the natural history of termites, finding out some very interesting facts. Perhaps he would have become a noted entomologist, following the methods of his friend, W. M. Wheeler, had not Mr. Lathrop again interfered. The next chapter is headed "The Lathrop-Fairchild Odyssey Begins." Mr. Lathrop carried him off, and one fateful night as the vessel lay off the Island of Penang, the two men had an earnest conversation, at the end of which "I had promised Mr. Lathrop that I would take up a study of the plants useful to man, and together with him, find a way to introduce their culture into America. It was a rather vague, ill-defined agreement, but it was a turning point."

We now find the two men spending many years going up and down the world, exploring for useful plants. Mr. Lathrop had no particular interest in scientific research as such, and apparently did not even care much for ornamental plants, but no expense or trouble seemed too great if it resulted in securing some plant valuable as food or for some commercial product. One would like to review all these adventures in some detail, but they must be left for readers of the book. Mr. Lathrop was not always easy to get along with, and had an impatient temperament, so that he often wanted to leave a place at the very time when Fairchild thought it most profitable to stay. But whatever his faults, he was a constant friend and supporter, and without him, many splendid opportunities would have been missed. On the other hand, we must recognize that in Fairchild Lathrop found an extraordinary treasure, and it is greatly to his credit that he so readily appreciated this fact. The book is written in a modest vein, but we are amazed at the energy, enterprise and resourcefulness exhibited, and the ability to enlist the aid and interest of all sorts of people in many countries. The narrative is full of side-lights on the people and countries visited; thus, for example, in Egypt he visited the palace of Queen Hatshepset (1570 B.C.) where he found a bas-relief representing the introduction of the incense tree from the land of Punt. "A warm feeling of understanding surged through me for this woman who, like myself, appreciated the value and romance of plant introduction. Here on the walls of her palace in Thebes, she had commanded a bas-relief to be cut commemorating her importation of a new tree into her domain. It was quite thrilling, for, as far as I know, there are not a half dozen memorials commemorating the introduction of new plants."

At length Fairchild returned to Washington, to superintend the now great enterprise which had grown up, largely through his activities. "I had expected to find it difficult to settle down to a desk in Washington, but on the contrary it proved so fascinating that there were not hours enough in the days or nights in which to accomplish all there was to do. Beside each day's mail, and routine, and reports on my travels to be written for future reference, there was the world-wide field of plants still waiting to be introduced."

On one occasion, he was invited to a dinner party. "It was a small party, and I found myself seated beside Miss Marian Bell, who had recently returned from New York, where she had been working in the studio of Gutzon Borglum. Our conversation was largely on art, about which I knew nothing but could talk a good deal, having traveled with Mr. Lathrop, who was a real connoisseur. It was the first chance I had to talk to Miss Bell, and I was fascinated by her. . . . I left the house, my mind in a whirl, a whirl which has really never stopped since. It was the beginning of a part of my life which has been completely different and vastly more beautiful than anything I had dreamed possible."

Thus he became a son-in-law of Alexander Graham Bell. Of these later happy years, not yet finished, much might be said, but I hope I have written enough to arouse some of the enthusiasm which should greet such a stimulating book.

T. D. A. COCKERELL

UNIVERSITY OF COLORADO

REPORTS

PILOT FITNESS FOR NIGHT FLYING[1]

A LIGHT sense tester correct in principle and convenient for use is an important instrument for testing pilot fitness for night flying.

Important functions to be tested are: (a) the ability to see at night and at low illumination and the effect of dark adaptation on this ability, and (b) the amount and speed of dark adaptation. Normal or better-than-normal sensitivity in light adaptation is also important. The eyes that are needed for night flying are the best of what might be called the normal group; that is, of those that have both good dark and good light vision. More important than speed and range of adaptation, however, is the place in the scale of sensitivity at which the adaptive change occurs. Some eyes have a good range and speed of adaptation, but the adaptive change begins so low in the scale of sensitivity that they never attain the degree of sensitivity that gives the special fitness needed for night flying.

The ability to see at night and at low illumination

[1] From the Research Laboratory of Physiological Optics, Baltimore, Md.

and the effect of dark adaptation on this ability. In general, the ability to see at low illumination may be tested by determining the threshold of light sensation, or what is often called the light minimum. The effect of dark adaptation on this ability may be tested by determining the light minimum at the intervals selected for consideration from the beginning of dark adaptation until the process is complete. The results of these determinations when plotted against time in the form of a curve give a complete picture of the course of adaptation of the eye in question throughout a period of time. Thus one can obtain the eye's sensitivity at any time from the beginning to the end of dark adaptation. Whether one or a number of these intervals is chosen for test depends on the purpose for which the test is being made. If the eye's maximum sensitivity is wanted approximately, for example, the test should be made at the end of an interval of 20 or 30 minutes.[2]

In order to show the amount of individual variation that may be found in the ability to sense light at different intervals in the course of dark adaptation, a study was made of 206 non-pathologic cases ranging in age from 9 to 70 years.[3] The results of this study are given in Fig. 1. The curves in Fig. 1 show also that age above 35 years exerts an important effect on the power of the eye to adjust itself for seeing at low illumination. From this it would seem that the testing of the light sense renders an additional service in helping establish the case against age as a disqualifying factor for night flying and of presenting evidence against those who wish to continue in this capacity beyond their time of fitness.

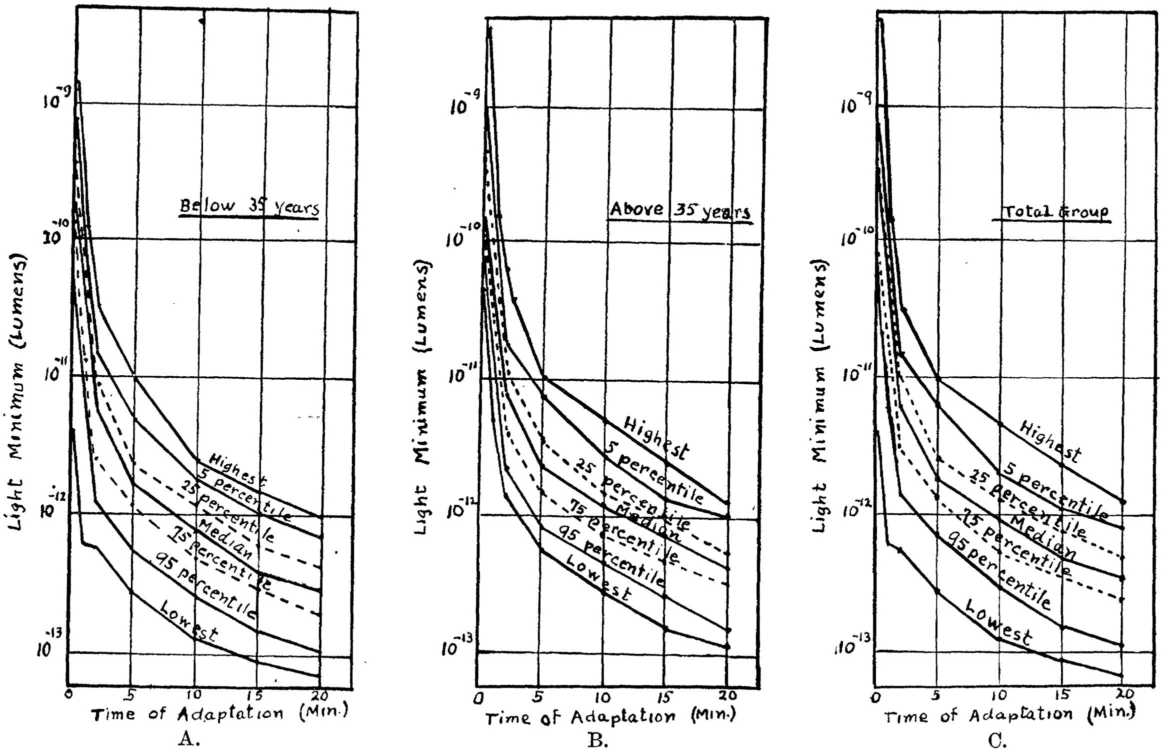

FIG. 1. The light minimum for 206 non-pathologic cases, ages 9 to 70 years, at the end of the period of light adaptation and after 1, 2, 5, 10, 15 and 20 minutes of dark adaptation for the highest, lowest and the 5-, 25-, 50-, 75- and 95-percentile cases: A, for the entire group; B, for the group below 35 years of age; and C, for the group above 35 years of age. The light minimum is expressed in lumens entering the eye per sq. mm of stimulus.

THE AMOUNT AND SPEED OF DARK ADAPTATION

Those intimately conversant with the ocular needs of the night flyer say that speed is more important

[2] The determination of the light minimum for the discrimination of detail in objects may also be used as a test of ocular fitness for night flying. That test, however, will not be considered in this paper. Depending on the size of detail that is used, the test may be made for either foveal or extrafoveal vision. In this connection it may be noted that the adaptive change in the fovea has a very much smaller range than in the surrounding portions of the retina and that the greater number of objects which it is important that the aviator see are extrafoveal in size. Both intrafoveal and extrafoveal sizes of test object are doubtless needed for a complete study of the eye's fitness for night flying. So far as we know, it has not been determined whether in all cases candidates will be given the same ranking in a group when tested for foveal and extrafoveal powers of adaptation.

[3] For the details of this study see C. E. Ferree, G. Rand and M. R. Stoll, *British Jour. Ophthal.*, 18: 673–687, 1934.

than total amount or range of adaptation. That is, what the night flyer needs more than anything else is the power to change his vision quickly from the illuminated cockpit and instrument panel to the outside world and back again. In this connection it may be noted that the transition from outside back to the cockpit does not present so serious a problem because light adaptation takes place with very much greater rapidity than dark adaptation. What problem there is comes from the fact that until sufficient light adaptation has taken place a disturbing dazzle may be present. In most cases at medium intensities this effect will disappear in a few seconds. If found necessary, a test for this can easily be devised. However, in relation to fitness for night flying it is perhaps well to point out again that neither speed nor amount of change in sensitivity is as important as place in the scale of sensitivity at which the adaptive change occurs. That is, it is quite possible that a candidate might have a good range and speed of adaptation and still a comparatively poor power to see at low illumination both at the beginning and at the end of dark adaptation. Such a person would obviously be unfit for night flying. The night flyer should have normal or better-than-normal ability to see objects the instant he looks from the cockpit to the outside world, as well as normal or better-than-normal power to increase this ability as dark adaptation is prolonged. The point should be tested, not assumed; that is, the test should be made at the beginning as well as at the end of the period of adaptation selected.

For testing the amount or range of adaptation the light minimum can be determined at the beginning of dark adaptation and at the end of some interval of suitable length, preferably 20 or 30 minutes for the approximate total range. A good conception of the amount of adaptation that may be expected in a group of non-pathologic observers may be obtained by inspecting the curves of Fig. 1; also a fairly good conception of the range of individual variation in this amount, although these curves were not plotted specifically to bring out this point.

For testing speed of adaptation obviously many possibilities are presented. These will be discussed in detail in other papers. In this paper we shall limit ourselves to the suggestion of a routine procedure that will give information on all the essential points noted above as important in rating fitness for night flying.

The instrument recommended for these determinations is the Ferree-Rand Light Sense Tester in the simplified form manufactured by the Bausch and Lomb Optical Company (Fig. 2). This instrument possesses many unusual features which render it easy and convenient to make accurate studies of the light

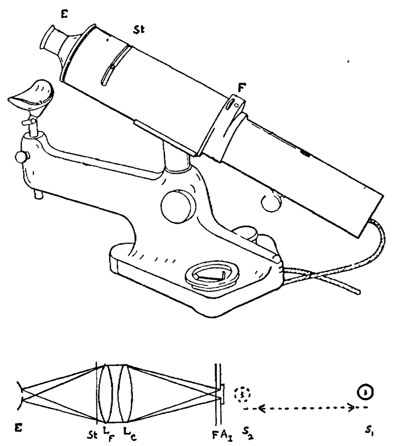

FIG. 2. Simplified light sense tester with diagram of its optical system. S_1, source of light in far position; S_2, source of light in near position; A_1, intake aperture with diffuser; F, battery of filters; L_C, collimating lens; L_F, focusing lens; S^t, plate containing stimulus aperture; E, eyepiece.

sense and the effect of dark adaptation on the light sense. Some of these are: (a) All variable effects due to size of pupil, also as far as is possible to accommodation, distance of projection of the image and condition of refraction are eliminated from the results. (b) For the determination of amount and rate of adaptation a pre-exposure field variable in size is provided, surrounding and including the test field. (c) The test field may be quickly varied in size through a visual angle ranging from near zero to 36 degrees and given any shape that is desired. (d) A scale is provided indicating the amount of light entering the eye expressed in lumens per sq. mm. of test field. (e) The instrument can be used with equal facility in any state of adaptation, light or dark, and all adjustments can be made without interfering with the state of adaptation of the observer. Further, all scales can be read by the examiner in the dark. (f) The instrument is completely self-contained, neat and compact in construction and conveniently portable. (g) Provisions are also made for producing a wide range of intensity of light in both pre-exposure and test fields without change in the color or composition of the light, for making an objective check on the judgment and for checking the constancy of the amount of light delivered at the pupillary aperture of the instrument for any given reading of the scale.

The test should be made as follows. After a suitable period of adaptation, perhaps 3 to 5 minutes, to the pre-exposure field of the instrument, the light minimum should be determined and then redetermined after 2, 3 or 5 minutes of dark adaptation as may be desired. From the results obtained, the sensitivity of the light-adapted eye may be derived, the rate of gain in sensitivity for a given period of dark adaptation, and the sensitivity at the end of this period. This would seem to give the most important information needed; namely, the light sensitivity of the light-adapted eye, the sensitivity that may be attained after a selected period of dark adaptation and the speed of dark adaptation. This information would enable the examiner to exclude eyes defective in power to see at low illumination when either light-adapted or dark-adapted (hemeralopia, avitaminosis, etc.) and to select the best of the normal eyes.

In our thinking as to the comparative importance of pilot fitness as a safety factor in aviation, it is well to keep in mind a statement made by Major-General James E. Fechet (Ret.), formerly chief of the U. S. Army Air Corps.[4] Discussing the causes of airplane crashes, he says that in more than half the number of cases these crashes are due to personnel error or to undetermined causes. In the personnel group he includes the pilot, the weather man, the airline operations manager and the mechanic. A small per cent. of these crashes—less than five, he says—is due to mechanical failure—engine malfunctions, breakage of some part of the plane or its essential accessories. From this it seems that not the plane but its operation is chiefly at fault.

C. E. FERREE
G. RAND

SPECIAL ARTICLES

HUMAN TOXOPLASMOSIS: OCCURRENCE IN INFANTS AS AN ENCEPHALOMYELITIS VERIFICATION BY TRANSMISSION TO ANIMALS*

A PROTOZOAN encephalomyelitis in infants, described in recent years,[1, 2] has been experimentally transmitted to animals and shown to be due to a Toxoplasma. The latter is a Protozoan which in smears appears of crescentic shape, measures 4–6 microns in length and 2–3 microns in width. It is pointed at both ends or has one blunt end and has a central chromatin body. Although it is of uncertain classification, it is characterized by an affinity for many tissues, especially the central nervous system, wide-spread geographic distribution and pathogenicity for a wide variety of hosts. In spite of the last, human infection has not hitherto been established, one report being very doubtful.[3] Its occurrence is now proved by the recent transmission of the infection to animals from an infant.

The child became ill at three days of age and developed convulsive seizures, disturbances in respiration and symptoms of involvement of the spinal cord. Terminally, irregular reddish-brown areas were observed ophthalmoscopically in each macular region. The infant died at the age of 31 days. Autopsy, limited to the nervous system, revealed a wide-spread encephalomyelitis, characterized by focal areas of inflammation and necrosis, and disseminated miliary granulomas. The right eye showed a localized chorioretinitis. A Protozoan morphologically identical with Toxoplasma was present in all the lesions.

Fresh tissue removed from lesions in the cerebral cortex and cervical spinal cord five hours postmortem was emulsified in sterile physiological saline. Four rabbits, 26 infant mice and 9 rats were inoculated with the emulsion intracerebrally. Eighteen infant mice were cannibalized by the mothers, but of the remaining 8, 6 showed the following evidence of having been infected: (1) They became ill and were sacrificed or died in from 18 to 40 days. (2) They showed lesions in the central nervous system resembling those seen in the human case. (3) Protozoa like those in the nervous system of the infant were present in the lesions. (4) Transmission to rabbits and mice was attempted from 4 of these mice and was successful in each instance, using brain tissue for intracerebral inoculation with the production of similar lesions containing parasites, and further successful serial passages. The other mice showed a meningo-encephalitis but no parasites.

Three of the rabbits died in from 9 to 13 days and showed a meningo-encephalitis. Parasites were found in the lesions in 2 and successful transmission of the infection to rabbits and adult mice by intracerebral inoculation of emulsified brain was carried out from each of the 3. The fourth rabbit and the 9 rats showed neither clinical nor pathological evidence of infection. Excluding 18 cannibalized infant mice and 6 rats dying shortly after inoculation apparently of cerebral trauma, one finds that 9 or three-fifths of the remaining 15 animals became infected. That this was not a spontaneous infection activated by the inoculations is evidenced by (1) the high percentage of infection following the inoculation of the human material, (2) the fact that toxoplasmosis has not been described in rabbits or mice in North America and (3) the absence of similar infection in many animals of the same stock similarly inoculated with other materials.

* Investigation aided by a grant from the Friedsam Foundation.

1 A. Wolf and D. Cowen, *Bull. Neur. Inst. N. Y.*, 6: 306, 1937.

2 A. Wolf and D. Cowen, *Ibid.*, 7: 266, 1938.

3 J. O. W. Bland, *Lancet*, 219: 52, 1930. *Brit. Jour. Exper. Path.*, 12: 311, 1931.

4 J. E. Fechet, *Flight Surgeon Topics*, School of Aviation Medicine, Randolph Field, Texas, 1: No. 2, 44–48, 1937.