



LOCUST

LOCUST (in modern taxonomy, Pers. *malak-e mohājer*), the term used for any gregarious, short-horned grasshopper (Bei-Bienko and Mishchenko, Part 1, p. 35). The generic Persian term *malak* (vs. Mid. Pers. *mayg* in the Pahlavi *Vendidad* (q.v.); Av. *maḍaxa-*) is regarded as a borrowing from an Eastern Iranian language (cf. Pashto *malax(ay)*; see Horn, p. 227, no. 1010, and Morgenstierne, p. 49). The species of special importance in Iran include the Desert Locust (*Schistocerca gregaria* Forsk.) (*malak-e daryā'i*), the Moroccan Locust (*Dociostaurus maroccanus* Thnb.) (*malak-e marākeši*), and the Italian Locust (*Calliptamus italicus* L.) (*malak-e itāliā'i*). While the locusts are capable of swarming, both as nymphs and adults, the grasshoppers are only solitary (Abivardi, p. 45).

Locusts and grasshoppers belong to the superfamily Acridoidea (Order: Orthoptera; Class: Insecta) and have all the typical features of the order; i.e., incomplete metamorphosis, elongated body, jumping hind legs, chewing mouth parts, directed downward, a well-developed pronotum covering the thorax from above and the sides, narrow tegmina (thickened forewings) and wider wings (if these organs are developed), folding fan-like, and unsegmented cerci (sensory appendages) at the tip of the abdomen.

In addition, Acridoidea themselves (Figure 1) are characterized by relatively short antennae, usually not more than half the length of the body and consisting of not more than 26-28 segments; 3-segmented tarsi (the feet; lowest sections of the legs) on the hind legs, short ovipositor in the female bearing 2 pairs of valve visible from the outside, and short, hard, and unsegmented



cerci. Tympanic organs, if developed, are always situated on the sides of the first abdominal segment. Eggs (Figure 2) are laid in masses, usually protected, and arranged in the form of a pod (Bei-Bienko and Mishchenko, Part 1, pp. 3-4).

LOCUSTS IN IRANIAN HISTORY

Locusts are ancient enemies to agriculture and long ago attracted man's attention. The most important ancient Near Eastern zoological encyclopedias, which go back to the Sumerian (2900-2354 B.C.E.) and Akkadian (2334-2154 B.C.E.) periods, list different insects, including locusts (Abivardi, pp. 462-63). These encyclopedias comprise a series of unbaked, clay tablets called *Har-ra = Hubullu* (Bodenheimer, 1948, pp. 266-67). Tablet no. 14 of this series, which lists over 120 insects, reports on a "Marine Locust" (Landsberger, pp. 19, 123), apparently referring to the Desert Locust (*Schistocerca gregaria* Forsk.). In these periods, special prayers were conducted to keep the locusts away. In Babylon, the farm tenants were obliged to drive away the locusts, and on large farms guards were employed against them (Landsberger, p. 122). The most ancient depiction of a locust is, apparently, the picture (in color) painted on the wall of a tomb from the 12th dynasty of Egyptian pharaohs, i.e., about 2400 B.C.E. The first data about mass reproduction of locusts and grasshoppers and the devastation caused by them deal with Egypt, Libya, and Palestine and date to 1490-904 B.C.E. (see Bei-Bienko and Mishchenko, Part 1, p. 65); other ancient sources document the destruction and hunger caused by locusts in ancient China, Armenia, Syria, and Mesopotamia (including western Iran).

In Iranian sources, the locust is mentioned in the Avesta (ca. 10th-6th cents. B.C.E.) in the *Vendidad*, where it is said to be generated as a result of violation of taboos of ritual purity (*Vd.* 7.26). Like the ant (*maoiri*, *Vd.* 14.5) and other insect and amphibian life, it is among the *xrafstra*, the evil creations of Angra Mainyu (q.v.) which it is meritorious to kill (see the prescription in *Vd.* 14.5; see also Poure-Davoud, pp. 178-79). A passage later interpreted (see below) as referring to the locust is *Vd.* 1.4: Angra Mainyu sends an affliction against the Sogdian land which kills animals and plants. Nevertheless, from the Achaemenid period (559-330 B.C.E.) comes the depiction on a silver vase of a locust feeding on a grapevine (Gutsch, p 193).

Later text references are in a Zoroastrian source of Sasanid (226-651 C.E.) and post-Sasanid date, the *Bundahišn* (q.v.; Abivardi, pp. 449-50), and in the Pahlavi translation of the *Vendidad*. *Bd.* 31.7 renders *Vd.* 1.4, saying: "the locust always

devours green-herbs, and death comes to animals and oxen” (Anklesaria, p. 265), and *Bd.* 31.27 (rendering *Vd.* 1.14) names the descent of locusts as one of the results of sorcery practiced against the Sistan region. Chap. 22 of the *Bundahišn* is titled “On the nature of the xrafstar,” with 22.17 listing the locust (“which kills man”) among the land vermin. Chap. 24 deals with the good creations and their evil antagonists. Thus *Bd.* 24.35 considers birds as biological agents against locusts: “the magpie bird kills the locusts” (tr. Anklesaria, p. 201) and is its particular antagonist (*hamēstār*). The text observes: “Ohrmazd mostly diverts, with omniscience, these noxious creatures to the benefit of the creatures; just as the bee which prepares honey, the worm from which there is silk ...” (22.29). The conclusion is this: “of all beasts, birds and fishes, every one is created (by Ohrmazd) in opposition to a noxious creature” (24.31). Finally, a late Pahlavi glossary of ideograms includes an entry for “locust” (vocalized as *malak*), which is written QMC’ (from Aramaic *qamṣā*; Maškur, p. 138).

Descriptive details are found in the Babylonian Talmud, the texts of which range in date from the late Arsacid (250 B.C.E.-226 C.E., q.v.) through the Sasanid period (Abivardi, pp. 455-57). It lists various insect pests, including the *arbeh*, i.e., the Desert Locust (*Schistocerca gregaria* Forsk.) (Bodenheimer, 1928, p. 43; cf. the “red locust” [Hebr. *’rbh*] of Lev. 11:22). Interestingly, the description of kosher grasshoppers in the Talmud is a sign of the morphological knowledge about these insects in the past (Bodenheimer, 1928, p. 43): “The grasshopper (or locust) must have four walking and two jumping legs as well as four wings. The wing(s) must cover the body, to a great extent, lengthwise and widthwise.” The Talmud also refers to the presence or absence of tail (ovipositor) and the form of the head (long, round, or hunchbacked).

The study of zoology in Persia in the early Islamic period, from the Caliphs until the beginning of Mongol domination (651-1206 C.E), mainly involved attention to qualities and virtues of each animal species, in order to derive moral and spiritual lessons from it, rather than desire for zoological description. Practical concerns, however, led the Persian physicians and pharmacologists to devote considerable attention to the use of animals, including locusts, in the treatment of man and domesticated animals (see Abivardi, pp. 470-94). Medieval writers seem to have known about the biology of locusts. For instance, in 1263, Zakariyā’ b. Moḥammad b. Maḥmud al-Kammuni al-Qazwini (Abivardi, p. 495) refers to two groups of grasshoppers (and locusts) and describes their biology (Wiedemann, p. 252):



In the spring the locusts search for a soft soil in which they dig a hole by the aid of their tails, lay their eggs and fly away. They are destroyed by the birds and the cold. When the development (of the eggs) is complete and the spring is over, the young insects open up the burrowed eggs and appear as tiny crawling animals on the earth surface. It is said that each locust lays many eggs. They hatch out of the eggs and eat seeds, etc., whatever they see, until they get strong and able to fly. Then they raise themselves from the ground and migrate to another region where they lay their eggs (again). The author of (the book on) agriculture says: As the farmers see that the locusts are approaching a village, the inhabitants of the village hide themselves from locusts, so that nobody is seen. If the locusts see no human being, they pass over the village and none is settled. One burns the locusts at the village in order to repel them from the region, otherwise they die on the ground.

It is unfortunate that, in a recent edition of Rašid-al-Din's *Ātār va ahyā* (14th cent.), Chap. 14, which discusses locust control, is missing (Introd. to Rašid-al-Din, *Ātār va ahyā*, ed. Sotuda and Afšār, p. 14; Abivardi, pp. 501-2).

Up to the 1920s, Iranian efforts to combat locusts remained primitive. For instance, when swarms of locusts arrived, the farmers searched for a certain spring water known as *āb-malak* “locust water.” This was regarded as the only method of fighting them, because it was presumed to lure a kind of predator bird. The merchant and traveler Sir John Chardin describes this lore in the late 17th century (Sykes, pp. 178-79; Abivardi, p. 531). Otherwise farmers could only look on anxiously, unable to do anything except hope that the insects would pass by and not settle down.

LOCUSTS OF IRAN

Scientific studies on locusts of Iran were originally conducted by Russian scholars who were involved in controlling the Desert Locust (*Schistocerca gregaria* Forsk.) and the Moroccan Locust (*Dociostaurus maroccanus* Thnb.) in Persia in order to prevent invasion of the Russian territories (Abivardi, p. 45). The following description draws mainly on Abivardi (pp. 567-96). For additional detail, see in the Bibliography the literature (e.g., Zomorodi, pp. 491-92, 599-601, 641-44, 671-72) and the FAO website.

The Desert Locust (Schistocerca gregaria Forsk.). (1) Importance. The Desert Locust, or *malak-e daryā'i* (Figure 3), is one of about 20 locust species present in tropical and subtropical areas. It is probably the economically most

important locust, mainly due to the vast area of distribution and its appearance in very large swarms (Figure 4). During recessions, it is sparsely distributed in the Sahel in Africa, on the Arabian peninsula, and in parts of Iran, Pakistan, and India. During plagues, the area of distribution increases to the Mediterranean area in the north, to Tanzania in the south, and to Bangladesh in the east (Wiktelius et al., p. 463).

Although long-term average crop losses due to the Desert Locust may not be large, the catastrophic damage which may be caused during an outbreak has far-reaching consequences on the local and national economy. In fact, The desert locust is one of the most important pests of agricultural crops in the following regions: Turkey, Iran, Iraq and other Arab countries, Afghanistan, Pakistan, and India, as well as the countries of northern, central, and eastern Africa; and it is a threat to 20 percent of agricultural lands of the world (Esmāili et al., p. 129). In order to avoid devastating damage by the locust, regional agents must be capable of dealing rapidly with swarms containing in the order of 100 billion insects (Abivardi, p. 567). As reported by Davāči (pp. 157-58) these swarms may travel a distance of about 4,000 km with an average speed of 11 to 15 km per hour.

(2) Host range. This insect is a highly polyphagous species that eats the leaves and removes the bark from trunks and stems of practically all plants that happen to grow where the locust is found (Abivardi, p. 567).

(3) Distribution. The total distribution areas of *S. gregaria* extends over some 29 million km² of Africa and southwestern Asia. The location and the extent of breeding are, however, subject to annual fluctuations, so that only some parts of the potential breeding areas are affected in a single year. In Iran it may occur almost throughout the country during the years of outbreak. Both northern parts (e.g., Khorasan and Anzali) and southern regions (e.g., Khuzestan, Bushehr, Fars, Makran, and Baluchestan) may be infested (Abivardi, p. 567).

(4) Outbreaks. Although locusts have been known in Iran since antiquity (see above), documented reports on the outbreak of the Desert Locust in this country only go back to the 17th century (Abivardi, pp. 567-68; see below). For instance, Sir John Chardin, who resided in Persia during 1666 to 1678, reports on an indigenous method used for motivating birds against locusts (Sykes, pp. 178-79). Travel journals of the German physician Engelbert Kaempfer, who lived in Iran between 1683 and 1688, also provide information on sporadic



outbreaks of this insect in the provinces of Khuzestan and Bandar Abbas (see Muntschick, 1987). Sir James Morier (1818), who visited Iran from 1810 to 1816, also reports on large swarms of the Desert Locust in different parts of Persian territories. Other outbreaks include three in Baluchestan (1869, 1900 and 1912) and, more widely in Iran: 1923, 1926-30, 1940-45, 1950-55, 1958-62, 1967 (Zomorodi, pp. 491-92), 1982 (Zomorodi, pp. 599-600), and 1988. According to Esmāili et al. (p. 129), in the outbreak of 1961, an area of 2,500,000 ha were sprayed against the Desert Locust.

(5) Gregarization. The Desert Locust (as well as other locusts) can occur in a solitarious and a gregarious (swarming) phase. Solitary locusts live separately, the hoppers (nymphs) do not move together, and the adults usually fly individually at night. In contrast, gregarious hoppers move in marching bands, and the adults move together in cohesive, day-flying swarms. The direction of movement is mainly downwind both for hopper bands and swarms. This mode of direction results in small hopper bands combining and forming larger hopper bands. The same is true for swarms. Large hopper bands can cover several ha, and large swarms can cover hundreds of square km (Wikteliuss et al., p. 463).

Although gregarization is a consequence of high population density, brought about by favorable climatic and nutritional factors, research of the past two decades shows the involvement of three different pheromones, namely (a) the gregarization pheromone, (b) the sex maturation pheromone, and (c) the oviposition pheromone, in achieving such phase transformation. Immediately after the final molt, the adults of *S. gregaria* are very weakly pigmented. Later, parallel with hardening of the cuticle, they develop a darker color. Further color changes occur in the gregarious phase, in which the young adults are pink, while the old ones are bright yellow (Abivardi, p. 568).

(6) Control. The Desert Locust upsurges usually develop in remote and thinly populated desert and semi-desert environs, hence their threat to rural farming communities is detected at very late stages. Because of their ability to migrate long distances, swarms of locusts may invade large areas within a short time, overwhelm pest control units in the affected countries, and jeopardize community participation. As there is no reliable preventive control measure against gregarizing populations (see below), the fire-fighting approach is the most widely accepted practice (El Bashir, p. 305).

Preventive control strategies require heavy investment in human and material

resources, even at times when there is no threat of locust resurgence. An effort for such investment, so far, has been much less supported by donors and governments. Effective surveillance is essential for a successful preventive control strategy. In addition to reliable transport facilities and efficient means of communication, ground surveys require well-trained and motivated field staff in all countries within the recession zone. Only a few locust-affected countries provide funds for surveys during recession periods, because locust control is not a priority at such times. Most of the donors also find it difficult to support locust-affected countries during recession periods for fear of mismanagement of donated funds and materials. As a result, almost a total breakdown of locust control units is witnessed in plagued countries, especially during prolonged recession periods, as was the case preceding the 1986-1989 Desert Locust plague (El Bashir, p. 306).

On the other hand, the political environment during plague periods is very favorable for government spending, especially in donor countries in which electronic media focus on the ravage of locust swarms. Therefore, present control methods consist of the “fire-fighting” approach using the following techniques described by Meinzingen (pp. 112-13). (a) Drift-spraying. This technique is presently the most common locust control method; it uses wind of not more than 3 m per second to disperse spray droplets over the target area and ULV (Ultra Low Volume) formulations that can be applied either by aircraft or by ground spray equipment. The advantage of drift technique is that large areas can be treated using small amounts of water and pesticides. (b) Barrier spraying. This method is essentially a drift-spraying which does not aim to give blanket coverage but treats strips or barriers within the target area and is usually used against hopper bands. Depending on density and the stage of hoppers, the pesticide is applied directly to the vegetation through which the hoppers march and feed. (c) Hopper band spraying. This technique involves the direct application of insecticides to hopper bands. (d) Locust swarm spraying. In this method, the flying swarms are controlled by aircraft using air-to-air spraying. To control settled swarms, ULV ground spray equipment can be used. (e) Dusting and baiting. Apart from conventional chemicals, IGRs (Insect Growth Regulators) and pathogens can be considered for this application. This method is usually used against hoppers.

(7) Pesticides used. Wikteliu et al. (pp. 463-64) present summarized information about the pesticides used in controlling the Desert Locust (see below). There are four main classes of chemical pesticides that have been or



still are used against this insect: organochlorines (already banned since mid 1980s), organophosphates, carbamates and synthetic pyrethroids. A new class, phenyl pyrazoles, has also recently been introduced. Other new classes of pesticides are insect growth regulators (IGRs) and biological pesticides (mainly fungus).

The properties of organophosphates, carbamates, and pyrethroids are essentially the same. They have a broad-spectrum activity and a rapid effect. They work mainly by contact and are efficient for short periods only and, consequently, they need to be targeted directly onto the locusts. These pesticides can be used for strategic spraying against hopper bands and swarms.

Fipronil (a phenylpyrazole compound) is a broad-spectrum pesticide with contact and stomach action against insects. It was recently developed especially for locust control, and can be used in extremely low dosages (5 g fipronil per ha). Because of its persistence it is potentially useful for barrier treatments. On the other hand, IGRs are slow-acting pesticides that can be used on hopper bands only.

Alternative approach. El Bashir (pp. 307-11) proposes an alternative strategy and tactics of locust control. This strategy, which is considered to be a preventive, environmentally friendly and sustainable one, is aimed at keeping locusts permanently solitarious. This formidable task may be attained through the manipulation of solitary populations so that numbers are kept constantly at low levels. Alternatively, the process of gregarization can be disrupted so that rapid population build-up is prevented. At present we can only speculate about the possible uses of locust semiochemicals for the management of the desert locust, because only laboratory data and very limited field experience are at hand. Nevertheless, the aggregation and solitarization pheromone complex appears to operate under field conditions. This complex and the oviposition-aggregating pheromones could be used for suppressing locust populations at the early stages of gregarization, while the sex pheromone is mainly for monitoring. The problems are how to detect those early stages in time and how to apply the material; another question is how long semiochemicals and the incorporated locust control agents will remain active.

For up-to-date information on global monitoring, outbreaks, publications, etc., see under Websites in the Bibliography.

The Moroccan Locust (Dociostaurus maroccanus Thnb.). (1) Importance. The Moroccan Locust, or *malak-e marākeši* (Figure 5), has been assigned the highest rank of economic importance as a major pest of many crops. Frequently, a swarm landing in cropland results in the clipping of plant stems almost at the soil level, as the thirsty insect seek to replenish water lost during flight. After such raids, the crop fields look like they were beaten by a hail storm (Latchininsky, pp. 168-69).

Although the Moroccan Locust normally occurs in its solitary phase throughout almost the whole of Asia Minor, some areas, including different regions of Iran, are subject to periodic invasion by locust swarms. *D. maroccanus* mostly threatens northern Iran, especially the region of Moghan steppes and the province of Khorasan bordering the former USSR and Afghanistan (Abivardi, p. 568). It is also distributed in the following provinces: Gorgan, Mazandaran, Khuzestan, Fars and Semnan, where it is known as an important pest of cereals, pastures, cotton and summer crops (Esmāili et al., p. 133).

(2) Host range. The Moroccan Locust is a polyphagous insect which feeds on many field crops and, sometimes, fruit trees (Abivardi, p. 568). Indeed, being highly polyphagous, the locust attacks all principle cereals, fabaceous plants, vegetables, forage, oil and industrial crops. Many tree species, including fruit trees, date palms and even the conifers are also ravaged (Latchininsky, pp. 168-169).

(3) Distribution. The distribution areas of *D. maroccanus* lies in the former Soviet Union, Middle Asia, the Caucasus, Afghanistan, Iran, Iraq, Syria and Turkey, and extends westwards along both side of Mediterranean Sea as far as Morocco and the Canary Islands (Abivardi, p. 568).

According to Latchininsky (p. 167) the common name “Moroccan Locust,” though technically correct, is misleading, because the foothills of the Atlas Mountains in Morocco from which the species was described by Thunberg in 1815 are located at the extreme west of its continental distribution. The actual distribution range of this insect spreads from the Atlantic islands (Madeira and Canary Islands) in the west, through the Mediterranean zone, to Afghanistan and southern Kazakhstan in the east. Therefore, while its longitudinal range stretches up to 10,000 km, it is restricted to 2,000 km in latitude (Latchininsky, p. 168).



In Iran it may occur almost throughout the country during the years of outbreak. Both the northern parts (e.g., Kordestan, Gombad-e Ghabus, Anzali, and Khorasan) and southern regions (e.g., Khuzestan, Bushehr, Fars, Makran, and Baluchestan) may be infested. Nevertheless, the northern parts of Iran appear to have suffered more from previous outbreaks (Abivardi, p. 568). According to Prof. Jalāl Afšār (p. 72) the Moroccan Locust has been known to devastate most of the wheat plantations of Gorgan, Moghan, Kermanshahan, and Shiraz.

(4) Outbreaks. Latchininsky (pp. 170-72) comprehensively describes factors favoring population increase of the Moroccan Locust. The habitats of *D. maroccanus* are restricted to the dry foothill zones receiving a mean annual precipitation of 300-500 mm. Early spring rainfall is critical for the species to flourish, with the optimum being approximately 100 mm. Thus, a shortage in spring rainfall usually results in the increase of locust numbers. If this spring precipitation deficit continues for two or more consecutive years, a dramatic population upsurge, leading to an outbreak, takes place. In fact, spring drought induces profound changes in vegetation cover, creating characteristic mosaic pattern with patches of bare soil and short, tufty grasses, making the habitat very favorable for the Moroccan Locust. Such a mosaic provides excellent conditions for oviposition (bare spots) and feeding (vegetation patches) assuring both survival and reproduction of this locust.

It should, however, be pointed out that the favorable ecometeorological background is a necessary, but often insufficient, prerequisite for the process of outbreak formation of *D. maroccanus*. Interestingly, the outbreaks of this locust are closely associated with human agricultural activities such as deforestation, drainage, excessive grazing and even wars. Thus, once uniform and dense vegetation cover becomes fragmented and the upper soil horizon compact and often bare, they create necessary conditions for locust concentration and gregarization (Latchininsky. pp. 171-72).

In contrast to the Desert Locust, *D. maroccanus* can only fly over distances of 70-100 km, rarely up to 200 km, during its entire lifetime (Latchininsky, p. 168). In outbreak periods, the swarms of the Moroccan Locust expand from the permanent breeding zones in the foothills down into the valleys, ravaging croplands. In periods between outbreaks, areas occupied by this species shrink dramatically and the populations retreat into remote and less-inhabited montane refugia, often for many consecutive years. As a result, “a ruthless pest becomes no more than an obscure member of the local acridofauna”

(Latchininsky, p. 168).

(5) Control. Fighting against the Moroccan Locust during its outbreaks requires a massive campaign, because vast infested territories need to be treated in a very short window of time dictated by the insect's brief developmental period (Latchininsky, p. 169). Furthermore, areas treated annually against this insect can be enormous, exceeding 650,000 ha (e.g., Uzbekistan in 1984). That is why military forces are often engaged in the operations against this insect (see Latchininsky, p. 170). In general, methods used to combat the Moroccan Locust are similar to those practiced in Desert Locust control (see above).

The Italian Locust (Calliptamus italicus L.). (1) Importance. The Italian Locust, or *malaḳ-e itāliā'i* (Figure 6), also causes very high damage to crops during its mass outbreaks. Nevertheless, it is a pest of only local importance (Abivardi, p. 569). According to Afšār (p. 72) the Italian Locust is reported to devastate summer crops, industrial crops, and sometimes wheat fields.

(2) Host range. The Italian Locust is also a polyphagous insect attacking many cultivated crops as well as wild plants. According to Esmāili et al. (p. 128), this insect prefers to lay its eggs in meadows, field edges, and the lands covered by members of the Graminae family. The newly emerged nymphs feed for a while on weeds, in particular *Artemisia* species, and later on different crops, such as cotton, sugar beet, summer crops, beans, potatoes, alfalfa, etc. Following the feeding period, and maturation, they return to their permanent centers, located in foothills and mountainous areas, for oviposition. They have one generation per year and often attack the crops around their oviposition sites (Esmāili et al., p. 128).

(3) Distribution. The Italian Locust is of particular interest because of its wide geographical distribution, as well as the diversity of its habitats. Its habits vary from those of a solitary grasshopper to those of an occasionally gregarious one. It is now known to occupy a vast territory, from Transbalkania, through southern Siberia and the lowlands of Middle Asia, Iran, Asia Minor, the Caucasus, southern Russia, central and southern Europe and its Peninsulas, including the higher altitudes (Abivardi, p. 569). Available records on its distribution in Iran mostly come from northern part of this country.

(4) Outbreaks. The outbreak of the Italian Locust is quite irregular. Although the reasons for its outbreak is not known, hot and dry years appear to be suitable for their population increase (Esmāili et al., p. 128).



(5) Control measures. General principles for control of the Italian Locust are similar to those mentioned for the Moroccan Locust and the Desert Locust (see above).

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