know a great deal about the physiological minutiae of tree growth, no one is really sure whether the large size and structure of these woody perennials confer upon them anything that is physiologically unique. The publication of a book on the structure and function of trees is a rare and consequently welcome event; when the book is professedly concerned with "those aspects of the physiology which are peculiar to tall woody plants" it is even more so. The only disappointed readers of this book will be those who have no stomach for long-standing controversy or those who, from the title, may have expected a wider-ranging treatment of the subject than a review virtually restricted to growth and the movement of assimilates.

The first three chapters (by Brown), comprising about half the book, deal with primary and secondary growth and the relation between growth and habit. Inevitably, such a review is selective, but this one provides a balanced, if unadventurous, account of current knowledge that will be valuable to students and teachers; it could do much to broaden the horizon of cell physiologists (if only they will read it), and it discovers a treasure trove of potentially rewarding research topics.

This section is followed by two chapters (by Zimmerman) on xylem and phloem transport—the latter described by a manuscript reviewer as "a clear statement of party line" but subsequently balanced by brief notes of alternative postulates, including the pump concept of the sieve plates. An iconoclastic and provocative chapter by Tyree on steady-state thermodynamics of translocation introduces the Onsager equations and argues a case for the experimental detection and measurement of translocation by electrical phenomena. The concluding chapter (by Zimmerman) treats the storage, mobilization, and circulation of assimilates, again highlighting several potential research fields.

Zimmerman and Brown set out to produce a textbook that would bridge part of the gap between modern standard plant physiology texts (with their inevitable molecular and cell biology bias) and ecological treatises on tree growth. They have succeeded admirably and we should be grateful to them; on the question of "what is a tree?," however, we still have no better authority than Gertrude Stein.

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Sleep Studies

Normal Sleep in Man. An Experimental Contribution to Our Knowledge of the Phenomenology of Sleep. UROŠ J. JOVANOVIČ. Hippokrates, Stuttgart, 1971. 328 pp., illus. $30.

An impressive variety of multidisciplinary investigations have led to major advances in the detailed phenomenological description of sleep in man and in lower animals. Extensive studies of the phylogeny, ontogeny, neurochemistry, psychology, neuroendocrinology, and physiology of sleep in recent years have led to a number of theoretical formulations of sleep-waking mechanisms. These include concepts regarding the anatomy and chemistry of biogenic amines in the central nervous system and of neural circuitry, as well as of biorhythmic aspects of sleep. On the basis of these data and new concepts, there is increasing interest in and evaluation of the nosology and etiology of sleep disorders in man.

This monograph is a report of a series of studies carried out by the author with major emphasis on the polygraphic recording and direct behavioral observation of nocturnal sleep in man. The author plans to follow this with a second monograph on "Problems of Disturbed Sleep." By the use of the electroencephalogram (EEG), myogram (EMG), oculogram (EOG), cardiogram, respirogram, phallogram, and dermatogram, 491 nights of "normal" sleep were monitored for 189 healthy subjects. The results are analyzed in terms of repetitive observational polygraphic descriptions and not in relation to specific hypotheses generated by a sharply focused research inquiry. Unfortunately, it is difficult to compare Jovanovič's polygraphic descriptions with modern concepts of sleep-stage patterns, since both his recording methods and his electroencephalographic sleep staging are significantly different from present generally accepted procedures. He classifies EEG "depth of sleep" patterns into five major categories (A, B, C, D, and E) or stages, with each stage having three substages, there thus being a total of 15 separate patterns. The concept of "depth" is defined solely by the persistence of EEG wave pattern, with no independent measure of arousal threshold used. The lack of mentalis EMG recording in most studies and the use of only one EOG channel recording also create difficulties in comparing results to other studies. Surprisingly, no comparison or even reference is made to the accepted standard manual of sleep-stage recording and classification (A. Rechtschaffen and A. Kales, *A Manual of Standardized Terminology, Techniques and Scoring System for Sleep Stages of Human Subjects*, U.S. Public Health Service Neurological Information Network, Bethesda, Md., 1968).

In spite of these methodological difficulties, the author essentially confirms the well-accepted findings that normal nocturnal sleep is composed of a sequence of 80-to-90-minute cycles; that relative duration of phases of the cycles, as well as EEG wave pattern, changes according to time of night; and that rapid eye movements are correlated with desynchronized sleep 96 percent of the time. In addition, the results confirm previous findings regarding the pattern of myoclonic twitches, heart rate and respiratory rate, and penile erections, as well as the high correlation (80 to 90 percent) of vivid dream reports with "desynchronized" (REM) sleep. Surface EMG recordings were made from both arms during sleep, and several interesting findings are reported. In right-handed individuals (without left-handed family members), there were twice as many group discharges from muscles of the left arm as from the right. For left-handed individuals the opposite result was found. These results were the case for total sleep as well as during "desynchronized" sleep.

Although most of this monograph is devoted to reports of sleep in normal adult man, results of a study of sleep in 17 children ages 2 to 14 and 8 adolescents ages 15 to 18 are also included. The findings essentially confirm previous reports regarding sleep-stage cycling and percentage relationships of these sleep stages in these age groups as well. One interesting section is the report of results of an attempt to totally deprive two young adults of sleep for a period of 5 days. Neither could be kept awake beyond 114 hours, and after 2½ days both subjects developed increasing transient sleep periods, lasting a few seconds, with significant psychological and performance decrements. The recovery sleep was prolonged, with increased "deep" sleep as well as increased percentage of REM sleep. The subjects felt fully recovered after 12 and 16 hours of sleep respectively.

This monograph cannot be recommended as a general text for nonexperts in the field, for the differences in methodology make direct comparisons

with the findings reported in the extensive recent literature difficult. Moreover, the absence of adequate discussion of other important aspects of sleep in man such as the effect of drugs, neuroendocrine phenomena, sensory evoked responses, and the relation of sleep to central nervous system biogenic amines, makes this an inadequate general review. Although much of this report essentially confirms previously published work, the extensive normative data reported should be reviewed by those investigators with specific interests in sleep research.

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