Monitoring Desert Locusts in the Middle East: An Overview

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ABSTRACT
Desert Locusts, *Schistocerca gregaria* (Forskal), are the most dangerous of locust species. Under favorable environmental conditions, a few solitary individuals can dramatically multiply, form large swarms able to migrate great distances, and threaten agriculture over a large part of Africa, the Middle East[1] and Southwest Asia. There have been six plagues of Desert Locusts this century, one of which lasted almost 13 years. Initial Desert Locust control efforts were largely curative; the trend in the twentieth century has been toward preventing such plagues from occurring. Affected countries have assumed ever more responsibility for monitoring locust breeding areas and treating infestations before they increase in size and number. Five of the 18 countries which currently undertake comprensive surveys for, and control efforts against locusts, are in the Middle East. Most recently, Saudi Arabia completed large scale control operations to prevent a sudden outbreak of locusts from becoming a plague. Over the years, our knowledge of the Desert Locust has evolved along with our ability to manage locust plagues. The challenge in the future lies in the implementation of control strategies that insure food security with minimal environmental consequences.

INTRODUCTION

Locusts are part of a large group of insects commonly called grasshoppers belonging to the family *Acrididae*. The Desert Locust, *Schistocerca gregaria* (Forskal), is one of about a dozen species of short-horned grasshoppers (*Acridoidea*) that are known to change their behavior and physiology in response to changes in population density by forming swarms of adults or bands of wingless nymphs called hoppers. Swarms may contain billions of individuals behaving in unison; they can migrate over hundreds or even thousands of kilometers. Bands can contain a similar number of non-flying nymphs which also act as a cohesive unit. True grasshoppers form neither bands nor proper swarms. However, the distinction between locusts and grasshoppers is not entirely clear-cut. There are some species, such as *Oedaleus senegalensis*, which occasionally form small loose swarms. Locusts such as the Tree Locust (*Anacridium* sp.) rarely form bands. Some locust species, such as the Australian Plague Locust (*Chortoicetes terminifera*), do not change shape and color in response to changes in density.

[1] For the purposes of this paper, the Middle East is defined as those countries that extend from Egypt to Turkey eastwards to Iran, including the entire Arabian Peninsula.

DESERT LOCUST LIFE CYCLE

The Desert Locust poses the greatest threat of all locusts to humans because hopper bands and adult swarms can rapidly arise and migrate, potentially threatening food security in some 60 countries in Africa, the Middle East and Asia. A desert locust lives three to five months although this is extremely variable and depends on weather and ecological conditions. The life cycle comprises three stages: egg, hopper, and adult (Figure 1).

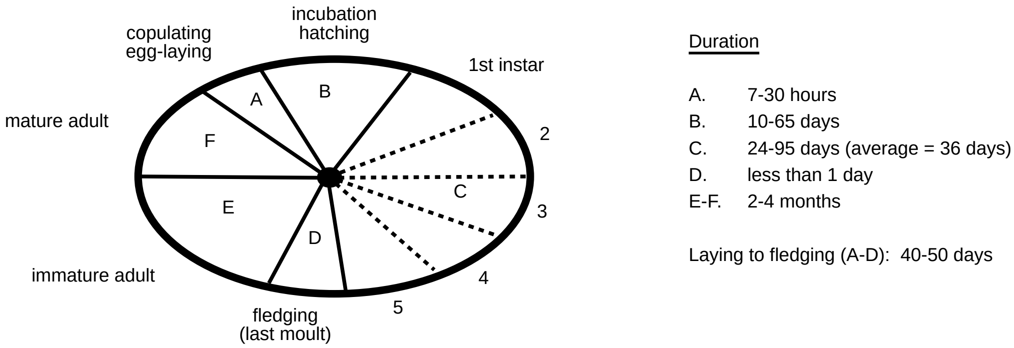

Figure 1 The life cycle of the Desert Locust.

Females lay egg pods containing 80 to 158 eggs in bare ground and often, but not exclusively, in moist sandy soil. They usually lay about three times. The eggs hatch in about two weeks although this can vary from 10 to 65 days (Ashall and Ellis 1962; Roffey and Popov 1968). The emerging hoppers develop in five to six stages over a period of about 30-40 days, depending on temperature. At the final molt, the young adult (or fledgling) emerges. Under optimal conditions (lush vegetation, maximum day temperatures of 30°C or more, and sufficient rain for vegetation growth), adults generally mature in about three weeks, although this process can take as along as eight weeks. If conditions are cool or dry, and therefore unfavorable for final maturation, immature adults can survive for six months or more.

The great majority of the eggs that are laid survive and hatch. On the other hand, very few of the hoppers which emerge from the egg survive to fledge. Most die during the first instar stage due to inadequate water reserves, cannibalism and predation by ants. Cannibalism, parasitism, and predation continue to take a toll during the rest of the life cycle. Nevertheless, between 5 and 10 viable adults result from a single female (Greathead 1966; Roffey and Popov 1968).

PHASE CHANGE

A Desert Locust has different states called phases: solitarious, when individuals are at low population densities; gregarious, when they are at high densities; and a transition from the solitarious phase to the gregarious and vice-versa known as transiens.

The behavioral change depends on micro-scale environmental factors such as the spatial distributions of food plants, and macro-scale factors such as convergent wind fields that force locusts to become concentrated in relatively small areas. This change can rapidly take place, often within a few hours of crowding (Roessingh and Simpson 1994). The capacity to behave gregariously is passed from parents to their offspring and increases over several generations of crowding (Islam *et al.* 1994ab). The color of the locust also changes from brown in solitary adults to pink and yellow in immature and mature gregarious adults, respectively. Morphological changes (i.e. in color and shape) occur after the change in locust behavior. The full gregarious color takes one crowded generation to develop and shape takes two or more. The pronounced differences between gregarious and solitarious adults (their ambi-morphism if you will) meant that until 1921, scientists believed that gregarious and solitarious locusts were actually two different species.

MIGRATION

Temperature and wind influence the migration of both solitary adults and swarms. Solitary adults fly for only a few hours at night. Swarms generally take off several hours after sunrise in warm weather and fly throughout the day until just before or just after sunset. On especially hot days, swarms may settle around midday and take off again in the afternoon. Temperature limits the height of a flight. Swarms are thought to fly between 1,500 and 1,800 meters above the surface of the ground (Rainey 1963; Schaefer 1976). All major swarms travel downwind. In sunny warm weather, swarms tend to fly about 10 hours, but they have the ability to fly continuously for 13-20 hours. A swarm is displaced at some fraction of the wind speed because many of the adults spend some time on the ground. The ground speed of a swarm is usually about 20-50% of the wind speed. The average daily rate of net displacement of swarms varies from 5 km in cool weather to 200 km in warm weather with a consistent wind direction.

Desert Locust adults and swarms can migrate great distances in a short amount of time. They can stay in the air for long periods, for example, they regularly cross the Red Sea, a distance of more than 300 km, and sometimes move across the Sahara from Sudan to Mauritania to Morocco, a distance of nearly 5,000 km (Figure 2).

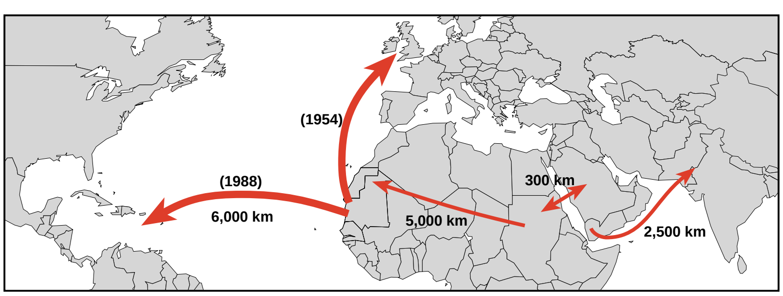

Figure 2 Some examples of long distance Desert Locust migration.

There have been some exceptionally impressive swarm migrations, for example from Northwest Africa to the British Isles in 1954. Over ten days in October, 1988, in the most spectacular migration in recent history, Desert Locusts crossed the Atlantic Ocean from West Africa to the Caribbean, a distance of about 6,000 km.

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DESERT LOCUST RECESSIONS AND PLAGUES

In most years, Desert Locusts are usually restricted to the semi-arid and arid deserts of Africa, the Middle East and Southwest Asia that receive less than 200 mm of rain annually. This is an area of nearly 16 million km^2 covering 30 countries (Figure 3).

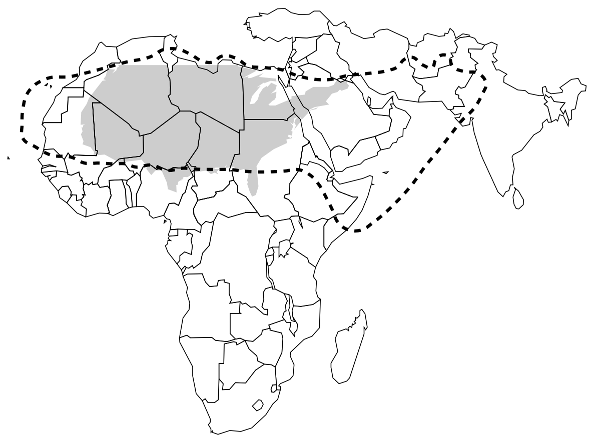

Figure 3 The Desert Locust recession area (dotted outline) in relation to the size of the continental United States.

Within this area, low densities of solitarious locusts are permanently present and breeding on a small scale in favorable habitats. The numbers are so low that hopper bands and swarms rarely form, and the threat to crops or food security of the host country is insignificant. Scientists have labeled these relatively quiet periods as recessions. In the past, recessions have lasted from less than a year to seven years.

When a favorable combination of conditions occurs, locust numbers and densities markedly increase, which leads to gregarization. This occurs in desert areas after rain falls in sufficient amounts and duration to allow locusts to concentrate and multiply which, unless checked, can lead to the formation of hopper bands and swarms. This is commonly referred to as an outbreak. After two or more successive seasons of solitarious-to-gregarious breeding occur in the same or neighboring regions, a dramatic increase in locust numbers and simultaneous outbreaks may follow; this is commonly referred to as an upsurge. During this period, both the size of the total gregarious population and the size of the bands and swarms that make up that population increase and can lead to a plague. Outbreaks occur often but they do not necessarily lead to upsurges. Similarly, most upsurges die out before leading to a major plague.

During plagues, Desert Locusts may spread over an enormous area of some 30 million km^2, extending over all or part of 60 countries, which encompass more than 20% of the total land surface of the world. The Desert Locust thereby threatens the livelihood of a tenth of the world's population. There have been nine major plagues between 1860 and 1997. Plagues occurred in 75% of the years between 1860 and 1963, but in only 12% of the years since then. They have varied in length from one to 22 years. The last plague occurred in 1987-89.

PLAGUES IN THE MIDDLE EAST

During this century, Desert Locust plagues have occurred in the Middle East on seven different occasions: 1901–1908, 1912–1917, 1926–1933, 1941–47, 1949–1962, 1968 and 1987–89 (Waloff 1976) (Figure 4).

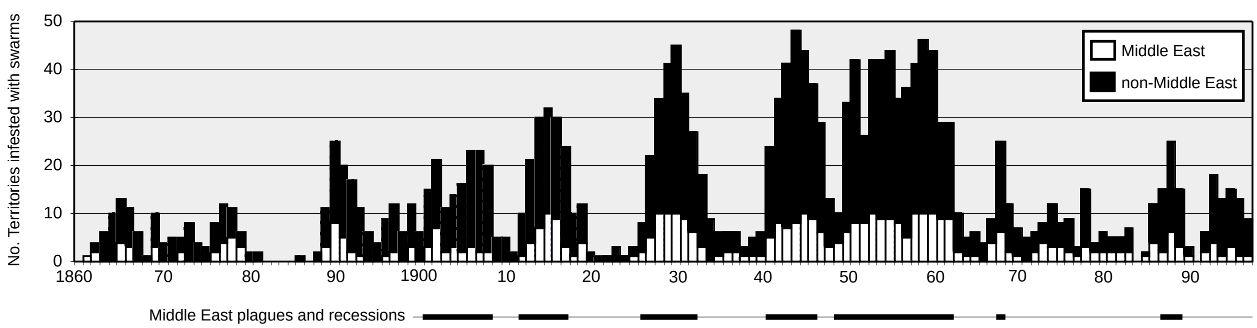

Figure 4 Plagues and recessions of the Desert Locust in the Middle East and elsewhere, 1860-1997.

These plagues lasted between one and 14 years; they were separated from each other by one to 19 years of calm (recession) in between. After the 1941-47 plague, there was a brief recession the following year, broken by an upsurge that led to a major plague that lasted 13 years, the longest continuous plague in the Desert Locust area this century (Waloff 1966). This plague was believed to have started in the Empty Quarter of Saudi Arabia following unusually high rainfall (Lean 1965). During 1949, it spread into the Arabian Peninsula and Iran as well as further east and west. Egypt reported swarms from 1950 onwards, Iraq, Israel, and Jordan in 1951, and Syria in 1953. By 1962, the plague was declining in the Middle East and a long recession period persisted from 1963 to 1985, occasionally interrupted by a small outbreak or upsurge and one short-lived plague (1968) until the next major plague of 1987-89. There was an upsurge in 1993-96 which did not lead to a plague. Most recently, there was an outbreak in Saudi Arabia in 1997 which was controlled.

Since 1860, swarms have been reported more frequently in southwestern Arabia than in other parts of the Middle East. There were a total of 72 years in which at least one swarm was sighted in this area (Table 1).

Table 1 Swarms in the Middle East between 1860 and 1997.

	No. yrs w/swarms 1860-1997	% yrs w/swarms 1860-1997	No. yrs w/swarms during plagues	% plague yrs w/swarms
S. Arabian peninsula (south of 20N)	72	52.2	41	56.9
N. Arabian peninsula (north of 20N)	69	50.0	39	56.5
Arabia (east of 55E)	54	39.1	33	61.1
Iran (south of 30N)	51	37.0	34	66.7
Egypt & Sinai	44	31.9	36	81.8
Israel & Jordan	39	28.3	30	76.9
Iran, other areas	31	22.5	28	90.3
Iraq	27	19.6	25	92.6
Syria & Lebanon	25	18.1	19	76.0
Turkey	13	9.4	13	100

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Swarms occurred more often in territories adjacent to southwestern Arabia and in southern Iran than in northern areas of the Middle East. In these northern regions, swarm reports tended to coincide with plague periods. (These frequencies do not indicate the number of swarms, only whether any swarms occurred in a given year.)

During the winter and spring of most years, relatively few solitarious locusts are present along the coastal plains of both sides of the Red Sea and the Gulf of Aden. Occasionally, similar numbers of locusts are present on the coast and in the interior areas of northern Oman as well as in southeastern Iran. Only after locusts in these places substantially increase in numbers under unusually favorable conditions and form swarms do they threaten other countries in the Middle East. This is rare, however; Iraq, Kuwait, Lebanon and Syria last reported swarms in 1962. Swarms may also invade the Middle East from Southwest Asia or Africa, but such swarms mostly affect the Arabian Peninsula.

DESERT LOCUST MONITORING IN THE MIDDLE EAST

HISTORICAL SURVEYS

Desert Locust monitoring and control was first the responsibility of farmers as they struggled to defend their crops. During the twentieth century, governments have accepted the responsibility for organizing country surveys and control campaigns (Lean 1965). Although locust experts discussed the establishment of an international anti-locust organization at a number of conferences (including Rome 1931; Paris 1932; London 1934; Cairo 1936; Brussels 1938), early international cooperation remained confined to research activities rather than operational monitoring and control (Lean 1965). During World War II, the British established the well organized Middle East Anti-Locust Unit (MEALU), which commenced operations in Saudi Arabia in 1943, and in Yemen, Kuwait and Oman shortly thereafter. MEALU hired the explorer Wilfred Thesiger after WWII to undertake Desert Locust surveys in the Arabian Peninsula (Thesiger 1959). Experts from Egypt and India and workers from Sudan and Palestine assisted MEALU. In Egypt, a similar unit existed and operated as well in northwestern Saudi Arabia. In Iran, MEALU worked with Iranian, Russian, Indian and, later, American specialists (Lean 1947). MEALU was disbanded in 1947 and replaced by the East African Desert Locust Survey (DLS) in 1948.

DLS was responsible for monitoring known outbreak areas and making regular surveys of solitarious locust populations in Ethiopia, Iran, Libya, Oman, Saudi Arabia and Yemen. Its headquarters was in Nairobi with field bases in Asmara, Hargeisa, Jeddah and Aden (Uvarov 1949).

In the 1950s, there was a growing interest in international cooperation in monitoring locust populations. This led to United Nations Food and Agriculture Organization (FAO) coordination of international locust control efforts in the Arabian Peninsula beginning in 1956, at which point the British units disbanded (Lean 1965). In that same year, DLS merged into the DLCO-EA (Desert Locust Control Organization for Eastern Africa) which was based in Addis Ababa. In 1958, FAO and other UN agencies began ecological surveys in desert regions and marginal lands where Desert Locust outbreaks most often occur. During the ten year project, they surveyed more than 110,000 km^2, half of which were in Egypt, Iran, Saudi Arabia and Yemen. Equipment was provided to affected countries to allow regular monitoring and forecasting. International experts and field workers assisted in those countries where areas requiring regular surveys were too large for the national government.

In 1965, three long distance surveys were undertaken in Algeria, Saudi Arabia and Iran as part of the FAO ecological surveys. These surveys are thought to be the precursor to the system of national and international surveying and monitoring which now operates in locust affected countries.

Monitoring and control efforts in the field before and after WW II were supplemented by the efforts of the Anti-Locust Research Center in London (UK) which established a centralized system of reporting, mapping, and data analysis on the changing distribution of the Desert Locust in 1929. This organization provided monthly bulletins and forecasts to affected countries. Its work continued under the International Desert Locust Information Service (IDLIS) at the center from 1958 onwards, funded by the UK and FAO (Uvarov 1958). In 1979, FAO assumed this responsibility as part of its mandate and as a result IDLIS was replaced by the Desert Locust Information Service (DLIS) at FAO Headquarters in Rome. The DLIS is now part of the Locust and Other Migratory Pests Group at FAO.

CURRENT SURVEY METHODOLOGY

Over the years, strategies of Desert Locust control have evolved from curative efforts to an emphasis on prevention, that is, finding and treating infestations before they form large hopper bands and swarms. This requires regular monitoring of locust breeding areas and the ability to quickly mount small scale control operations in many of the 60 countries affected by the Desert Locust. Currently, about 18 countries in Africa, the Middle East and southwest Asia maintain a regular survey program for monitoring the Desert Locust (Cressman 1996). These are countries that are frequently infested and have therefore established specialized anti-locust units responsible for survey and control. These units are usually part of the Ministries of Agriculture under the supervision of the Plant Protection Departments. Some units are autonomous while others are incorporated into the national plant protection or agricultural extension programs.

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Of the sixteen Middle Eastern countries considered in this paper, five have well established National Locust Units with nearly regular monitoring programs (Egypt, Iran, Oman, Saudi Arabia, Yemen), four have smaller and less active programs as part of the general Plant Protection Department (Iraq, Jordan, Kuwait, UAE), and seven do not have specialized units nor do they maintain programs (Bahrain, Israel, Lebanon, Palestinian Territories, Qatar, Syria, Turkey).

There are two basic types of surveys. Assessment surveys are conducted in areas that have a history of locust breeding or presence, or where rain has been recently reported or is thought to have occurred, or where reports of locusts have been received from local inhabitants, scouts, or agriculture extension agents. The purpose of an assessment survey is to monitor locust populations and assess the suitability of the habitat for breeding, and to determine whether significant populations are present that may require control. Search surveys are conducted in areas known to contain significant populations in order to estimate the total infested areas, and to delimit the areas that require control. Results from searching permit decisions on if, when, and how control should be conducted.

Assessment surveys are generally the first type of survey to be undertaken in order to determine if locusts are present in an area or to identify areas of green vegetation where locusts are likely to gather. Estimates of densities made at each survey stop can be used to identify those areas where significant numbers of locusts (*i.e.* gregarious locusts, groups, or high numbers of solitary locusts) may be present. Once these areas are identified, a search survey in the identified areas determines the geographical extent and size of the infestations. From this information, the scale of risk and level of required control can be estimated. Information from both types of survey provides a more complete picture of the overall locust situation (Figure 5).

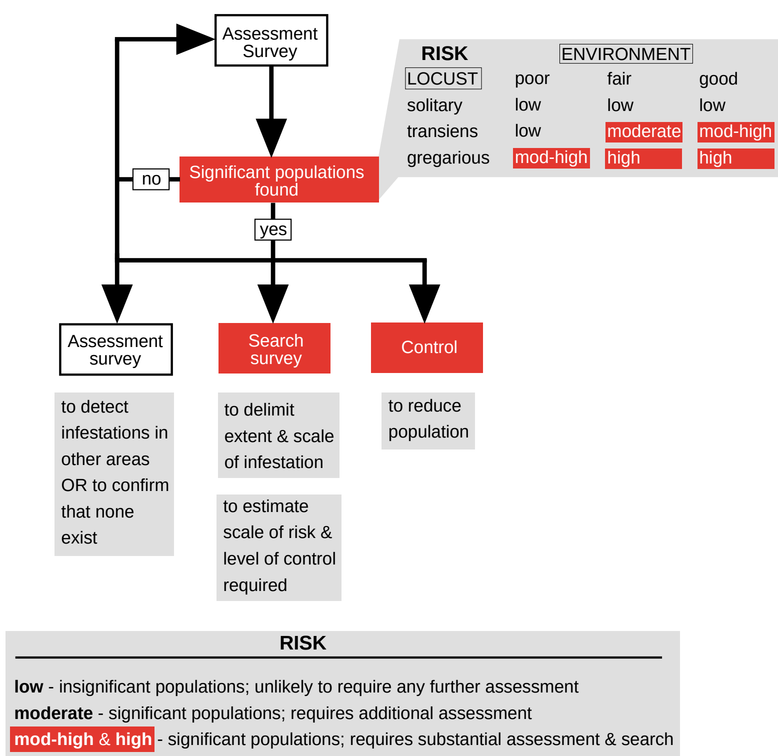

Figure 5 Schematic of Desert Locust monitoring and related decision-making.

Assessment surveys are regularly carried out in those countries with National Locust Units. Specialized staff from these units conduct ground surveys in four-wheel drive vehicles in desert areas. Survey itineraries usually include those areas where locusts or green vegetation were previously seen, areas that are known to be favorite locust habitats and areas in which there is no information. Surveys concentrate primarily on areas of natural vegetation, often in remote, hard to access areas, rather than crop lands. Survey officers also gather information about locust sightings, green vegetation blossoming, and recent rainfall from agricultural extension agents, villagers, truck drivers, travelers, and nomads.

At each survey stop, survey officers will walk several hundred meters, depending on the extent of the vegetation, and count the number of adult locusts that they disturb. Officers will also stop and closely inspect the ground or small bushes for hoppers. The results including the date, location, and notes on the vegetation and soil moisture are written on a standardized reporting form. More and more survey officers are using a hand-held geographic positioning system (GPS) to determine the latitude/longitude coordinates of their position. Surveys are generally conducted early in the morning and late in the afternoon when locusts are most active.

Based on the results of a survey, the need for further assessment or search surveys can be determined. During search surveys, control targets may be identified which allow decisions to be made on the most suitable control method.

Aerial surveys are sometimes undertaken at the beginning of the rainy season to identify areas of green vegetation for later inspection by ground teams. Another aerial survey may be conducted midway through the season and perhaps a final one at the end to provide updated information on the habitat. Most affected countries do not have the resources to carry out such surveys, with the exception of Pakistan which has its own fleet of aircraft. The DLCO-EA uses its aircraft to provide survey services to its member countries.

Remote sensing imagery can assist in the detection of green vegetation and thereby help to guide ground survey teams. Since the late 1980s, imagery has been used in parts of West Africa and more recently (1997), in the Red Sea area. The imagery is captured and processed within the region of interest, in this case, Niamey (Niger) for West Africa and Asmara (Eritrea) for the Red Sea area. Remote sensing imagery currently has several limitations that must be overcome before it can be used on a regular and operational basis. The primary limitation is the need for ground validation which is a time consuming and expensive exercise that must be carried out in several areas within a region since it is not possible to extrapolate

Remote sensing imagery currently has several limitations that must be overcome before it can be used on a regular and operational basis. The primary limitation is the need for ground validation which is a time consuming and expensive exercise that must be carried out in several areas within a region since it is not possible to extrapolate results from one area to another.

results from one area to another. Such validation is required to calibrate imagery and reduce the difficulty in interpretation. Furthermore, a procedure must be developed to deliver processed and calibrated imagery to users in locust-affected countries in a timely manner. Several research institutes and FAO are currently investigating these issues.

ANALYSIS AND FORECASTING

Ground and aerial survey teams transmit their findings to the National Plant Protection Headquarters for collation and analysis as well as to FAO Headquarters where analysis and forecasting at the international level is performed. In the case of a highly mobile pest such as the Desert Locust, a centralized system offers several advantages over national or regional systems in terms of a global view of the locust, habitat and weather situation, access to data not easily available at other levels, objective interpretation of data, and the ability to provide affected countries with information that they themselves would not readily produce or otherwise obtain (Cressman 1997a).

Until recently, data analysis was undertaken manually by plotting survey results, rainfall reports, and habitat conditions on a series of maps of differing scales. These data were compared to historical data including locust frequencies and long-term average rainfall. In 1996, FAO introduced a geographic information system (GIS), SWARMS (*Schistocerca* Warning Management System). The system allows for storage of data in several databases, display of current data on maps consisting of various thematic overlays, and comparison to historical data (Cressman 1997a). In this way, the forecaster can better visualize the spatial and temporal relationships between the various data types and query the data in order to gain a good understanding of the current situation and how it may develop.

At present, a smaller national GIS has been developed and is being evaluated for operational use in one of the affected countries (Cherlet, personal communication). The purpose of the system is to allow a National Locust Unit to better manage and analyze data collected in its country. There are strong links between the national GIS and SWARMS to allow sharing of data. In this way, it is anticipated that Desert Locust monitoring will become more of a cooperative effort and partnerships will develop among countries and with FAO in terms of data collection, transmission and analysis.

THE LOCUST OUTBREAK IN THE ARABIAN PENINSULA, 1996-1997

OVERVIEW

An outbreak of Desert Locust during the 1996-97 winter was a classic example of a situation that could have led to an upsurge or a plague. Successive rainfalls made conditions extremely favorable for breeding along 900 km of the Red Sea coastal plain in Saudi Arabia (Figure 6).

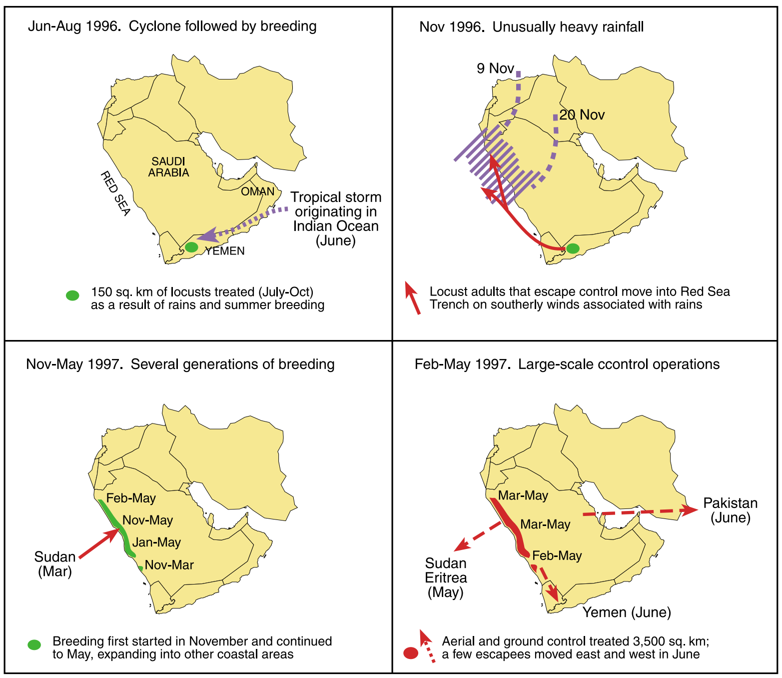

Figure 6 Overview of the origins and development of a Desert Locust outbreak in the Arabian Peninsula, 1996-97.

Good conditions persisted for nearly six months which led to a dramatic increase in locust numbers, most notably during March and April when hoppers and adults changed phase from solitary to transiens (Cressman 1997b). Large scale control operations involved more than 70 teams and four aircraft and used 340,000 L of pesticide. (Saudi Arabia 1997). This effort prevented significant swarm formation and migration as well as any major loss to crops.

ORIGINS AND DEVELOPMENT

Solitarious Desert Locust adults were first reported on the Red Sea coastal plains of Saudi Arabia in November 1996. These adults probably originated from locusts from the Yemeni interior which had themselves appeared after a cyclone in June. Some of the

Yemeni locusts perished in control operations but others were probably drawn into the Red Sea Trench on southerly winds associated with an unusually strong and persistent depression over the northern Red Sea in mid-November 1996. This depression also resulted in light to moderate rainfall over a large portion of the coastal plains along both sides of the northern Red Sea from 15-25 November. In Saudi Arabia, rains were reported on the coast from Al-Lith to Khulais but were estimated to have extended to Al-Wajh in the north.

The majority of the incoming adults landed on the coastal plains of Saudi Arabia and most likely dispersed over a wide area from Al-Lith in the south to Al-Wajh in the north, making it difficult to find them. Small scale breeding first occurred shortly after the rains, primarily near Al-Lith and Badr, producing a new generation of solitarious adults that appeared from late January onwards. Densities were still relatively low, mostly from 1-3 per ha with a few locations reporting up to 100 per ha.

In mid-January, widespread light to moderate rains fell on the coast north of Jeddah to Yenbu. Adults are thought to have concentrated in this area during the following weeks, increasing in density to nearly 1-2 adults/m^2 (10,000-20,000/ha) which was probably enough to induce a partial phase change from solitarious to transiens. Egg laying occurred shortly after the rains on the coastal plains near Khulais and Badr.

Heavier laying by solitarious adults and groups of transiens occurred in late February in Al-Lith, Usfan-Tuwwal, Khulais, Rabigh, and during the first half of March in Usfan-Tuwwal, Masturah, Badr, Yenbu, and Umm Lajj. Breeding during the latter period was supplemented by several low density mature swarms reportedly coming from the western shore of the Red Sea on 8-15 March. The swarms, which also laid eggs upon arrival, were estimated to vary in size from 5-50 km^2 with densities of 5-20 adults/m^2. Other laying adult densities were estimated to be about 2-5/m^2. Consequently, locust numbers rapidly increased during this period.

High density hatching commenced about mid-March and increased over the next few weeks in all areas. This led to large numbers of hoppers and, in some cases, grouping and small band formation during April. By the end of April, hoppers were fledging and new adults started to appear.

Another period of laying occurred in early April that coincided with more rainfall. The breeding was primarily concentrated on the northern coast near Yenbu, Umm Lajj and Al-Wajh as well as further south near Khulais. It consisted of late maturing adults from the incoming swarms combined with adults produced locally earlier in the year. Those in the north were not reported by locals who collect them for both personal consumption and for sale in local markets. Densities of laying adult groups were probably higher in northern areas than near Khulais and were estimated to be about 5-20/m^2. Hatching occurred in late April and new adults started to appear by late May. Fourth and fifth instar gregarious hopper groups were present near Al-Wajh at the end of May in densities of up to 50 hoppers per m^2 (Cressman 1997b).

Vegetation rapidly dried on the coastal plains in early May. As a result, most of the immature adults and a few small groups and swarmlets that had survived the control operations moved off the coastal plains and migrated across the Red Sea to Sudan where they arrived on 15 May and in Eritrea at the end of the month. By the end of the month, hopper groups and only low numbers of adults remained on the Red Sea coastal plains of Saudi Arabia. Most of these became concentrated in the few remaining green areas along the base of the foothills and some of the adults moved up the valleys of the foothills east of Khulais and Al-Wajh. By mid-June, vegetation was completely dry and the few remaining adults had left the coastal plains. On 21 June, one small swarm was reported in northern Yemen which later dispersed.

CONTROL

The National Locust Unit (Locust Control Center, Jeddah) of Saudi Arabia mobilized its resources, which are significantly greater than those of most affected countries. It began ground control operations in mid-February against mature adult groups at Al-Lith, Khulais and Rabigh, treating a total of 1,000 ha. During March, the Saudis extended operations to all other areas with the assistance of a helicopter; they were able to spray more than 25,000 ha of laying adults, hopper groups, bands, and fledglings, including incoming swarms. During April, two fixed-wing aircraft joined the on-going operations and more than 81,000 ha of hopper bands and immature adults were treated. In May, an additional fixed-wing aircraft was added and 140,000 ha of mostly immature adults and some hopper bands were treated. In June, more than 28,000 ha were treated. During the entire campaign, more than 70 ground teams and four aircraft from the Saudi National Locust Unit applied more than 340,000 litters of pesticide to approximately 3,500 km^2.

ASSESSMENT

During the outbreak, average infestation levels (the percent of green vegetation in which locusts are present) were about 8% but varied from 1-30%. The initial buildup of locust numbers was missed during the first four months (November - March) because adults were scattered along the coastal plains and foothills and often were not reported by locals. Such a large area is not only extremely difficult to monitor effectively but impossible to treat because of the wide dispersion and low density of the locusts involved. This problem was compounded by the fact that large expanses of green vegetation encouraged a general increase in locust numbers rather than concentrating the infestations at particular points. Hence, good control targets in which high numbers of locusts could be treated in small compact areas did not exist until the end of the season when vegetation began to dry up. This was after several periods of breeding had occurred.

Nevertheless, the Government of Saudi Arabia was able to mobilize a large amount of resources to undertake a ground and aerial campaign that, given the difficult circumstances, significantly reduced locust infestation levels and effectively prevented the formation of large and numerous swarms. As a result, only groups of adults and a few small swarms formed and migrated from the coastal plains to the west, south and perhaps east. There were no reports of significant crop damage.

The Desert Locust has adapted to one of the harshest environments on Earth. It has developed a variety of mechanisms to survive in conditions of high temperatures, low rainfall, strong winds and sparse vegetation.

DISCUSSION

The Desert Locust has adapted to one of the harshest environments on Earth. It has developed a variety of mechanisms to survive in conditions of high temperatures, low rainfall, strong winds and sparse vegetation. Its ability to migrate long distances gives it access to vegetation over a huge area while at the same time decreasing threats to the species by natural predators. It quickly capitalizes on favorable conditions by rapid maturation and reproduction. As conditions become less favorable, it changes its behavior to that of an individual organism, which is more likely to survive in situations of diminished habitat.

During the twentieth century, our understanding of the Desert Locust has evolved. It was originally thought that the Desert Locust was two different species, one solitarious and one gregarious. Dr. Boris Uvarov first demonstrated that it was indeed one single species with the ability to change its behavior in response to environmental changes. Since then, its biology, behavior, and population dynamics have been extensively studied in the field and the laboratory. Locusts and grasshoppers in general have often been the focus of research due to their conveniently large size and their relative ease of captive rearing. The remarkable ability of this species to survive during times of drought and vegetation scarcity, and also to capitalize in more humid times on relatively brief flowerings of vegetation has meant that it poses a particular challenge to the human beings with whom it shares a habitat.

Control techniques have also evolved from simply burying hopper bands and collecting adults to more complicated methods of chemical treatment. Most of this development occurred during this century and coincided with the advent and use of synthetic compounds after WW II. The types of pesticides commonly used in locust control have changed from strong organochlorides to safer organophosphates as humans have become more aware of the effect of pesticides on the environment. For example, the organochloride dieldrin was the pesticide of choice from the 1950s onward because it persisted for months in the desert. However, such persistence also appeared to have detrimental effects on human health and the environment and dieldrin was banned in the late 1980s. The concept of using a different formulation and applying pesticides at a lower dose rate in overlapping swaths was first tried out against locusts. This is commonly referred to as ultra-low volume (ULV) spraying and is the basis of current locust control. Today, the evolution of control agents continues as scientists develop and test alternative products such as insect growth regulators and mycopesticides, which are more target specific and environmentally friendly.

It has only been during this century that our understanding of the Desert Locust and its relationship with the environment has increased to a point that allows for better management of this pest through improved strategies of monitoring and control.

Application methods have changed over the years from the spreading of arsenic by hand in the late 19th century to manual baiting and dusting, to the present day use of hand, vehicle-mounted, and aerial ULV sprayers. Although the latter methods require a higher level of skill and expertise, they are much safer for the user.

Finally, the strategies of managing Desert Locusts have advanced. Historically, farmers tried to control locust infestations using any available means when their crops were attacked. This rather unsystematic approach, comparable to putting out brush fires as they flare up, often led to poor results and did not stop plagues from developing or spreading. WW II marked a turning point for locust survey and control. International cooperation was strengthened, specialized field units were established, systematic survey and control operations were undertaken, and new pesticides were developed and became available. Based on these advances as well as knowledge gained in the previous 50 years about the Desert Locust and its environment, alternative strategies were developed.

The current strategy used by national and regional locust units focuses on the need to keep locust numbers at a sufficiently low level to prevent swarm formation and the development of plagues. Control decisions are based on information gathered by and exchanged with national agencies and international organizations that have developed programs to regularly monitor locusts and the weather in the desert before they reach agricultural areas. This strategy is quite effective because countries have come to accept that international cooperation is critical in the fight against the Desert Locust. Nevertheless, plagues are not always prevented and often substantial control operations are required to reduce locust numbers and try to bring a halt to an upsurge or plague. It has become apparent that such operations could be strategically applied at certain times or in specific areas. One example is the delaying of control operations until locusts become concentrated into a relatively small area, which would allow more locusts to be treated using a lower quantity of pesticides applied over a smaller area.

CONCLUSION

Desert Locusts have threatened agricultural crops for the past 5,000 years or more. It has only been during this century that our understanding of the Desert Locust and its relationship with the environment has increased to a point that allows for better management of this pest through improved strategies of monitoring and control. The use of modern technology has been of some help in reducing the large desert areas that must be surveyed and treated. Undoubtedly, the fragile environment of the deserts in Africa and the Middle East will continue to change in the future, partially as a function of human activity. It is likely that the Desert Locust will adopt itself to these changes in order to continue to survive as it has done in the past. Therefore, the challenge in coming years will be to adopt Desert Locust management strategies accordingly and apply them in a manner that continues to insure food security while minimizing any detrimental effects on the environment.

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