Wilson by Prof. Hale and his collaborators. Its adoption, however, has not been favoured, on account of the difficulty of figuring with optical perfection the thin glass faces and the edges of the honeycomb structure. In addition, doubts have been entertained as to the optical permanence of a heavy cemented structure subjected to wide ranges of temperature.

The plan which at the present moment appears most promising to the astronomers concerned is to make the mirror of fused quartz, a substance which possesses a very small temperature coefficient. The process consists of fusing a mass of nearly pure silica in a circular electric furnace which constitutes the mould. The disc thus obtained contains a large number of small bubbles, but it can be ground to the approximate curvature of the mirror desired and then coated to a sufficient thickness with perfectly transparent quartz free from bubbles. The final figuring is then carried out on the surface of this clear layer. The quartz composing the clear layer is sprayed on to the hot disc by means of multiple oxy-hydrogen burners. A 22-inch disc has already been constructed in this way, and it is now proposed to make a 60-inch mirror before finally embarking on the construction of the 200-inch mirror itself.

With regard to the figure of the mirror, it has been decided to construct it with a focal length of 55 feet, that is, with a focal ratio of f 3·3. The use of such a small focal ratio will give an immense concentration of light, but in common with all short focus mirrors the field of good definition will be small. It is proposed to remedy this defect by the use of a correcting lens, designed by Dr. F. E. Ross, which will be placed immediately in front of the photographic plate at the principal focus of the 200-inch mirror. Dr. Ross has in addition to this computed a correcting lens which will, it is hoped, reduce the equivalent focal ratio to f 2·2. Provision will also be made for a Cassegrain arrangement with an equivalent focal ratio of f 10. The convex mirror in this arrangement will be 60 inches in diameter.

The telescope will be mounted equatorially. The problem of the mounting will be an engineering enterprise of no mean dimension, and the lessons learnt and the difficulties met with and overcome in the mounting of the existing 100-inch telescope will doubtless be invaluable in this connexion.

Considerable attention is being paid to the selection of a suitable site. It is highly important that the efficiency of the 200-inch should not be impaired by poor seeing arising from atmospheric tremors. The experience gained with the 100-inch has shown that at Mount Wilson itself a 200-inch telescope could be depended upon to show a gain in keeping with its increased size. It is, however, probable that a still better site can be found in California, and the possibilities are being explored by observations at various sites with portable telescopes.

One of the proposed models for the 200-inch telescope, which is now on exhibition in the building of the National Academy of Sciences, Washington, D.C., is shown in Fig. 2. It should be mentioned that the plans include the provision of an adequate laboratory and workshop. W. M. H. G.

The Locust Problem.

By Dr. A. D. IMMS, F.R.S.

THE theory of the phases of locusts, advanced by B. P. Uvarov in 1921, is now well known to entomologists and has proved a fertile stimulus to further investigation of this important problem. It recognised the existence among these insects of two definite or extreme forms—one gregarious and the other solitary — which are connected by a continuous series of less defined transitional forms. Messrs. B. P. Uvarov and B. N. Zolotarevsky[1] have recently discussed certain aspects of the problem, in the light of new observations made by S. A. Predtechensky in Russia, and by the junior author in Madagascar. Although their remarks apply more especially to the well-known species *Locusta migratoria*, these authors believe that a standard phase nomenclature, applicable to all species, would be both possible and advantageous. According to their interpretation a locust can exist in three unstable biological phases, namely, a solitary one, *phasis solitaria*: a gregarious one, *phasis gregaria*, and a transitional phase between these two which they term *phasis transiens*. These phases differ from each other in morphological and colour characteristics, on one hand, and in biological features (mainly behaviour) on the other. Whether it will prove possible to distinguish such phases solely by the convenient method of examining their morphological characters, can only be determined by studying the whole series of phases of a given locust in a specific locality.

The solitary phase consists of isolated individuals and is represented where no swarms exist, or have existed, within at least one preceding generation. The transient phase is not represented by any definite form, but by a continuous series of transitional forms between the solitary and gregarious phases. Such a series may be observed either (*a*) when the transformation is from the solitary phase towards the gregarious phase, when it may be termed *phasis congregans*; or (*b*) the tendency is in the opposite direction, when it is termed *phasis dissocians*. These two phases are, therefore, essentially of a biological nature, but it appears that it may be posssible to distinguish them also by minor details of structure and colour. The gregarious phase is that assumed when individuals form dense and extensive emigrating swarms (Fig. 1). Recent studies of *Locusta migratoria* have shown that, although this species is a very

[1] Phases of Locusts and their Interrelations. *Bull. Entomological Research*, **20**, pp. 261-265, Oct. 1929.

definite unit, it exists as three subspecies, namely, *rossica* in Central Europe and possibly Western Europe, *migratoria* (*sensu str.*) in south-east Russia and *migratorioides* in the tropics and subtropics. Each of these subspecies may pass through the three phases already mentioned, but it is possible that all may not prove to be equally polymorphic. The application of this theory to other species indicates that, in the past, the solitary and gregarious phases being in most cases so distinct they have hitherto not been recognised as such. Great confusion has naturally resulted, since they have been regarded as distinct species under separate names. From the practical point of view of locust control it is, obviously, of prime importance to study the behaviour of these insects in the light of Uvarov's theory. The theory lends a new interpretation of the causes of locust outbreaks, and by directing research along a defined course it will co-ordinate investigation, hitherto largely prosecuted blindly in the hope of eventually alighting upon some solution of the problems concerned. It opens up the possibility that transformation of locusts into the gregarious phase may sometimes be circumvented, and the location of the breeding grounds of the latter phase may lead to the destruction of immense numbers of potentially harmful individuals. This aspect of the subject is fully discussed in Uvarov's recent treatise [2] on locusts, which has already been noticed in these columns.

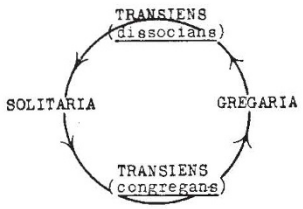

FIG. 1.

On April 29 of this year the chairman of the Committee of Civil Research [3] appointed a scientific sub-committee of ten members under the chairmanship of Sir Henry Miers, with the following terms of references :

"To consider and report on :

(*a*) Means for the mass destruction of the Desert Locust *Schistocerca gregaria* Forsk.

(*b*) Methods for ascertaining the reasons for the periodic swarming of this species with a view to its control."

The depredations of the Desert Locust are of immediate concern to the Empire, since an enormous area of British Africa is periodically affected besides Palestine, Transjordania, and Iraq. In Kenya, for example, it is mentioned that £50,000 has already been spent on control and relief measures with respect to an outbreak of this insect which is still continuing at the present time. The Kenya government has now taken power to prohibit all exports of foodstuffs from the territory, and the Legislative Council has passed a resolution authorising expenditure up to £200,000 to the Food Control Board to enable it to discharge its function.

As a preliminary step the Committee of Civil Research has issued two reports of the Locust Sub-Committee which were presented to Parliament in July 1929. In the first report it was recommended that the collection of information from all available sources respecting the habits and behaviour of the Desert Locust should be proceeded with forthwith. This information should be collated and distributed to the territories affected by the insect in question. In order to effect this scheme, it was recommended that financial arrangements should be made to enable the Imperial Bureau of Entomology to commence this work. In its second report the Sub-Committee drew up a draft scheme of the research it deemed necessary to be carried out, and stress was laid upon the possibility of employing aeroplanes for purposes of reconnaissance and perhaps also for the destruction of locusts. It recommended that colonial governments, interested in this specific locust problem, should be communicated with and invited to indicate whether they would assist by contributing to the cost and by providing local facilities if a proportional Imperial contribution could be arranged. It also suggested that communication, in a similar sense, should be made for the purpose of obtaining the views of the Government of India. With the object of obtaining the fullest information possible respecting the Desert Locust, it is further suggested that inquiries should also extend to foreign territories affected by the insect in question.

About the middle of the present year evidence of the enormous destruction occasioned by the Desert Locust in Palestine had come to hand in the form of an article by Mr. G. E. Bodkin,[4] Government Entomologist. The history of locust invasions in Palestine indicates that these visitations have occurred in recent years with remarkable regularity. Thus 1865, 1878, 1890, 1902, 1915, 1928 are marked by visitations of this insect—an unvarying period of 12-13 years elapsing between the events. The year 1915 was a most disastrous one, and in the Jaffa district alone damage to the extent of about £200,000 is stated by Mr. Bodkin to have resulted from locust depredations. Since the destruction was practically universal in Palestine the damage in the whole country reached a colossal figure. The suffering endured by the population, as it happened, was alleviated to a marked degree by the War, which involved the occupation of Palestine by the British army. The large supplies of food thus brought in, and the liberal payment for services rendered, helped the population at a time when it was demoralised by the destruction of a means of livelihood.

Palestine was visited by another invasion in 1928, and the chief facts respecting this event are recounted in Mr. Bodkin's article. It appears that there were three successive waves of invasion, but, by comparison with the event of 1915, they were but light. Ability to anticipate such an occurrence resulted in very little serious damage being incurred. The appearance of the Desert Locust in Hauran and in Egypt the previous year gave timely

[2] "Locusts and Grasshoppers." London, 1928.

[3] Committee of Civil Research. Locust Sub-Committee. First and Second Interim Reports. London. H.M. Stationery Office, 1929. Price 3*d*. net.

[4] "The Locust Invasion of Palestine during 1928." *Bull. Entomological Research*, **20**, pp. 123-139, Aug. 1929, with 3 text figs. and 3 plates.

warning, and preparations for a control campaign the following year were soon embarked upon. Consequently, 1928 was the first time that locust invasions in Palestine were combated with an adequate organisation of material, equipment, and personnel. The campaign was assisted by the drought, which rendered the ground unsuitable, for the most part, for the insects to lay many of their eggs.

The nature of the control measures that were applied can only be briefly mentioned here. The destruction of the winged locusts, prior to egg-laying, means the elimination of hordes of potential young locusts, and Mr. Bodkin describes a type of flame-thrower devised for this purpose. These machines did good service at night owing to the habit of the Desert Locust of clustering in dense masses at that time. The arming of large numbers of villagers with hand nets resulted in further destruction, and they also assisted by encircling swarms of gravid locusts, and slowly driving them to a common centre, to be exterminated by use of flame-throwers. The methods prosecuted were so efficient that most of the egg-laying became restricted to the Jericho district. The resulting young locusts or 'hoppers' were destroyed by spraying with kerosene emulsion, and later by fire and by means of arsenicals. Mr. Bodkin's instructive and timely report should do much to encourage those who have to encounter the same menace in other lands. It is evident that adequate preparation, and the application of the right measures coupled with a knowledge of specific locust behaviour, were collectively responsible for the good results achieved.

The Palestine outbreak is directly related to a much more formidable and simultaneous invasion by the Desert Locust of the southern Sudan, Kenya, and Tanganyika Territory. The duration of this menace cannot be foretold with certainty, but it appears probable that it will continue until 1931. The reports of the Committee of Civil Research synchronise, therefore, with a recurrent outbreak of first magnitude. This fact should serve to stress the urgency of carrying out the procedure advocated with as little delay as possible. A judicious expenditure of £20,000 or £30,000 in the course of four or five years should reap benefits out of all proportion to the money so devoted. The greatest need is for exact information on the behaviour and habits of the Desert Locust, and the co-ordination of such information from as many sources as possible. Without this knowledge, we shall be merely groping in the dark for many years to come simply because there is no adequate foundation to work upon.

Irradiation and Health.

THAT exposure to sunlight or some source of ultra-violet, luminous, or heat rays has a beneficial effect upon general health has been claimed by many competent observers. That insolation is of great value in the treatment of various forms of tuberculosis may be taken as well established, although the cooling power of the open air, as well as the sun's rays, plays a part in the favourable effects produced. Again, that vitamin D is formed from ergosterol in the skin when the latter is exposed to ultra-violet light has been definitely shown, as well as the development of an increased bactericidal power in the blood, after suitable irradiation of the same organ. But whether such effects are accompanied by an increase in the resistance of the body to infection has not been satisfactorily demonstrated, in spite of a very general impression that suitable exposure to a source of light does improve the general health. Colebrook [1] has therefore submitted this question to an experimental study, and at the same time has investigated the influence of light upon the rate of healing of a purely local infection.

In the first investigation the influence of light upon the health and development of school children was studied: their ages ranged from five to seven years, and the period of observation extended from August 1927 to March 1928. They were divided into three groups, upwards of a hundred children in each: one acted as a control, the others were exposed, clad in bathing slips only, three times weekly to a direct current long-flame carbon arc lamp; in one of these the light from the lamp was screened by glass, so that only rays longer than about 3342 A. reached the children. The dosage aimed at was one which would just fail to give an erythema reaction on the skin of a child of average sensibility: it was gradually increased by diminishing the distance of the child from the lamp, by increasing the time of exposure, and also the output of the lamp. Pigmentation of the skin was produced in a number of the children by the treatment. The groups were selected to be as similar as possible as regards ages and types, and it was considered that the home conditions were, on the average, also similar in the groups and were such that any benefit due to the irradiation would be easily seen and not counteracted by a poor home environment.

The progress of the children was followed by recording height and weight at intervals, by frequent observations of the occurrence of chilblains and colds, or other infections, and by noting the subjective impressions of the medical officer, teacher, and parent. The results were, in brief, that exposure to light had almost no beneficial effects whatever: in fact, the advantage was usually to the control group as compared with the lamp groups, or to the screened lamp group as compared with the unscreened. However, as regards progress in schoolwork, exposure to light, especially the screened lamp, appeared to be of favourable influence, whilst the unscreened, and

[1] Medical Research Council. Special Report Series, No. 131: Irradiation and Health. A: Ultra-Violet Irradiation of School Children; B: Irradiation of Varicose Ulcers. By Dora Colebrook. Pp. 47. (London: H.M. Stationery Office, 1929.) 1s. 6d. net.