modes of achieving duplicate loci—"unequal exchange" (intrahomolog translocation), generating tandem duplications, and tetraploidy. Tandem duplications are inherently unstable. One duplicated region can be eliminated by a well-placed crossover after asymmetric pairing. On the other hand, tetraploid segregation of a locus is hardly independent. The former homologs must diverge appreciably, "diploidize," before independent transmission emancipates one of the duplicate genes. Any mode of duplication may cause a gene-dosage problem, depending on species and the particular portion of the genome. Polyploidy is lethal in mammals, but tetraploidy and subsequent diploidization have been documented in many plants and, more pertinent here, in several modern fish.

Ohno ignores other modes of duplication involved in speciation in organisms whose chromosomes permit study—for example, Diptera—and herein lies the most serious flaw of the book. One finds duplications in reverse order or well separated on the same or different chromosomes. These are not lost by asymmetric crossing-over and do not require extensive chromosome change (diploidization). They do, however, originate infrequently, as do the inversions and translocations more easily identified in related vertebrate species.

Ohno takes lack of linkage between the mammalian hemoglobin alpha- and beta-chain loci or immunoglobulin light- and heavy-chain loci to signify that "either at the fish stage or at the amphibian stage, the mammalian ancestor went through at least one tetraploid evolution." He attributes the nearly uniform number of isozymic loci for many other enzymes in fish, birds, and mammals to loss of redundant loci during diploidization, though tetraploid fish, such as carp and salmon, have double the number of these isozymes.

Genome size has undoubtedly evolved. Although DNA loss sometimes accompanies specialization and although some "living fossils" have the highest DNA content known, the net tendency must have been for DNA increase in most vertebrate lineages. Tetraploidy can be ruled out in the urodele lineages. Here Ohno attributes the increase in genome size exclusively to tandem duplication, demonstrating that enormous redundancy can stop a lineage "dead at the amphibian stage."

Other lineages must have incurred meaningful, function-changing duplication—tetraploidy. Ohno proposes separate chromosome-doubling events in the lineages leading to birds and to mammals. The grounds for this are threefold: constancy of genome size within these groups though the bird genome is about half the size of the mammalian (living reptiles spanning the gap); presence of microchromosomes among vertebrates only in some of the snakes and lizards, reptiles with small genomes, and birds; and sex-determination in birds, snakes, and mammals by a chromosome confined to one sex—the female in birds and snakes and the male in mammals.

That the separation of bird from mammalian ancestry is ancient is confirmed by paleontology. That it occurred in the most recent ancestral group capable of polyploidization (which Ohno convincingly argues is incompatible with well-defined chromosomal sex determination) seems doubtful. This would imply at the least a biphyletic origin of living reptiles, placing turtles and crocodiles with the mammals, a view of reptile phylogeny not shared by many paleontologists.

The necessity for this phylogenetic artifact disappears with other types of duplication, whose existence is shown most simply by the number of chromosomes in the haploid set that can carry ribosomal RNA cistrons: only 1 in the frog *Xenopus*, at least 5 in man, and possibly all 11 in the Chinese hamster.

Found throughout the book are inconsistencies, misrepresentations, and errors of fact. Trivial errors even on page 1 bespeak careless editing and are counterpersuasive. Some corrections are perhaps worth making. Only about 20 percent of the sense strands in the *Escherichia coli* genome are expressed most of the time, similarly to the non-repetitive DNA in mouse brain. Some "living fossils"—*Limulus*—are as polymorphic for isozymes as are other species. Actin is considered potentially homologous to the subunit of microfilaments, not of microtubules. Sister-chromatid exchange in ^{3}H-labeled cells is very likely induced by ^{3}H decay.

The errors, aggravating but mostly not crucial, raise the question, To whom is this book addressed? This is fun reading for armchair biologists, or for serious biologists who find sustained conjecture diverting. It may also goad somebody into generating data relevant to the more pivotal conjectures. As Ohno says, "In order to avoid early obsolescence, the author, judging on the basis of the scant evidence available, is obliged to anticipate future developments and paint a picture with broad strokes of his brush." I would demur slightly. It was a palette knife.

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Neuroendocrinology

The Pineal Gland. A Ciba Foundation symposium, London, June 1970. G. E. W. WOLSTENHOLME and JULIE KNIGHT, Eds. Churchill Livingstone, Edinburgh, 1971 (U.S. distributor, Williams and Wilkins, Baltimore). xii, 402 pp., illus. $14.50.

Between the lucid 20-page introduction to this symposium by Kappers and the excellent 10-page summary of it by Wurtman lie some 350 pages of fascinating reading. It reads like a "who dunnit," even though the membership list in the front tells us that all 26 distinguished participants did it. The first half of the book concerns what the pineal is, the second half what it can do. In the end, we learn that the pineal is undoubtedly a classical endocrine organ (Mess), a photo-neuro-endocrine organ (Collin), or a neurotransducer (Antón-Tay), designations that are not mutually exclusive. We learn that, under the influence of neural input (light/dark especially), it synthesizes potent amines and indoles (Axelrod; Shein) and other active principles (Moszkowska) which appear to act selectively upon the midbrain and hypothalamus (Antón-Tay; Fraschini) or pituitary (Moszkowska) to modify the synthesis and release of pituitary gonadotropin (Moszkowska; Mess; Reiter; Fraschini; Herbert) and adrenocorticotrophic hormone (Motta; Singer). We learn also that electrical activity of the brain, and behavior, are modified by the pineal (Nir; Martini) and that melatonin (administered, and presumably also from the pineal) is unique in its ability to increase a brain enzyme (pyridoxal kinase), which catalyzes the formation of pyridoxal phosphate, a cofactor necessary for the formation of such potent compounds as serotonin, dopamine, and gamma amino butyric acid. And we learn much more, not only from the formal presentations but also from the generally extensive discussions. (Either the discussions were carefully planned or many of the participants "just happened" to have slides handy. In any case, many new data were added from the floor.)

Careful studies of the ultrastructure of the pineal gland of a variety of species by Kelly, Collin, Oksche, Arstila *et al.*, and Pellegrino de Iraldi add new descriptions and data to old on the development of the pineal and its evolution from a sensory to a secretory organ.

A shortcoming of this symposium is that the generally excellent recent work of W. B. Quay, who has contributed so much to the anatomy and physiology of the pineal, was not presented or even discussed. Nor was C. L. Ralph present to describe his recent work utilizing a direct bioassay of melatonin. Further, the influence of the pineal on melanocyte physiology in lower vertebrates and the interrelation of melatonin and melanocyte stimulating hormone were not considered. These are broad topics of general interest and importance.

In spite of the wealth of new information contained in this publication, it is quite apparent that the pineal gland still offers something for everyone, and its potential is expanding, as is its literature. In this particular volume, the formal presentations are well introduced and well documented and smoothly combine old and new information, and the discussions that follow each are superb. The publication lag is slight and the price reasonable. This volume will serve well both students and professionals from a variety of disciplines.

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Soviet Neuroscience

Electrophysiology of the Central Nervous System. V. S. RUSINOV, Ed. Translated from the Russian edition (Moscow, 1967) by Basil Haigh. Robert W. Doty, Transl. Ed. Plenum, New York, 1970. xii, 516 pp., illus. $37.50.

This volume of 34 short papers is basically a festschrift for M. N. Livanov, a leading Soviet electrophysiologist, that appeared originally in Russian in 1967. In providing a compendium of representative work or reviews by 24 Soviet neuroscientists, it has the clear value of augmenting our too-limited acquaintance with Soviet efforts in this field. The other contributions are from Western authors or groups or others who regularly publish in Western journals—Adey, Andersen, Buser, Brazier, Doty, Grastyán, John, Purpura, Remond, and Yoshii—and of these only Buser, Grastyán, and the Yoshii group (Hori, Toyohara, and Yoshii) have presented here data that may not be readily available elsewhere.

Twelve of the papers are concerned with studies of single neural units and related matters. In six of these the focus is on the analysis of the generation of unit activity, and EPSP's, IPSP's, and dendritic potentials fly thick and fast. I found these papers attractive and interesting (Andersen and Lømo's is especially clear) and a relatively painless way to gain some familiarity with the work of leading contributors, both Western and Soviet, to the subject. A review of ephatic (nonsynaptic) transmission by Belenkov is well done. Functional properties of the unit are considered in three papers and the study of single units in conditioning and habituation in another three.

The main bulk of the volume (18 papers) concerns the electroencephalogram, and no less than ten studies involve in part at least the encephaloscopic technique developed by Livanov (and independently by Gray Walter). The method is designed to evaluate changes in EEG wave amplitude simultaneously in different areas of the brain and requires the use of fairly sophisticated computer techniques. It is presumed to provide a way of studying the actual concurrent participation (synchronism or synchronization) of different cerebral areas in learning, sensory processing, and other critical functions of the brain. Livanov and his associates have applied the synchronism technique to everything from the study of early conditioning in rabbits to human psychopathology. The auto- and cross-correlograms of Brazier and Barlow, Adey, and Walter and the temporospatial potential maps of Remond are related techniques and are represented as well. But the Russian scientists have achieved a sputnik of sorts in a report by Aslanov of the intercorrelations (1225) among 50 cortical areas through scalp electrodes in man. The analysis of multiple channels of EEG information has developed rapidly in recent years, but the techniques, Soviet and Western, have seemed to lead by some considerable distance the demonstrated utility. It is not clear, generally, what the masses of intercorrelations, correlograms, and isopotential maps are telling us about structure, function, or pathology. The single-unit studies (with the built-in sampling bias that all recognize) seem clearer somehow; the complexities of neural transmission, generation of the macropotentials of the EEG, and the physiopathology of epilepsy are beginning to be unraveled. But I believe that we should continue to support macroprocessing efforts, at least on a modest scale, until there is a chance to see more evidence of their predictive or interpretative value. Some promise of future payoff is provided, perhaps, in the daring and imaginative Soviet attempts to apply these techniques to such problems as obsessive neuroses (Aslanov) and to schizophrenia and epilepsy (Gavrilova *et al.*). The findings, based on small numbers of cases, must be called suggestive rather than convincing; further, the problems inherent in monopolar recording against a supposed "indifferent" reference are not dealt with. One would wish also for a standard EEG evaluation in such patients of such phenomena as diffuse abnormality, presence of spike or slow wave foci, bilaterally synchronous slow waves, and the like in order to anchor to some extent the analysis of "synchronisms." One does note satisfying evidence of critical evaluation of the phenomenon, however; Zhadin's biophysical analysis suggests that synchronization does not inhere in nerve tissue itself but is a result (artifact?) of properties of conducting media such as cerebrospinal fluid, bone, meninges, or the electrodes themselves. Other papers of more than passing interest within this group include a traditional but satisfying study of thalamocortical relations by Narikashvilli *et al.* and a scholarly analysis of the effects of blindness on occipital alpha rhythms by Novikova.

Of the four miscellaneous papers remaining, the one of special interest is that of Buser *et al.*, which appears to settle the question of the origin of "hypnotic" akinesia in the rabbit.

In summary, I must say that I found the book of considerable value; although the pieces are generally short and sometimes lacking in detail, the taste of Soviet neuroscience that it provides is both satisfying and stimulating.