

## THE AREAS OF ORIGIN OF LOCUST FLIGHTS IN THE DIFFERENT PARTS OF INDIA WITH REFERENCE TO THE QUESTION OF THEIR CONTROL

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IN the course of the Locust Research Work carried out during the period 1931 to 1939 under the auspices of the Imperial Council of Agricultural Research in north-western India, a great mass of information was collected in regard to locust movements in India during the past locust cycles. These data are at present under study by the writer at Bangalore in correlation with the character of the seasons, the nature of the rainfall and the prevailing wind-directions. A detailed report of the results of these studies will, in due course, be presented for publication. In the meantime, in view of the topical value of the character of locust movements in India, with reference to the question of locust control during the current cycle, a few remarks on the character of locust flights in India are offered in these notes.

### SOURCES OF LOCUST OUTBREAKS IN INDIA

Cotes (1891) was of opinion that most of the Indian swarms originated from the Rajputana desert, though he conceded that in the case of flights appearing in north-west Punjab, they should have come from breeding grounds beyond the Sulaiman Range. Webb-Ware (1915), on the contrary, held that the main source of the Indian swarms was the Great Kirman Desert of Persia. The generally held view in the earlier days, however, was that the primary swarms came from the west from beyond the Indian borders, and remained breeding in India for two or more years, until they ultimately perished.

Since 1921, when Uvarov (1921) propounded his theory of phases among locusts, views about the origin of locust swarms have been profoundly modified. According to him, during times when swarms disappeared, locusts reverted to a solitary phase of life and were confined to their breeding grounds, but when under the influence of favourable weather conditions, their numbers were multiplied, they again resumed their gregarious phase existence. During the period 1932 to 1939, when swarms of the Desert Locust were absent in most places or occurred in small numbers, investigations were conducted in many of the locust areas, such as the Red Sea Coast of Sudan, north-west India, and French West Africa, on the ecology of the locust, as a result of which a confirmation of the phase hypothesis was obtained from more than one source, and a great deal of additional knowledge regarding the solitary phase locusts has been gathered. As against the generally held view that solitary phase locusts were non-migratory, it has been found that they react to changes in the environment more or less like the gregarious phase, and are capable of migrating

long distances from one rain-belt to another with the change of seasons. The transformation of the solitary phase into the gregarious has been observed to take place in locations where ecological conditions are specially favourable for crowded breeding; and in years inaugurating a fresh cycle of locust infestation, there is little doubt that such centres of outbreak occur over a wide area and that flights originating from such places become fused together to form locust swarms—large or small.

### THE GENERAL MOVEMENTS OF LOCUSTS IN INDIA DURING YEARS OF OUTBREAK

Most of the data on locust activities available for various past years in India have been, after analysis with reference to seasons, plotted on maps year by year, and as a result of a study of these maps, the following inferences in regard to the sequence of events observable in most years during the past locust cycles have been drawn.

1. In the case of most of the past locust outbreak cycles, there is a general lack of information on locust activities for areas outside India and, in fact, even for those within Indian limits, in regard to the periods when initial outbreaks had been brought into being, so that it is not possible to make a general statement as to how these are usually caused. From observations made during the last swarmless interval from India, viz., 1932 to 1939, however, there is a great deal of evidence to indicate that the outbreaks in India are set on foot by incursions of groups of locust individuals produced in outbreak centres situated partly in British Baluchistan, and partly (possibly mainly) in Iran and eastern Arabia. In some cases, these incursions may to a certain extent take the shape of regular swarms even at the outset. Such immigrant locusts would breed intensively in the Sind-Rajputana area in case the monsoon rainfall should be favourable, and be able to start a new cycle of swarm infestation in the Indian areas, as in 1926.

2. Except in years in which, as a result of the activity of overwintering swarms, spring breeding occurs in Baluchistan and the Punjab, the season usually starts with the arrival of swarms from the direction of Iran in May-June. The strong south-west winds prevalent at this time of the year generally carry the locusts rapidly across Sind into the Rajputana desert areas, and often beyond into the Punjab, United Provinces and Central India, and even into Bihar and Bengal.

3. In the Ganges valley, the influence of the monsoon begins to be felt from the beginning of June, when easterly winds from the Bay of Bengal gradually advance westwards through the United Provinces into the Punjab. With the development of the easterly current, most of the swarms reaching the United Provinces, Bihar and Bengal are usually swept back westwards so that they tend to become concentrated in western U.P., in eastern Punjab, and in Rajputana at the time of breeding.

4. With the fall of monsoon rains in July, egg-laying and breeding begins in the desert areas of Sind and Rajputana, and in parts of



the Punjab and the United Provinces, and the new generation of locusts is ready to fly by the end of August or the beginning of September. If good rainfall should occur in August and September, the later batches of swarms from the west, and sometimes even the new generation of locusts, may breed in September and October, and the adults of such late broods would be ready for flight only by the end of October and during November.

5 With the withdrawal of the monsoon early in September from north-west India, the Rajputana area and the neighbouring parts of the Punjab and the U.P. become dry areas and locusts tend to leave them, the direction of their flights being determined by the wind movements prevalent at the time.

6. Swarms bred in the Punjab and U.P. areas and in parts of eastern and north-eastern Rajputana usually come under the influence of the strong westerly winds that develop in September-October in the Gangetic valley, and are carried into the United Provinces, Central India and the Central Provinces, and may often reach Bihar, Bengal and Assam in November-December. Swarms reaching the southern parts of Central India and the south-western districts of the Central Provinces are often swept southwards and westwards into Berar, Bombay and Hyderabad by the north-easterly winds that usually prevail in October and November; and some may even reach in certain years the northern districts of Madras under the influence of the northerly winds that sometimes develop at that time. Some of the Rajputana swarms fly south into the Western India States, Kathiawar and Gujarat in October-November, and others, mainly from western parts of Rajputana, fly westwards into Sind, Baluchistan and western Punjab during autumn.

7. In the case of the second or late generation produced in the Rajputana desert areas, the cold weather will have set in by the time the insects assume wings, and owing to the change in the weather conditions, the urge for an immediate migration out of the desert is not so strong as in September-October. Limited migration, however, still continues so that the desert area is generally clear of swarms by the middle of winter.

8. In years of late breeding, large numbers of locusts may be found passing the winter in parts of Sind, the Punjab and the U.P., the swarms generally being found in a quiescent condition, or undertaking short migrations during spells of warm weather.

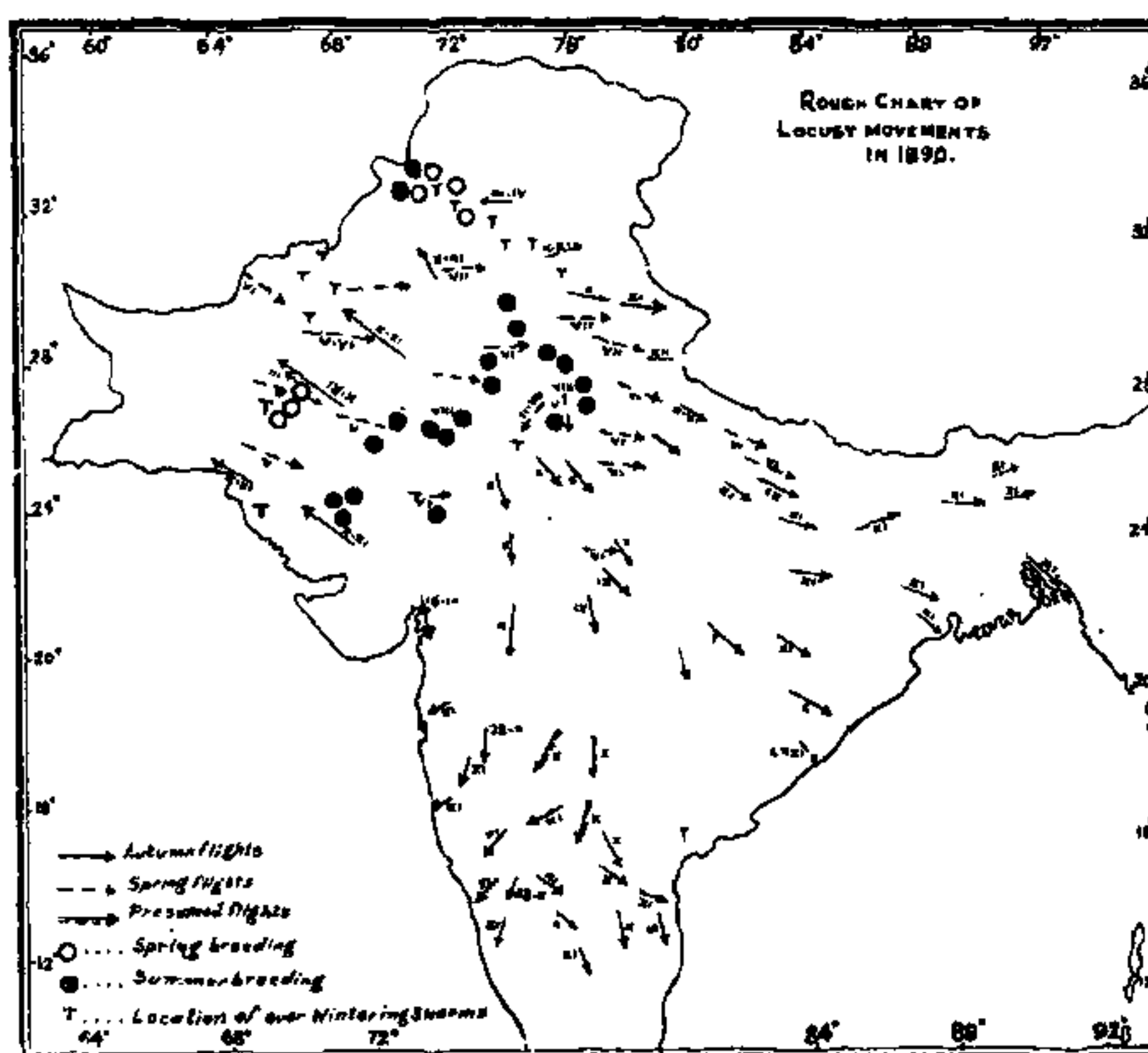
9. Swarms are found in the winter months in other parts of India also in certain years, e.g., Western India States, Bihar, Bengal or even in South India, but none of these ever breed in these areas. On the other hand, those found in the Punjab, Sind and Baluchistan become mature and breed in spring, if the spring rains are favourable.

10. The swarms breeding in the spring months of March-April in northern and central districts of the Punjab, are ready to fly by the end of April or the beginning of May, and migrate with the westerly winds that prevail in May-June in the Gangetic valley, to-

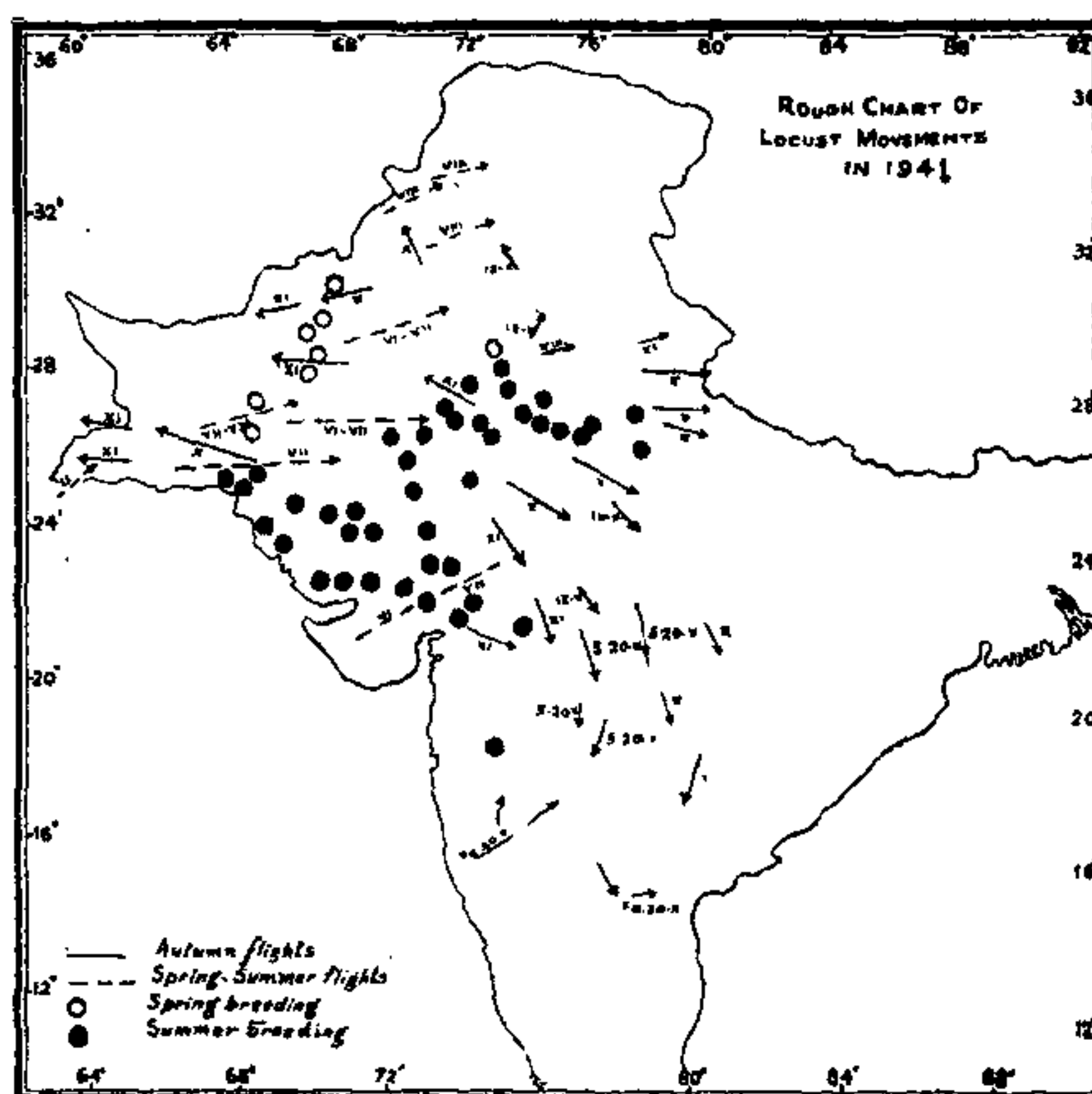
wards the east or south-east into the United Provinces, Central India, Central Provinces and Bihar.

11. Swarms of over-wintered yellow locusts migrate in spring from Iran and Oman into Baluchistan (Mekran and Chagai) and breed there in March-April, and the adults emerging therefrom migrate eastwards in May into Sind, Rajputana and the Punjab and thence join the flights of the Punjab-bred migrants eastwards towards U.P. and Bihar. Those breeding in the uplands of north Baluchistan and in the Kandahar and Arghastan areas of Afghanistan begin their flights only later and reach India by about July, while the pink swarms bred in eastern and north-east Iran reach India only much later in July-August.

Most of these movements are illustrated in Map No. 1, which shows graphically the locust

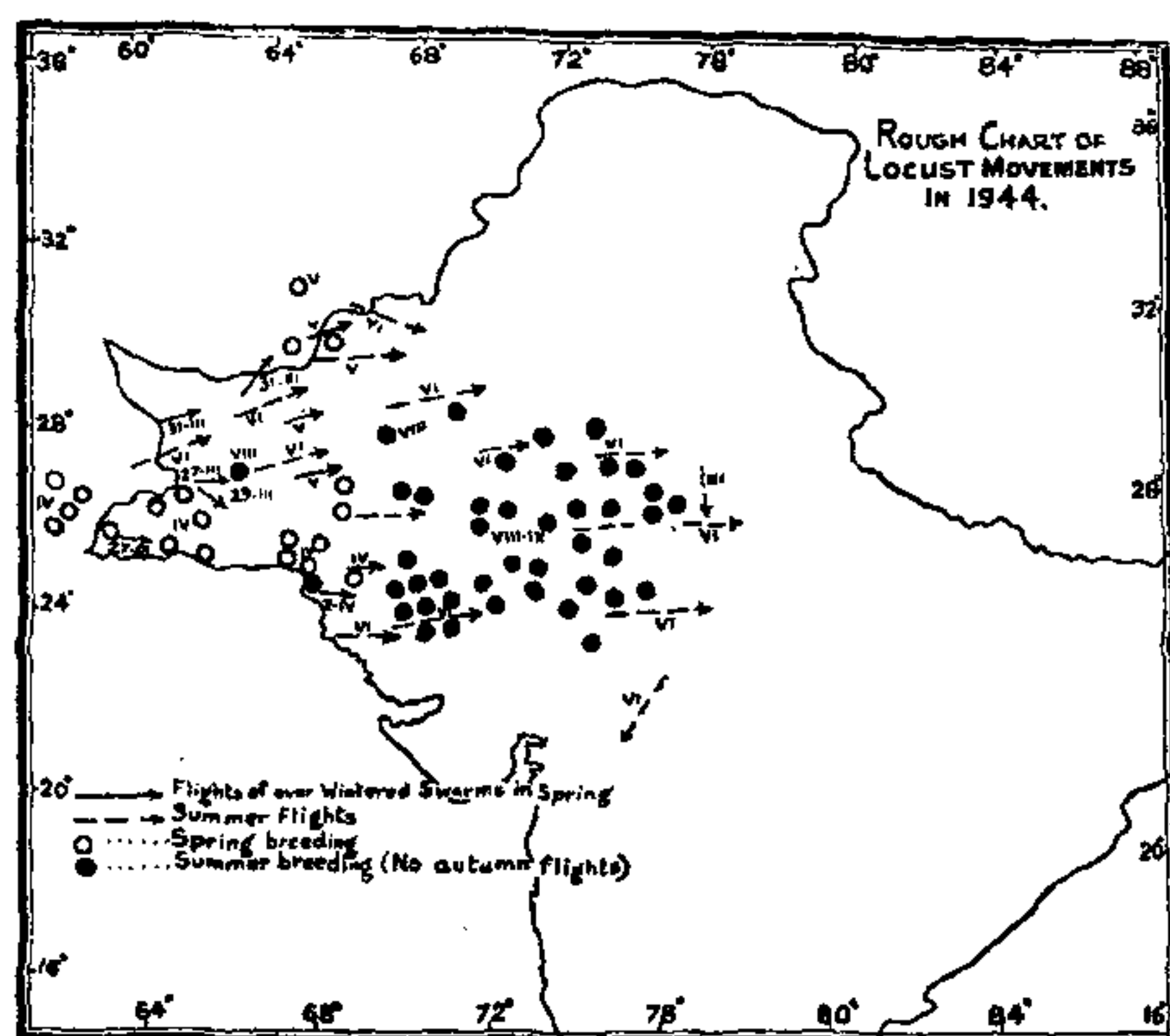


MAP 1



MAP 2





MAP 3

situation in India for the year 1890, when flights reached as far east as Dacca and as far south as the Chingleput District in Madras in the autumn.

#### PAST LOCUST CYCLES IN INDIA COMPARED WITH THE PRESENT OUTBREAK: EFFECT OF CONTROL OF BREEDING CENTRES ON SWARM PRODUCTION

The present cycle of locust infestation in India started in 1940, and Dr. Pruthi (1941, 1944) has given an account of the origin of the new cycle and the progress of the infestation up to September 1941 in *Current Science*, November 1941 (Vol. 10, No. 11) and from October 1941 to June 1944 in *Current Science* (Vol. 13, No. 7). As in the course of the study of the data on the past locust cycles in India, it was found that the work was handicapped by an entire lack of information in certain cases and by insufficient or doubtful data in others, it was hoped that the doubtful points might be elucidated in the light of the fuller data of the present cycle. With the help of the information given in the fortnightly communiques of the Imperial Entomologist on the "Locust situation and progress of control in India", the activities of locusts were, therefore, roughly mapped for the years 1940 to 1944 for purposes of comparison with similar maps prepared for important years of past cycles.

On comparison of the events of past outbreaks with those of the present, however, it was apparent that it was only in the case of the years 1940 and 1941, that locust movements were at all comparable with some of the past years, for it was only in these two years that locust developments in India ran a natural course unaffected by any seriously undertaken control measures. In 1940, flights radiated in autumn from the breeding areas in Rajputana west, north-west, north-east and south-east. In 1941, spring breeding occurred chiefly in Kachhi and Jhalawan. In June-July, locusts appeared from the west in several waves of migration and flew into Sind, Rajputana and Western

India States. Good breeding occurred in the Thar area of Sind and in parts of Rajputana, Lasbela and Western India States, during the monsoon months, and the resultant swarms spread in October south-east into Central Provinces, and southwards as far as Belgaum District in Bombay and Bellary District in Madras (*vide* Map No. 2, 1941).

On the other hand, during the years 1942, 1943 and 1944, locust activity was more or less normal so far as spring breeding and spring flights were concerned. From May onwards, swarms from the west from beyond the Indian borders migrated every year into Sind and Rajputana, and in 1943 reached as far east as Bihar by June. There was intensive breeding in the desert areas of Sind and Rajputana after monsoon rainfall, but autumn flights were conspicuous by their paucity, especially during 1943 and 1944 (*vide* Map No. 3, 1944). This circumstance can be attributed solely to the progressively more efficient and well-organized control measures adopted since 1942 in the Sind-Rajputana areas as well as in other provinces where summer breeding occurred.

An examination of the locust movement maps of some bad years of past outbreaks—for instance 1878, 1889, 1890, 1901, 1903, 1929 and 1930—would show that as a result of heavy summer breeding in Rajputana, the Punjab and the United Provinces, swarms had spread during the autumn of these years as far east as Bengal and Assam, and south as far as the northern districts of Madras. The relief from locust depredations afforded to the Provinces and States situated east and south of Rajputana during 1942, 1943 and 1944 should, therefore, be ascribed to the efficiency of the control measures carried out at the right spots under the direction of the Locust Control Organization of the Government of India.

Even in the case of the spring and early summer flights, there is no doubt that the control operations undertaken in Baluchistan, and parts of Oman and Iran and in the Punjab, had apparently gone far towards limiting the number of spring flights from the west into India, but as the greater part of the flights from the west had presumably been derived from spring-breeding areas in Iran and Arabia (possibly even further west from the Red Sea areas), the question of a more thoroughgoing solution of the locust problem in India has assumed an international aspect and is clearly dependent on an organisation of control on an international basis.

1. Cotes, E. C., *Jl. Bomb. Nat. Hist. Soc.*, 1891, 6, 242-62.
2. Pruthi, H. S., *Curr. Science*, 1941, 10, No. 11.
3. —, *Ibid.*, 1944, 13, No. 7.
4. Uvarov, B. P., *Bull. Ent. Res.*, London, 1921, 12, 135-36.
5. Webb Ware, F. C., *Agr. Jl. India*, 1915, 10, 19-66.

*Note.*—The cost of printing this contribution has been defrayed by a generous grant from the Rockefeller Foundation for the publication of results of scientific work made to us through the kindness of the National Institute of Sciences, India.—Ed.