brethren, have come to possess a new interest for Americans in connection with our recently acquired possessions.

To the question, "Can Anglo-Saxons ever become completely acclimatized in the tropics?" a more or less guarded negative reply has been given by probably a majority of the most eminent authorities. This, it will be observed, does not mean that Anglo-Saxons cannot live in the tropics under conditions of special caution. It does imply, in the minds of its advocates, that Europeans can never expect to perform the same work under the same conditions as the natives. If this be the case, it presupposes the continuance of a distinctively menial or servile class as a permanency, which appears to be inconsistent with the theory of a purely democratic colony.

In favor of the pessimistic view regarding tropical acclimatization are urged the high death rate, the physical deterioration, and the reduced fertility of Europeans in the tropics. The first two of these considerations are certainly matters in which the improved sanitation of recent times may be expected to count for much. In fact, the annual mortality of European troops in India, which prior to 1859 had been 69 per 1,000, has now fallen to 12 per 1,000. The death rate of European children in India is considerably less than that of native children, and in some colonies compares favorably with that in many districts of Europe.

Whether, as has been sometimes claimed, white families in the tropics are likely to die out, is difficult of demonstration, because the stock is liable on the one hand to be reinforced by fresh European immigration, or on the other to be deteriorated by mixed marriages. But a paper presented at the Seventh International Congress of Hygiene and Demography by Sir Clements Markham shows that families of pure European blood had been settled in tropical places for more than two centuries without any deterioration, mentally or physically, of the later, as compared with the earlier representatives.

Regarding fertility as affected by removal of Europeans to the tropics, great diversity of opinion has existed. The analogy of plants seems to suggest a loss of fertility, at least temporarily, from a change of climate. For example, the chrysanthemum is said to have remained infertile for sixty years after its transplantation from China into France, so that the seed had to be continually imported. But after that time fertility began to be regained, till now the species propagates itself. European fowls, which when first brought to Bolivia became sterile, later regained their fecundity.

Regarding the human species, however, we are liable to error in judging from cases in which infertility is due to crossing of the breed with inferior races; or when possible lack of fecundity is overcome by fresh European admixture. Yet, as against a permanent sterility of pure European families in the tropics there are abundant instances. It is said that Spanish women in Guayaquil, at a temperature rarely below 83° F., are exceedingly prolific, and that the French have a higher birth rate in Algeria than in France.

In general, we may say that it is not temperature or climate intrinsically which is the obstacle to acclimatization. Physiology has shown the marvellous adaptability of man to withstand the widest ranges of thermometric variation. Moreover, anthropologists agree that mankind is all descended from one primitive stock. Hence man *has* acclimatized himself, as a matter of fact, wherever by successive migrations he has permanently occupied new fields.

The only important obstacle, then, to acclimatization is pathogenic organisms, and not temperature.

The diseases to which a European is especially subject on removing to the tropics are yellow fever, dysentery, hepatitis, anæmia, and malaria. The first of these, yellow fever, constitutes the greatest immediate danger for the unacclimated stranger. The Creole population, as is known, are largely exempt from susceptibility to this disease, though even they, after having resided for a time in the temperate zone, have to go through an acclimatization on their return before they are safe from the disease. Their acclimatization is more quickly accomplished, however, than that of the European. Immunity against this fever is gained by a previous attack, and also by having passed through an epidemic of it, even without having contracted the disease. The time necessary to secure absolute safety against yellow fever is variable. The other tropical diseases which impede acclimatization—dysentery hepatitis, etc.—afford no security against yellow fever.

Dysentery, which is perhaps, next to yellow fever, the most fatal obstacle to the acclimatization of Europeans in the tropics, is rarely, except in great epidemics, fatal at the first attack; but with successive years it is apt to recur, either as dysentery or as chronic diarrhœa. Many of the cases are now known to be due to the *amœba coli*. The British Admiralty, on the theory that the mortality of the colonial troops from this cause is in direct ratio to the period of their stay in the tropics, removes and replaces such garrisons at short intervals, while the French Government sends annually to her colonies transports to carry away those soldiers who have become enfeebled by relapses and recurrences of dysentery. A certain number of individuals can never become acclimated to this disease, and find relief only by a return to temperate climes.

Another obstacle sometimes fatal to acclimatization, but of rarer occurrence, is hepatitis. This may be either primary, due to heat or malarial infection—in the latter case the enlargement of the liver being analogous to the accompanying splenitis; or the hepatitis may be secondary to dysentery, in which case abscess of the liver may result, usually with a fatal ending. These hepatic abscesses are said to be more common in Europeans than in Creoles after a dysentery. Other liver diseases, cancers, hydatids, and icterus, due to affections of the gall bladder and ducts, are said by Dr. Saint-Vel, in his work, "Hygiène des Européens dans les Climats Tropicaux," etc., to be rarer in the torrid than in the temperate zone, in spite of the common belief to the contrary.

A degree of anæmia may be considered physiological in hot countries. But it not unfrequently becomes excessive, interfering with the nutrition of the body and combining with a certain amount of malarial poisoning, and perhaps also of hepatitis, to impart the doughy, pale, and sallowish tint not uncommon in those who have lived long in the tropics. This anæmia, sometimes amounting quite to a cachexia, is most extreme in the immediate neighborhood of the equator, growing less with every degree of latitude, and is by no means confined to the white race, though it is only as it occurs to Europeans seeking acclimatization that it deserves mention in this connection.

Intermittent and remittent fevers, now known to be due to the various species of malarial organism, and other manifestations of malarial cachexia are the obstacles which most commonly stand permanently in the way of acclimatization. Recent observations have shown that malaria exists, at least in the northern hemisphere, nearly as far up as the Arctic circle, and the deadly nature of the Tuscan Maremma (lat. 43°) has even given a name to the disease. Still, the most virulent types of the disease are of tropical origin. An individual may resist these influences for a time, to fall a victim without any apparent change either in his own carefulness or in the nature of the surrounding miasmatic influences. Malaria is not confined, like yellow fever, to the coast regions, but is distributed widely. High altitudes are not exempt from it, and it was found by Curran even on the chain of the Himalayas. Still, it is more common in lower levels where vegetation once covered with moisture is left, by a subsidence of the water, exposed to the atmosphere. There are some regions, as, for instance, parts of Senegal, Madagascar, and French Guiana, where the malarial influence is so strong that, while individuals have overcome it, it may be said that, as a race, Europeans hitherto have failed to become acclimated.

In passing from the tropics to the temperate zone, the obstacles in the way of acclimatization are much less than when the emigration is in the other direction. The transi-

tion of seasons from the heat of summer to the cold of winter has a tonic effect, and is favorable to those suffering from anæmia, hepatitis, and malaria. Certain inflammatory chest affections, however, are liable to be caused in Creoles by a northern winter, as well as some cutaneous diseases dependent perhaps on the change in the amount of perspiration. It is often claimed that persons removing to the temperate zone are in special danger from phthisis. Dr. Saint-Vel (*loc. cit.*) says that the reverse of this is true. Some negroes die of tuberculosis in the hospitals, but there are usually circumstances of special exposure in these cases, while those negroes who are well cared for and live at service are remarkably free from phthisis. Confusion has perhaps been made of the negro with the monkey in this respect, but the tuberculosis so common in the latter animal is due to his confinement and to other conditions not obtaining in the case of the negro. The experience of all the Northern States of our country shows that the negro acclimates well in the temperate zone; but observations are wanting as to his power of adapting himself to really cold climates.

The Creoles residing in France are particularly long-lived. Their acclimatization is said to be more readily accomplished than that of whites returning after a long residence in the tropics; but, as a whole, the effect of removal from lower to higher latitudes is more beneficial than that of moving in the contrary direction. Arctic animals do less well in temperate regions than those from the tropics.

Hygiene of Acclimatization.—Hygiene can do something to overcome the obstacles in the way of acclimatization. It is especially important in combating dysentery, anæmia, and malaria. Contrary to what has been sometimes taught, a robust frame is an assistance to acclimatization. The immigrant to the tropics should, if possible, reach his destination in the cool season, that the transition may be as moderate as possible from his native clime. For the same reason the tropical emigrant should reach the temperate zone in the summer. In going to the tropics one should not deprive himself wholly of a meat diet, though of course less meat and very little fat are required. The food should be sufficient in all its constituents to keep up the strength. Alcoholic excess is to be especially avoided. The light wines are much preferable to spirits. A slight diarrhœa is to be checked at once, as otherwise it may run on to the severe chronic intestinal fluxes. The dwelling should be situated high, with the sleeping-room on the second floor. Alluvial bottoms are to be avoided as places of abode, and the domicile should not be erected in the track of breezes blowing over marshy districts. Exposure to the night air is unwise, especially when there is a fog hanging about. Food should be taken before going out in the morning, and a daily dose of quinine should be made use of.

Reference should be made to the probably important part played by certain insects, notably the mosquito, in the communication to man of malaria and possibly of other diseases that have given to some tropical regions an unsavory reputation for deadliness to Europeans. If the teachings of Koch and other believers in the mosquito inoculation of the malarial parasite be confirmed, the employment of nets and bars will assume an important part in the hygiene of acclimatization.

Direct exposure to the equatorial sun during the middle of the day should be avoided. Only the natives can withstand its fierceness. On the other hand, draughts, especially of night wind, should be as carefully avoided as in temperate climes. While the clothing should of course be light, it should be of cotton rather than linen, and merino undergarments should be worn, and changed frequently in order to keep the large amount of transuded moisture absorbed. Nostalgia, which retards acclimatization, should be avoided as far as possible. If society is wanting, work must be relied upon to take up the mind. It is said that the workers acclimatize more readily than the idlers in hot countries. Of the various forms of exercise, which is always so important from a hygienic point of view, riding and driving are especially desirable in warm countries. Cool and cold baths daily are of use. The advantages of hydrotherapy are often combined with those of high elevation in the sanatoria which are located in the mountainous districts (where such exist) in many warm countries, and whither the half-acclimated European repairs from time to time with much benefit to paludic, dysenteric, and hepatic affections. Finally, if dysentery obstinately recurs in the high altitude, or if the system does not throw off miasmatic impressions, it is better, after a reasonable time, to abandon the attempt at acclimatization and return to a temperate climate. The ocean voyage will be likely to cause some relief, and after a reconstitution of the bodily powers in the home country, a second attempt at acclimatization may be more successful.

Charles F. Withington.

ACCOMMODATION AND REFRACTION. See *Eye, Dioptrics of.*

ACCOMMODATION AND REFRACTION, DISORDERS OF.—Accommodation is the name adopted to designate the adjustive power of the eye for distinct vision at different distances. As used in modern ophthalmology, it may be more narrowly defined as the power of active optical adjustment of the eye for near vision. In the case of the normally proportioned (emmetropic) eye, the eye, in a state of rest, is adapted for distinct vision at a distance, the accommodation coming into play to increase the optical power (refraction) of the eye to meet the requirements of distinct vision at shorter distances.

The existence of an active accommodative adjustment, effected through an increase in the convexity of the crystalline lens, was demonstrated by Thomas Young (Philosophical Transactions, 1801), but the validity of his proofs was not generally recognized until fully half a century later. The first actual observation of the change in curvature at the anterior surface of the crystalline lens, by Maximilian Langenbeck (1849), was confirmed (1853) by A. Cramer, who, by the employment of more refined methods, measured both the increase in curvature and the position of the anterior lens surface. This was followed closely in time by the wholly independent and altogether admirable research of H. Helmholtz (1855), which definitively established the fundamental theory of accommodation on an exact mathematical basis. Tscherning, who has lately taken up the subject anew, (1894, 1895), has brought to light important additional details.

The changes in the eye in accommodation consist in (*a*) a notable increase of convexity in a central area of the anterior surface of the crystalline lens, (*b*) a much smaller but positively demonstrated increase of convexity in a central area of the posterior surface of the crystalline lens, and (*c*) a slight displacement forward (*i.e.*, in a direction toward the posterior surface of the cornea) of the anterior lens surface; the position of the centre of the posterior lens surface remaining unchanged.

Accommodation is accompanied by active contraction of the pupil, the effect of which is to stop off all but a comparatively small central portion of the crystalline lens, thus excluding the peripheral portions of the lens from participation in the formation of the retinal image. Both accommodation and the accompanying pupillary contraction are essentially binocular acts, and they are sensibly equal in the two eyes. They are, moreover, associated with convergence of the visual axes upon the object for which both eyes are accommodated, thus making it possible to see near objects single, as well as distinctly, with the two eyes.

These several adjustments, which go to make up the complex act of binocular accommodation, are co-ordinated under the control of the third (common motor) pair of cranial nerves. Thus the impulse to accommodate, in order to see a small near object distinctly, evokes not only the needful lenticular and pupillary changes in both eyes, but also the simultaneous action of both recti interni muscles, resulting in convergence corresponding to the distance of the object. Similarly, the impulse to converge the visual axes, in order to make the two retinal images fall each at the central fovea in its own eye and so to prevent the confusion incident to double vision, evokes a simultaneous and equivalent accommodative change, with contraction of the pupil, in both eyes.

The physiological bond by which accommodation and convergence are co-ordinated is, however, elastic, within certain limits. Thus the relation of the two adjustments may be altered, for the time being, by looking through concave or convex glasses, or through divergent or convergent prisms, so as, with unchanged convergence, to force or to relax the accommodation, or, with unchanged accommodation, to increase or to diminish the convergence. Such experiments are, however, fatiguing, and cannot, as a rule, be long continued without giving rise to a vivid sense of discomfort and of functional disturbance.

Again, the relation of accommodation to convergence is progressively changing, from youth to old age, in connection with the physiological increase in the hardness of the crystalline lens, which nevertheless first makes itself seriously felt after middle life as an accommodative insufficiency under the familiar aspect of *presbyopia* or old sight, in which reading becomes difficult or impossible at the ordinary distance of holding the book.

Again, there are many persons, subjects of anomalies of the eyes which involve notable variations in the relation of accommodation to convergence, who nevertheless experience no difficulty in the habitual free use of the eyes in near work, or perhaps even imagine that they enjoy exceptionally good vision. These are, however, generally cases of a congenital anomaly, or else of one which is of gradual development, giving time for a correspondingly gradual change in the relation of the two adjustments one to the other.

The accommodative power which the eye can bring into exercise is called the *range of accommodation*; it is conveniently measured in units called dioptries, one dioptrie (1 D) being equivalent to a convex lens of 1 metre focal length.

The maximum range of accommodation for any eye is attained when the fellow eye is covered, or otherwise excluded from participation in the visual act, and is free to assume a position of extreme convergence. This maximum range is called the *absolute range of accommodation*. The range of accommodation for the two eyes together, under convergence for any particular distance, is called the *relative range of accommodation*.

The relative range of accommodation varies greatly for different distances. Thus Donders (1858) found that in a young person of the age of fifteen years, it was possible to accommodate with either eye singly up to a distance of 3.69 Paris inches (about 10 cm. $= \frac{1}{10}$ metre), indicating an absolute range of accommodation of about 10 D. With the two eyes together, it was possible to see distant objects distinctly through concave glasses of any power up to a limit of 11 Paris inches (negative) focal length (about 29.7 cm. $= \frac{1}{3.37}$ metre), indicating a relative range of accommodation of about 3.37 D under parallelism of the visual axes. Under convergence for a distance of 3.9 Paris inches (about 10.5 cm. $= \frac{1}{9.5}$ metre) it was just possible to accommodate for that distance, but it was also possible to see distinctly, with the two eyes, through convex glasses of any power up to a limit of 9 Paris inches (about 24.3 cm. $= \frac{1}{4.1}$ metre) focal length, indicating a negative relative range of accommodation of about −4.1 D. Under higher grades of convergence, *i.e.*, for distances less than 3.9 Paris inches (10.5 cm.), it was impossible to accommodate, with the two eyes, for the distance of the point of intersection of the visual axes; in other words, distinct binocular vision was possible only at distances greater than about 10.5 cm. ($\frac{1}{9.5}$ metre), indicating a *binocular range of accommodation* of about 9.5 D. Under convergence for all distances greater than 3.9 Paris inches, it was found that the two eyes could accommodate for a distance less than that of the intersection of the visual axes, and also for a greater distance; in other words, the relative range of accommodation was in part positive and in part negative. "This distinction acquires practical importance from the fact *that the accommodation can be maintained only for a distance at which, in reference to the negative, the positive part of the relative range of accommodation is tolerably great.*"—Donders.

Fig. 10 shows, in the form of a diagram, the series of measurements of the relative accommodation in the case cited, as plotted by Donders; the ordinates indicate dioptries of accommodation, and the abscissas the corresponding degrees of convergence, namely, for distances of 1 metre and aliquot parts ($\frac{1}{1}$, $\frac{1}{2}$, $\frac{1}{3}$, to $\frac{1}{20}$) of a metre.*

By inspection of the diagram it is seen that the positive part of the relative range of accommodation—*i.e.*, the part above the diagonal line KK′—appears only in convergence for distances greater than about 10.5 cm. ($\frac{1}{9.5}$ metre); at 12.5 cm. ($\frac{1}{8}$ metre) the positive part is about three-sevenths as great as the negative; at 33.3 cm.

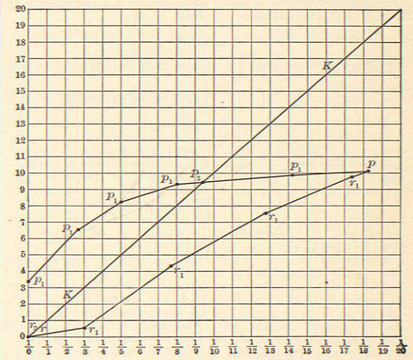

Fig. 10.

($\frac{1}{3}$ metre) the positive part exceeds the negative in the ratio of about 8 to 5.

These relations of the positive to the negative part of the relative range of accommodation correspond closely to actual conditions as learned from every-day observation of the working of the accommodation in young persons. Thus a child of say 12 years can ordinarily force his accommodation so as to see minute objects distinctly for a short time at a minimum distance of about 10 cm., using about 10 D of accommodation. At a little greater distance, about 12.5 cm., using about 8 D of accommodation, he can read for a much longer time, although not, as a rule, without a consciousness of effort leading to fatigue. At about 20 cm., using about 5 D of accommodation, the accommodation can often be maintained for hours together in close work, but not without incurring the risk of ultimate grave injury to the eyes when reading at so short a distance becomes habitual. The limit of ease and safety, for young persons, in long-continued use of the eyes in reading and study, is at about 33 cm. (about 13 English inches), or perhaps a little less, corresponding to an habitual use of not much more than 3 D of accommodation. At this limit of distance the relative range of accommodation is ample, and the positive part is at about its maximum.

* Fig. 10 has been slightly changed to conform to the metric system, which has come into general use in ophthalmology since the date of publication of Donders' work.