamus, to inhibit the development and function of the reproductive organs. Pineal extracts, already accepted to contain an antigonadotropic hormone, were even used in clinical treatment of genitosomia praecox (for this period, see Ariëns Kappers (2)). When the function of the pituitary gland became better known, especially after the second world war, the pineal was thought to influence the function of the basal hypothalamic nuclei, which, in turn, influence the production and release of the gonadotropic hormones in the pituitary. As is well known, the book by Kitay and Altschule (6) contributed much to the interest of endocrinologists in the pineal and stimulated work in this field.

Let us now turn first to some basic research on the influence of light on pineal function, which has been important for our modern concept of the pineal. From his physiological investigations on the effect of light and darkness on the pigmentation of *Phoxinus laevis*, Von Frisch (7) concluded that the pineal of this teleost fish is the principal, but not the exclusive site of extra-ocular photoreception. The melanophores of *Phoxinus* being of the innervated