Secretary Corner to suggest our confidence that this work for us shall endure. The Association is not unmindful of his eight years of devoted and successful service."

The concluding session on Saturday afternoon was held jointly with the Physical Anthropologists. There were three valuable papers of some length from each association. Especially noteworthy was Dr. Hrdlička's exhibition of a series of human tibiae having a large and long subcondylar process hitherto unreported, and still unexplained. Dr. Hrdlička remarked that all the major human bones have macroscopic features as yet undescribed. The final paper, by Dr. Edwards, showed how the distribution of the five pigments or color factors of the human skin may be recorded in life, by spectro-photometric measurements.

At the business meeting, 43 new members were received. Officers for 1939 and 1940 were elected as follows: *President,* Stephen W. Ranson; *First Vice-president,* T. Wingate Todd; *Second Vice-president,* Albert Kuntz; for 1939–1943, *Secretary-Treasurer,* Eliot R. Clark; *Members of the Executive Committee,* George W. Corner, Olof Larsell. A cordial invitation in behalf of the Faculties of the three Medical Schools in Boston—Boston University, Harvard and Tufts—was received from Dean Burwell; and accordingly the Anatomists will meet next year at the Harvard Medical School, in Boston, from April 6 to 8, 1939.

FREDERIC T. LEWIS
GEORGE W. CORNER

EASTERN SECTION OF THE SEISMOLOGICAL SOCIETY OF AMERICA

FOLLOWING the meeting of the American Geophysical Union in Washington, D. C., the Eastern Section of the Seismological Society of America held its thirteenth annual meeting at the Massachusetts Institute of Technology, Cambridge, Massachusetts, and Weston College, Weston, Massachusetts, on May 2 and 3, 1938.

The vice-president, Dr. Dean Vannevar Bush, in the name of Dr. K. T. Compton, welcomed the group to the Massachusetts Institute of Technology and expressed the hope that the excellent work being done in the field of seismology would very soon obtain a more wide-spread recognition on the part of the general public.

After the usual business routine, the reports of the various permanent and standing committees and the appointment of new committees, the first twelve scientific papers were presented. Following a luncheon in the Walker Memorial Building, as guests of the department of geology, a trip of inspection was made. This included an examination of the differential analyzer and a visit to the electrical engineering department shops, where a much larger and improved type analyzer is being constructed. The seismologists next examined Professor A. C. Ruge's shaking-table equipment and L. B. Slichter's new type portable seismographs. Moving over to Harvard, the Bridgman high pressure apparatus, the Birch equipment for the determination of velocities and a modern portable seismic outfit were successively inspected.

The sessions of May 3 were held at Weston, where after a brief address of welcome by the Reverend R. A. Hewitt, S.J., president of Weston College, the second group of ten papers was read and the officers for the ensuing year were elected as follows: *Chairman:* H. E. McComb, of the U. S. Coast and Geodetic Survey; *Vice-Chairman:* A. C. Ruge, of the Department of Civil Engineering, Massachusetts Institute of Technology; *Secretary:* A. J. Westland, S.J., Department of Geophysics, Saint Louis University; *Treasurer:* A. C. Chick, of Providence, R. I.; *Fifth Member of Executive Committee:* E. C. Jacobs, of the University of Vermont.

Weston College was host at the luncheon which terminated the activities of the morning. In the afternoon a visit was made to the elaborate new seismic vault at the college. Four papers were next read concerning the Benioff seismograph, and a round-table discussion followed on the Benioff operation, with Dr. E. A. Hodgson, of the Dominion Observatory, Canada, as chairman. The meeting was brought to a close with a visit to the Harvard Station at Oak Ridge to inspect the seismograph equipment there, and the 61-inch reflecting telescope of the Astronomical Observatory.

A. J. WESTLAND,
Secretary

SPECIAL ARTICLES

VITAMIN A AND ROD-CONE DARK ADAPTATION IN CIRRHOSIS OF THE LIVER[1]

DISTURBANCES in vision such as nightblindness have long been associated with malnutrition,[2] and in recent years this has been shown to be due specifically to variations in the vitamin A content of the body.[3] Lately, this relationship has received a rational understanding in terms of the association of vitamin A with the chemical structure of visual purple, the light-sensitive substance of the rods.[4]

It has generally been assumed that disturbances in

[1] Reported at the Symposium on Biophysics held at the University of Pennsylvania on November 6, 1937.

[2] H. de Gouvea, *Arch. f. Ophthalm.*, 29 (1): 163, 1883.

[3] L. S. Fridericia and E. Holm, *Am. Jour. Physiol.*, 73: 63, 1925; K. Tansley, *Jour. Physiol.*, 71: 442, 1931.

[4] G. Wald, *Jour. Gen. Physiol.*, 19: 351, 1935.

vitamin A metabolism involve rod vision alone, and it is on this basis that the dark adaptation of the rods has been proposed[5] as a diagnostic sign for vitamin A deficiency. However, because of the many similarities which rod vision and cone vision show,[6] in such functions as intensity discrimination, visual acuity, flicker and even dark adaptation, it seemed likely that disturbances might also be found in cone function.

There have been indications that this is correct. Intensity discrimination is influenced by the vitamin A content of the body,[7] and apparently this influence exists even at high intensities, where cone function predominates. If it could be demonstrated that vitamin A controls cone function, we should gain an insight into the chemistry of cone vision which would be particularly valuable because of the low concentration of sensitive substance in the cones,[8] and the consequent difficulty of direct chemical investigation of it. It is the purpose of this note to report that vitamin A does indeed affect both cone and rod functions. The measurements which demonstrate this are concerned with the dark adaptation of persons having cirrhosis of the liver, and with the effect upon it of vitamin A therapy.

The reason for choosing this disease is that night-blindness and keratomalacia have been reported in liver disease[9]; more particularly, our own observations on persons with alcoholic cirrhosis of the liver showed that some of them possess evidences of nutritional deficiency such as lesions of the skin and cornea which suggest the specific lack of vitamin A. Since the liver is the chief depot for storage of vitamin A,[10] it is probable that disease of the liver would disturb the metabolism and storage of this vitamin.

Our measurements were made using a newly designed adaptometer[11] which determines the course of dark adaptation under controlled conditions of pre-adaptation, retinal location, color, and the like, specifically chosen so as to separate cone from rod dark adaptation and to furnish enough of the course of both functions for accurate comparison. The white pre-adapting brightness is 1600 millilamberts and is viewed by the subject for 4 minutes. The test light passes through a violet filter (Corning 511) which transmits the spectrum only below 460 mμ, and is a flash of 0.2 second duration. The retinal region tested is a circular area whose diameter subtends 4.5° visual angle, and is located 8.5° nasally in the right eye.

Of the 14 persons with alcoholic liver cirrhosis tested, 13 showed plain evidence of disturbances in dark adaptation. None of them was jaundiced.[12] Two of these patients were fed large daily doses of vitamin A.[13] After 19 daily doses of 40,000 international units, the dark adaptation of one patient became normal. The other patient, whose liver cirrhosis was more extensive, responded more slowly and exhibited normal dark adaptation only after a ten-fold increase in the vitamin dosage. The measurements made on the latter patient will be considered in detail.

Fig. 1 shows graphically three sets of these measurements made at different times during vitamin A therapy. Curve C is after 127 days of therapy and corresponds to that usually obtained with normal people. It records the way in which the light intensity threshold changes in the dark, and shows the usual rapid primary cone adaptation followed by the slow

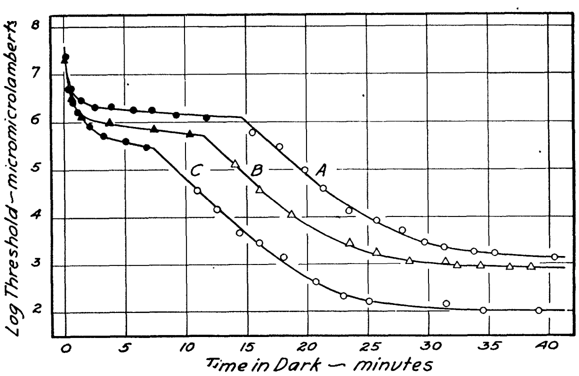

FIG. 1. The course of dark adaptation of a person with alcoholic cirrhosis of the liver determined at different times during vitamin A therapy. The points are single measurements and record the visual threshold to violet light during a stay in the dark following 4 minutes light adaptation to 1600 millilamberts. Those measurements which even at the threshold appear blue or violet to the subject are represented as solid symbols; they all fall on the primary cone portion of the curve. Those measurements which are reported as colorless at the threshold are shown by unfilled symbols, and represent the secondary rod portion of the adaptation. Curve A was obtained when the subject was on an ordinary diet. Curves B and C were obtained after 105 and 127 days respectively of vitamin A therapy. Note that both the cone and rod thresholds change and that the cone-rod transition point changes in different stages of the treatment.

[5] P. C. Jeans, E. Blanchard, and Z. Zentmire, *Jour. Am. Med. Assn.*, 108: 451, 1937.

[6] S. Hecht, *Physiol. Rev.*, 17: 239, 1937.

[7] C. Edmund and S. Clemmesen, "On Deficiency of A Vitamin and Visual Dysaptation," Copenhagen, 1936, 92 pp.

[8] S. Hecht and R. E. Williams, *Jour. Gen. Physiol.*, 5: 1, 1922; G. Wald, *Nature*, 140: 545, 1937; A. M. Chase, SCIENCE, 87: 238, 1938.

[9] Hori, *Arch. f. Augenheilk*, 31: 407, 1895; Jeghers, H., *Ann. Int. Med.*, 10: 1304, 1937.

[10] T. Moore, *Biochem. Jour.*, 25: 275, 1931.

[11] S. Hecht and S. Shlaer, *Jour. Opt. Soc. Am.*, 28: 1938 (in press).

[12] M. D. Altschule, *Arch. of Path.*, 20: 845, 1935.

[13] We used oleum percomorphum, carotene, and a vitamin A concentrate. The vitamin A concentrate (free of vitamin D) was supplied to us by the Vitex Laboratories, Harrison, N. J., through the kindness of Professor T. F. Zucker, of Columbia University.

secondary rod adaptation. The transition between the two is sharp and occurs after about 7 minutes in the dark. The data marked A were obtained when the subject had been on an ordinary diet for three weeks; those marked B were obtained after 105 days of vitamin A therapy.

There are two points of significance in these data. First, the time of appearance of the cone-rod transition is much longer for curves A and B than for normal. During treatment this transition point moved from its initial value of 15 minutes until at the end of the treatment it occurred at 7 minutes much as with the normal eye. Second, the A and B data show thresholds much above the normal, and this applies both to the cone section and to the rod section of the curves. During treatment the cone threshold was lowered by a factor of 5, and the rod threshold by a factor of 150—a ratio of 1 to 30.

The precise way in which the rod and cone thresholds varied in this subject is shown in Fig. 2. The points

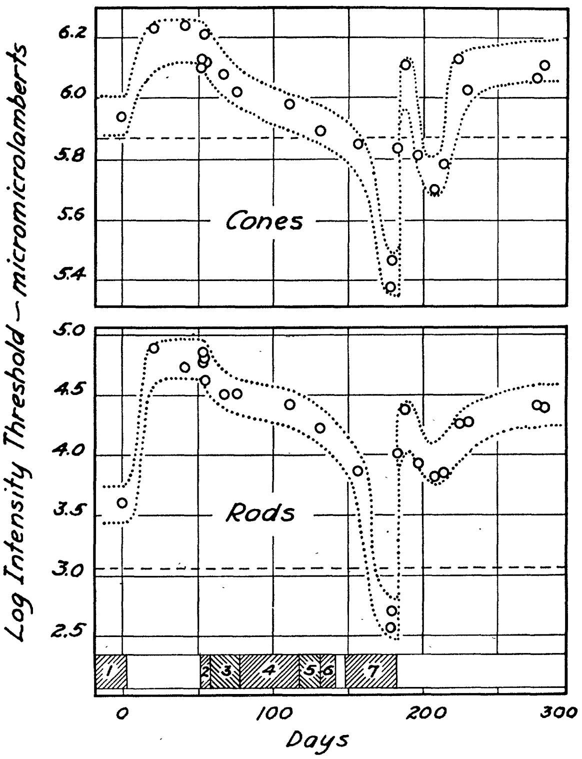

FIG. 2. Relation of cone and rod thresholds during dark adaptation to the sequence of vitamin A therapy. Daily vitamin A dosages in international units are as follows: (1) 40,000 units in oleum percomorphum, (2) 75,000 units in a D-free concentrate, (3) 60,000 units of carotene, (4) 60,000 units in oleum percomorphum, (5) 250,000 units in a vitamin D-free concentrate, (6) and (7) 500,000 units of the same concentrate. The clear spaces represent no vitamin A administration.

record the positions of the cone threshold after 6 minutes in the dark, and the positions of the rod threshold after 20 minutes, and both positions are plotted against days of therapy. Since the rod threshold variation is about 30 times that of the cones, the thresholds of the latter have been plotted on a proportionately larger scale. The median threshold of 15 normal individuals is represented by a dashed line. Through the measured points there has been drawn a band 0.3 log unit wide for the rods, and 0.15 log unit wide for the cones. The width of the band represents the extent of the extreme day-to-day variation that is found with normal people, and also with untrained patients of this type. This does not represent variations in the apparatus or in procedure, but in function and physiological condition. The therapeutic treatment is indicated at the bottom of the figure. A clear space means a normal diet with no added vitamin A, while a filled-in space represents some form of added vitamin A as explained in the figure legend.

When the subject was first tested, that is at 0 days in Fig. 2, he had been receiving 40,000 units of vitamin A daily for 58 days. At that time his cone threshold was only slightly higher than median normal and his rod threshold 0.55 log units above median normal. The rod data thus indicated a moderate degree of vitamin A deficiency. The treatment was discontinued, and 21 days later he was tested again. The thresholds of both functions had risen considerably. They fluctuated about this high level until the resumption of treatment, which took place on the 53rd day and continued with increasing daily dosage as indicated in the figure. Improvement was steady but slow until the dosage was increased to 250,000 and then to 500,000 units, when the threshold dropped precipitously to a point well below median normal. On discontinuance of treatment the thresholds rose rapidly, decreased again for about 20 days, then again rose to a high level.

The most striking aspect of these changes is the fidelity with which the cone thresholds vary with the rod thresholds. Since the rod thresholds apparently are changing in response to alterations in vitamin A concentration, the concomitant cone threshold variations indicate a similar dependence upon the presence of the vitamin. It is likely, therefore, that vitamin A has a chemical relation to visual violet resembling the one it has to visual purple.

CHARLES HAIG
SELIG HECHT
ARTHUR J. PATEK, JR.
LABORATORY OF BIOPHYSICS, COLUMBIA UNIVERSITY
RESEARCH DIVISION FOR CHRONIC DISEASES,
DEPARTMENT OF HOSPITALS, NEW YORK CITY,
AND DEPARTMENT OF MEDICINE, COLUMBIA
UNIVERSITY