

POLYAK, STEPHEN. *The vertebrate visual system. Its origin, structure, and function and its manifestations in disease with an analysis of its role in the life of animals and in the origin of man. Preceded by a historical review of investigations of the eye, and of the visual pathways and centers of the brain.* Edited by Heinrich Klüver. Chicago, The University of Chicago Press, 1957. xviii, 1390 pp., 546 figs. \$45.00.

It hardly seems possible for me to apply myself to the task of reviewing this *monumentum aere perennius* without visualizing Polyak in front of his microscope intent on showing me the objects of his passion, exquisite preparations of a structure in which every detail stirred his imagination. Though he knew all the time that the end was near, nothing had abated his zest or undermined his conviction that the creation of this book was a worthwhile task. At any rate, here was now someone all too willing to see and to learn, and I could feel the pleasure it gave him to instruct me. I left delighted with the day, having experienced something of the dark strength in this man devoted to the perception of light. "The people I respect most behave as if they were immortal and as if society were eternal" (E. M. Forster). If I left with that feeling, something of it may have been due to the fact that he knew Klüver could be trusted to finish the book. The work would not be in vain.

Now Professor Klüver, at the expense of two years of hard work, has seen the book through the press and we are presented with something that has turned into a complete and scholarly "account of the growth of our knowledge of the brain and, in fact, into a masterly introduction to the history of neuroanatomy, neurology, ophthalmology, and allied fields that will not easily find its equal" (Klüver). In addition, here is a life-size picture of Polyak, the savant, his attitude and preferences, seen also—I believe—through the thoughtful eyes of a student of human endeavour such as its editor.

Perhaps it is just as well to begin by pointing out what is not found in this book. It is not an electrophysiology or photochemistry of the retina nor does it attempt historical completeness in leading up to these modern, very fruitful lines of approach. Past masters of these fields such as Fritiof Holmgren, Kühne, König, Gotch, etc., are not included in a portrait gallery, otherwise singularly well stocked. Psychophysics of vision also falls outside the scope of Polyak's main line of interest. The author's intellectual inheritance has come down from the great naturalists, Lamarck, Darwin, Haeckel, perhaps through his teacher Elliot Smith, and from famous neurohistologists such as Kölliker, Flechsig, Retzius, Herrick, Ramón y Cajal who was another of his teachers. Polyak was also a learned historian, a student of Arabic scripts, Greek medical classics, familiar with many of the important languages of occidental civilization.

The neurophysiologist will not turn to this book in order to read its Part IV unless he happens to be something of a naturalist himself. If he is, he will find excellent drawings and photographs of a number of rare mammals as well as descriptions of their living habits, some of them singularly fascinating as, for instance, the Philippine Tarsier, called the most primitive living primate. To the student of vision, however, this section is of considerable interest because it also contains a general biology of the organs of sight throughout the vertebrate kingdom together with a most meticulous compilation of references to (what I suspect must be) all the relevant literature.

Polyak's histological work on the primate retina and the visual pathway is fully reviewed in this book. *The retina*, which was published in 1941, made his name famous also in the physiological world, chiefly because of his own discoveries and the great general interest in a structure which combined light-sensitive receptors with an attached nervous center and thus held out hopes of progress to both neurophysiologists and photochemists, not to speak of the many who are interested in colour vision. In these circles it is less well known that Polyak also was an acknowledged master of brain histology. I remember Polyak telling me that if, at the time, he had had the Klüver-Barrera staining method, his own labour would have been far less time-consuming. Sixteen years ago Le Gros Clark, an accomplished master himself (in *Physiol. Rev.*, 1942, 22, p. 227), wrote about him: "Polyak's work comprises the most complete presentation in recent years of the organization of the projection system in the monkey from the retina through the lateral geniculate body to the striate cortex." In this book it is presented with great clarity and excellent schematic dia-

grams, the culmination of a line of work to which many first-rate scientists have contributed—in recent times chiefly Henschen, Rönne, Minkowsky, Brouwer, Le Gros Clark. Having read some of this literature myself, I only miss a reference to Henschen's interesting ideas about special 'colour cells' in the striate area which were absent in nocturnal monkeys. Possibly Polyak hesitated to accept them.

The amount of histological work that has gone into the elucidation of the details of the visual pathway is something stupendous. Part of it is histology in the ordinary sense but much has come out of pathology in combination with ophthalmology. This is analyzed by Polyak in a manner that should make his work invaluable to ophthalmologists, neurologists and neurosurgeons, all of whom need the very details that he not only supplies but also evaluates with great criticism and circumspection.

The neurophysiologist with but little interest in the visual pathway will find the most interesting sections to be those dealing with the development of our ideas about localization and nervous centers, the great struggles of the past—and to some extent of the present—between the proponents of localization and those believing in generalized function of the brain. No one can fail to be excited by following this fight in retrospect under the competent guidance of Polyak. This is by no means of visual interest only; it is also a history of ideas which as neuroanatomical propositions finish a chapter, and so everyone can have the pleasure of seeing who the people were who worked with insight and care and came out victorious. Many neurophysiologists will have favourites among the classics and this adds to the pleasure. Filled, as this section is, with well-selected figures from old papers, descriptions of experiments, deductions, personal notes on the authors and portraits, it makes delightful reading. It also shows how slowly things are accepted in biology as compared with physics. Gratiolet described the radiation in the middle of the last century, the great Flourens distinguished several functions in the brain around 1820, Fritsch and Hitzig found the motor area in 1870, Ferrier the centers for eye movements in 1873, Munk discovered cortical blindness and thus the visual area in 1879, etc., in spite of which throughout the beginning of this century Henschen still had to struggle for acceptance of his ideas about visual localization. And yet in 1929 Flechsig was still alive and his *Gehirn und Seele* with the pictures of localization, seen in so many physiological text-books, must have been well known.

The great theme of this book is thus structural organization as it is seen at every level of the visual pathway from the retina upwards, and structural organization as it is gradually emerging from the hands and heads of men working at it from the beginning of documented civilization up to the present day. Much important old work is rescued in the process. The historical sections are enjoyable for this reason and also because they satisfy a real curiosity as to how, when and by whose activity facts and principles were elucidated which now are common knowledge.

We can now safely predict that the visual stations for a long time to come will be studied by physiologists with electrical methods supported by natural stimuli; in fact, this is a phase we already have entered upon. Here is collected within the same cover most of the relevant neuroanatomy needed for that work. In my own studies of the literature on the optic pathway—extremely insignificant though they be compared with Polyak's—I have nevertheless come upon several rarely mentioned papers while hunting up the possibilities of centrifugal control. Every one of these papers I have since found among Polyak's references. For want of real knowledge in the field of visual neuroanatomy I offer this as circumstantial evidence for my belief that everything in the least significant in this field will be found referred to.

It is not to be supposed that many people nowadays will give themselves time to read a book of 1000 pages. Experimenters tend to look askance at the anatomist's joy in a large mass of material; yet, on the other hand, they become annoyed when, in spite of this, they often look in vain for the very detail they need. A more important function of this work will be to serve as a standard book of reference in which one studies the sections and chapters required for a particular approach. It seems probable that many prospective students engaged in such pursuits will read a great deal more than they originally intended to, caught by Polyak's quiet enthusiasm for his theme and the breadth of outlook that makes it a history of neuroanatomy rather than a mere visual anatomy. Neurophysiologists will enjoy it most for this reason.

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