

## Locusts as an International Problem.

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THE statement that locust swarms recognise no boundaries has become a truism but until recently these vagabond tendencies of locusts served only to accentuate international discord. Reports on locust control published by various governments in most cases refer to the excellent results attained locally and to the futility of local efforts in view of the inactivity of the neighbouring countries. Such statements are sometimes true, but more often they are wholly, or partly, incorrect. In any case, there was often more unity between locust swarms bred in the neighbouring countries, than between their respective government departments, to the obvious advantage of the insect.

The necessity for co-operative action against the common enemy has been, of course, realised, but this co-operation is usually wrongly conceived. It is often argued that a locust invasion affecting several countries can be brought to an end, if only all these countries would agree to adopt vigorous control methods and to see that they are carried out. Painful experience of the last invasion of the African continent has proved beyond doubt that an outbreak, once it has been permitted to develop on a really large scale, is beyond practical possibility of being controlled. This is due to the enormous extent of invaded areas, many of which are sparsely, or not at all, populated. Further, the rate of multiplication of locusts is such that when only a small percentage of swarms of one generation escape destruction, the number of their progeny will be just as great as before, or even greater. The only practical policy at the height of an invasion is to concentrate all the efforts on the defence of standing crops. This defensive policy can be very effective, but it does not contribute to the solution of the problem.

The problem must, obviously, be approached from a different direction. It has been always known that locust outbreaks are not a permanent phenomenon, but there is a certain irregular periodicity in their development. Moreover, they always

arise first in somewhat restricted areas and only gradually the swarms spread over whole countries and continents. These two points suggest that it should be possible to prevent widespread invasions by concentrating the early efforts in the areas which can be regarded as original sources of the swarms. This conception remained on a purely theoretical basis until recently when the advances made in the study of locust biology and of the factors governing outbreaks have provided a firm foundation for formulating a practical policy of the prevention of locust outbreaks.

The fact of primary importance in this connection was the discovery of the phase variation in locusts. This phenomenon consists in the ability of locusts to develop in two forms, or phases, the solitary and the gregarious, which differ widely in their colouration, structure, physiological reactions and therefore, habits. A thorough experimental study of phase variation commenced only quite recently, but there has already accumulated a considerable amount of information on them, which it would be out of place to review here. It is sufficient to say that the majority of workers on the problem agree that the gregarious phase can be produced in any locust by breeding the larvæ in a dense crowd, *i.e.*, the density of population within a restricted area is the factor causing the transformation. The result of this transformation is a compact swarm of gregarious locusts differing from the original solitary ones in greater rate of activity and in the striking tendency to remain in close proximity to each other which ensures the existence of a swarm as a single unit.

If it is not difficult to obtain any desired density of the initial locust population in experimental cages, the question arises how can a crowding occur under natural conditions in the field. Suggestions have been made that a natural population of solitary locusts may become sufficiently dense to start the transformation merely as a result of a general increase in the numbers of locusts. Such a phenomenon,

however, has never been observed, while, on the other hand, definite observations have been made on the mechanism of phase transformation in the field under somewhat peculiar conditions. It has been found, that the initial concentrations of solitary locusts may, and do, occur as a result of seasonal fluctuations in the extent of favourable habitats. It is well known that locusts, like all other Acrididæ, are highly selective with regard to the type of vegetation. The result is often a patchy distribution, the locusts occurring only in small areas with favoured vegetation. If we imagine, for example, a vast desert area with scattered depressions where grasses grow, these depressions will harbour locusts, while none will be found in the intervening desert. The extent of such grassy areas would increase in years with good rains, and their locust population will also increase. If this favourable period is followed by a year of poor rains, the areas available for locusts will decrease at once, and they will become crowded in the depressions as if they were in cages. A transformation into the gregarious phase will inevitably follow, and the resulting swarms will migrate far and wide, reaching without difficulty the regions suitable for reproduction.

This is a theoretical scheme merely because it is generalised, but it is based on actual observations on the Desert Locust (*Schistocerca gregaria*, Forsk.) and on the Madagascar Migratory Locust (*Locusta migratoria capito*, Sauss.). Studies on the ecology of other locusts suggest that the process of transformation into the gregarious phase is always caused by the instability of their habitats when the latter are not continuous but patchy. It is, therefore, only a matter of intensive ecological research to discover the preferred habitats and the causes of fluctuations in their extent in each particular case.

Such research should, of course, always cover the whole distribution area of a particular locust species, and it would be futile to restrict it to a single country. Moreover, although the so-called outbreak areas, *i.e.*, localities where the initial transformation into the gregarious phase can occur, may be found in one country, the swarms produced there will eventually spread beyond its limits. Therefore, all countries subject to invasions by the parti-

cular locust have an immediate interest in the discovery of outbreak areas, and the investigations directed to that end should be organised internationally.

This principle has been actually adopted in the recent investigations organised in Africa by a number of governments interested in the locust problem. It was at once realised that some centralisation of research would contribute greatly to the success of the work and the participating governments agreed that the Imperial Institute of Entomology in London should act as the International Centre for Anti-Locust Research. The first important function of the Centre was to organise a regular collection of the information on breeding and movements of locusts over the whole territory of Africa and Western Asia. A system of monthly reports was organised and every country regularly submits such reports accompanied by maps. These local reports are summarised and monthly maps for the whole invaded area are prepared, so that the development of the outbreak can be followed step by step. As a result of this system, it became possible to reconstruct the whole history of outbreaks of three locust species, and to obtain general indications as to the probable original sources where the outbreak of each of them arose.

These general indications served as a starting point for field ecological research by special entomologists. Detailed plans for the field investigations prepared in each country are discussed at periodical International Locust Conferences, so that the work is distributed according to the possibilities of each country, and no overlapping occurs. The results are also reported to the Conference, while the field investigators keep in touch with the International Centre during their work, and are informed of any developments occurring in other countries. The functions of the International Centre include regular bibliographical work, so that anything published on locusts is brought to the notice of field workers. Advice on various points connected with the study of locusts is also supplied by the Centre, both to field entomologists, and to the already numerous workers in universities, etc., who take locusts as the objects for their researches.

Perhaps, the most interesting feature of this international organisation is that

came about without complicated diplomatic agreements, simply as a result of a soundly conceived policy, which received a willing support from all the governments concerned with the locust problem.

The results already achieved by the international organisation can be described as exceeding expectations. Indeed, with regard to one of the locust species under investigation, the African Migratory Locust, (*Locusta migratoria migratorioides*, Rch. & Frm.), it has been definitely proved that its recent invasion of the greater part of the African continent originated in a single area on the Middle Niger in the French Sudan. Practical schemes for establishing the permanent control of that area are now being prepared and it can be hoped that they will be effective in the prevention of future invasions.

Another locust of exceptional importance in Africa is the Red Locust (*Nomadacris septemfasciata* Serville), and three of its outbreak areas have already been discovered, and will be taken under control. Investigations are continuing to find other possible sources of outbreaks.

With regard to the Desert Locust, the invasion of which covers a great part of Africa and most of Western Asia, some good practical results have also been obtained. It has been found that outbreak areas of this species are found not in inner deserts, but on desert sea-coasts where peculiarly unstable ecological conditions are often favourable for the formation of the gregarious phase. Some of the outbreak areas have been definitely located on the coasts of the Red Sea in the Sudan and Arabia, and Indian entomologists have succeeded in defining potential outbreak areas on the Mekran Coast. However, there still remain extensive coastal tracts in Iran, Eastern Arabia, Eritrea and Mauretania where field investigations are either in progress, or should be carried out shortly, if a guarantee against future invasions is to be reached.

This, necessarily very brief, account of the international anti-locust work should be

sufficient to show that at least some hope can be entertained for a permanent solution of the locust problem. This has been achieved by unselfish co-operation of several countries, by a carefully planned general scheme of investigations and by centralisation of all the information on the problem in a single, internationally recognised, central institution working for the common benefit. It would not be an exaggeration to say that the international anti-locust research may be regarded as a unique example of determined international effort towards the solution of one of the greatest entomological problems. Whether this effort will be crowned with ultimate practical success, depends entirely on the continued international unity in dealing with the problem even when it will lose its present acuteness. The governments were induced to adopt a far-reaching anti-locust policy because of great economic losses caused by the last outbreak. When the outbreak subsides, there is danger that at least some of the governments may consider it more economical to do nothing and hope for the best. Should this happen, the whole carefully planned anti-locust scheme will be threatened with a collapse and the money and energy spent during the last few years will be largely wasted. The occurrence of another outbreak is only a question of time unless the present policy of prevention is rigorously carried to its logical end.

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