duce some unconventional material, and the latter may be particularly relevant for exobiology. After this diversion there are few further surprises. Chapters on the evolution of membranes, proteins, the genetic apparatus, and cells are contributed by Shah, Dayhoff, Woese, and Margulis, respectively.

The second part of the book is concerned with life elsewhere in the universe. Here the subject matter is changing more rapidly, and we do encounter some more recent material. Rasool gives an account of the atmospheres of the planets which was up to date at the time of writing. Chang and Kvenvolden seem about to demonstrate the prebiotic significance of carbon compounds on the moon. If they do not succeed, it is because, as they finally admit, such compounds have no prebiotic significance. Molecules in space are treated by Donn and extraterrestrial life and intelligence by Klein and Sagan, respectively.

What is the cause of this rash of books on exobiology and the origins of life? Unfortunately, I don't have time to answer this interesting question, since I must correct the proofs of my own second book on the subject.

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Ontogeny of Sleep Patterns

Sleep and the Maturing Nervous System. A symposium, Boiling Springs, Pa., June 1970. CARMINE D. CLEMENTE, DOMINICK P. PURPURA, and FLORENCE E. MAYER, Eds. Academic Press, New York, 1972. xviii, 470 pp., illus. $19.50.

Investigators of the maturation of the central nervous system are confronted by an embarrassment of riches: histological, biochemical, and physiological systems develop almost explosively after birth. The brain triples in weight during the first five years as the neonate is transformed from an essentially vegetative organism into a recognizable person capable of extraordinarily complex behavior. The present volume, based on a symposium sponsored in 1970 by the National Institute of Child Health and Human Development, reviews the developing sleep pattern in humans and animals in the context of various aspects of central nervous system maturation. The 19 formal papers are followed by comments initiated by invited discussants, the papers being organized according to the following topics: maturation of neural elements; development of electroencephalogram and activity cycles; reflex patterns and evoked potentials during sleep; and effects of some pathological processes (mental retardation, toxemia, autism) on human sleep patterns. Although the waking EEG has been intensely scrutinized for several decades, study of the sleep EEG in abnormal brain conditions, as exemplified in the last group of papers, has barely begun. It is already clear that sleep abnormalities may be observed where the waking EEG is normal, but clinical application of these findings is not yet possible.

The analysis of neurochemical changes in the maturing central nervous system is subject to various methodological difficulties, several of which are emphasized by Morgane and by Roberts. Biogenic amines, now in enormous vogue, have been invoked as controllers of sleep—noradrenergic systems for active (rapid eye movement) and serotonergic elements for quiet (slow-wave) sleep. In one noteworthy discussion, Shulte presents data squarely inconsistent with the latter possibility. The response to his findings provides yet another example of the dictum that theories are not abandoned because of inconsistent observations, but only when more attractive hypotheses emerge.

Parmalee and Stern provide an authoritative description of postnatal changes in human sleep. At birth (normal term), the infant spends roughly equal proportions of total sleep time in each sleep state—44 percent in active sleep (characterized by irregular respiration, muscle jerks, rapid eye movements) and 37 percent in quiet sleep (regular respiration, absence of body and eye movements). The remainder of sleep is transitional, that is, the defining parameters do not cluster perfectly. After three months active sleep occupies 25 percent and quiet sleep 49 percent of total sleep time; at eight months the respective values are 28 percent and 56 percent. The usual sequence of states in the neonate is waking—active sleep—quiet sleep. As the infant develops, quiet sleep more and more frequently follows waking, and by eight months it does so regularly. Electroencephalographic maturation occurs rapidly over the same period, and the infant achieves most of the distinctive features of slow-wave and REM sleep by the end of the first year.

There are two omissions from the volume that seem regrettable. First, it might have been instructive to include a comparison of milestones in the development of waking behavior and of sleep patterns. Second, a description of the course of sleep patterns after the first few years could have added useful perspective. Marked reductions in total sleep time and in the amount of deep sleep (characterized by high-voltage slow EEG activity) occur during adolescence; these changes should probably be considered maturational. Subsequent developments are best interpreted as the result of "aging": deep sleep continues to decline throughout adult maturity, and in late middle age an increase in awakening becomes apparent. It seems worth emphasizing that these latter changes in sleep EEG represent the most marked age-related alterations in central nervous system physiology measured thus far.

In spite of intensive research during the past decade, we remain ignorant of the biological function of either slow-wave or REM sleep. We are equally unable to specify with confidence the physiological mechanisms that control sleep. This reviewer suspects that the two problems are not separable; an understanding of function may be needed to determine which of several possible systems actually determines the occurrence of sleep.

In the absence of adequate theory, and with so much change going on at once, it would be incredible good fortune were meaningful relations to emerge between sleep and other maturational brain changes on mere empirical inspection. This volume reveals no such fortuitous outcome. Nevertheless, it seems likely that ontogenetic changes furnish an important clue to the function of sleep. The changes in infancy are well described in the book, and other contributions reflect the wide range of disciplines attracted to the challenge of what is becoming a central concern in neurobiology: the nature and function of sleep.

The book is well produced. It includes an index of subjects but not of authors. It provides a fair sampling of current research in several areas of brain maturation.

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