

Chapter 8. Swarming in Locusts

This chapter presents general information on Orthoptera, followed by the process of gregarization, the climatic factors that induce it, and the gregarious areas of *Dociostaurus maroccanus* and *Schistocerca gregaria*.

Contents

- 1. General information on Orthoptera
 - 1.1. Morphology
 - 1.2. Development cycle
 - 1.3. Systematics
 - 1.4. Some examples
 - 1.4.1. Desert locust
 - 1.4.2. Moroccan locust
- 2. Gregarization
 - 2.1. Definition
 - 2.2. Climatic factors inducing gregarization
 - 2.3. Gregarization areas
 - 2.3.1. Gregarization area of *D. maroccanus*
 - 2.3.2. Gregarization sites of *D. maroccanus*
 - 2.3.2.1. Degradation sites
 - 2.3.2.2. Regradation sites
 - 2.3.3. Gregarization area of *S. gregaria*

1. General Information on Orthoptera

1.1. Morphology

- Forewings (elytra) are straight and cover the membranous hindwings.
- Orthognathous head: the mouthparts are perpendicular to the body axis.
- Chewing mouthparts.
- Pronotum: an important element in systematics; one more or less pronounced keel indicates its height.
- Hind legs are adapted for jumping, with a greatly enlarged femur.
- There are two suborders: Ensifera and, especially, Caelifera.

Differences Between Ensifera and Caelifera

Ensifera

- Long antennae extending beyond the body.
- Long sword-shaped ovipositor with six genital valves.
- Stridulation by rubbing the two elytra against each other.
- Tympanal opening located on the inner surface of the fore tibia.
- Egg laid without an ootheca, in the soil or plant tissue.
- Examples: crickets and mole crickets.

Caelifera

- Short antennae not exceeding the pronotum.
- Short ovipositor with four valves.
- Stridulation by rubbing the edge of the elytron against the inner surface of the hind femur.
- Tympanal openings located on either side of the first abdominal segment.
- Eggs laid in masses in an ootheca in the soil.
- Examples: locusts or acridians.

1.2. Development Cycle

There are three biological stages during their life: embryonic, larval, and imaginal.

1. Embryonic stage

- Eggs are laid in an ootheca in different soils, a few centimeters below the surface.
- The incubation period varies according to species.
- Hatching marks the end of development of L1.

2. Larval development

- Larvae from the same ootheca hatch through a plug that facilitates their emergence toward the surface.
- An intermediate molt occurs at L1.
- Larval development is marked by the appearance of wing buds (pterothecae).
- There are five larval stages.
- Gregarious species: about 25 days under normal conditions and 35 days under unfavorable conditions.
- Solitary species: 30–90 days.

3. Imaginal stage

- The last-stage larva undergoes the imaginal molt and becomes an adult (imago).
- Males and females increase in weight; the female continues gaining weight until oocyte maturation.
- Males and females become ready for reproduction.
- The three stages together constitute one generation. The number of generations per year (voltinism) varies according to region, climate, and development time, which may be continuous or interrupted by diapause or quiescence.

1.3. Systematics

- Two suborders: Ensifera and Caelifera.
- Ensifera: Tettigoniidae, Gryllidae, and Gryllotalpidae.
- Caelifera form more than 90% of Orthoptera and include the species most dangerous to agriculture.
- There are four families and 18 subfamilies.
- Charilaidae.
- Pamphagidae: Akicerinae, Pamphaginae.
- Pyrgomorphidae: Chrotogoninae, Poekilocerinae, Pyrgomorphinae.
- Acrididae: Dericorythrinae, Hemiaceridinae, Tropidopolinae, Calliptaminae, Eyprepocnemidinae, Catantopinae, Cyrtacanthacridinae, Egnatiinae, Acridinae, Oedipodinae, Gomphocerinae, Truxalinae, Eremogryllinae.
- These different subfamilies are distributed among locusts and grasshoppers.

Locusts: species that exist in a solitary state and are harmless, but can group together, become gregarious and migratory, and cause considerable damage to agriculture, particularly during locust invasion periods.

Grasshoppers: species that are not capable of gregarization, but following a biotic imbalance such as prolonged drought, they can multiply very intensely and become highly dangerous.

1.4. Some Examples

In Algeria, two species are particularly dangerous: the Desert locust and the Moroccan locust.

1.4.1. Desert Locust: *Schistocerca gregaria*

- One of the most harmful species to crops; over the past century it has caused very serious damage in Algeria, sometimes leading to famine-related deaths of 250,000 people.
- 4–5 cm long; color varies: pink in solitary individuals and yellow in gregarious individuals.
- Egg laying occurs in light soils (dunes) and cultivated land: 40–80 eggs.
- Hatching occurs 15–20 days later.
- Larval life lasts 35–40 days.
- Gregarious instinct is acquired from L2.
- It is bi- or trivoltine, with imaginal quiescence during summer.

1.4.2. Moroccan Locust: *Dociostaurus maroccanus*

- One of the most harmful acridians in the Mediterranean; Algeria is the country where it causes the greatest damage.
- Egg laying occurs at the end of summer, about 30 eggs per ootheca, in stony soil.
- There is a long incubation period because it coincides with winter diapause.
- Hatching occurs from late February to June; the gregarious instinct is acquired from L2, when it causes the greatest damage.
- The amount of food consumed can reach several times its own body weight.

2. Gregarization

2.1. Definition

- According to Uvarov (1921), a given acridian species can occur in nature in two extreme states, called phases, which differ biologically and morphologically: the first is solitary and sedentary, and the second is gregarious and migratory. This is the phase theory.
- In 1934, Zolotarevsky conducted a study in the Sahel countries on *Locusta migratoria*. He observed that when conditions become dry and relative humidity approaches zero, the species passes from the solitary state (characterized by solitarigregaria, solitaricolor and solitariform) to a transiens state (characterized by gregarigregaria, solitaricolor and solitariform), and finally to the gregarious state (characterized by gregarigregaria, gregariform and gregaricolor).

2.2. Climatic Factors Inducing Gregarization

The factors involved are rain and wind.

Rain

- After a long period of drought, rainfall in gregarization sites causes the rapid growth of many herbaceous plants.
- Individuals then concentrate in patches of vegetation to feed and mate and subsequently lay their eggs before beginning their migration northward.
- It is from this point that individuals acquire the gregarious instinct.

Wind

- Wind acts as a vehicle for locusts during major invasions.
- Locusts can sometimes travel up to 200 km per day.

- Wind has enabled them to cross the Mediterranean and reach Europe.

2.3. Gregarization Areas

2.3.1. Gregarization Area of *D. maroccanus*

- Knowledge of the gregarization sites of this species makes it possible to identify the true causes leading to the appearance of migratory individuals.
- According to Pasquier, the Algerian gregarization area extends through semi-arid regions at varying altitudes of 400–1,000 m, near the 350–400 mm isohyets.
- These areas correspond to the Sidi Bel Abbès plain, the Chélif valley, and the Batna plateaus.
- What is a gregarization site? It is a place covering a few square meters where solitary individuals acquire the gregarious instinct and become migratory.

2.3.2. Gregarization Sites of *D. maroccanus*

There are two types of sites: degradation sites and regradation sites.

2.3.2.1. Degradation Site

- It forms following the degradation of a forest, either through fire or excessive tree cutting.
- The forest changes into scrubland, then bushland, then herbaceous vegetation with tall grasses, and finally vegetation dominated by short grasses.

2.3.2.2. Regradation Site

- It appears in a gregarization area where abandoned land left fallow attracts individuals of *D. maroccanus*.
- Runoff water is stored in the fallow land, inducing very high plant biomass and consequently attracting the insect.
- After mating, a large population forms and transmits the gregarious character from one generation to the next.
- This phenomenon is favored by flora consisting mainly of white wormwood, green wormwood, harmal, barley, Atlas pistachio, oak, and Aleppo pine.

2.3.3. Gregarization Area of *S. gregaria*

- In 1934, following long and difficult missions in certain Sahel countries, Zolotarevsky and De Lepiney determined the location of permanent sites where solitary individuals of *S. gregaria* live.
- These sites are located in the southern Sahelian transition zone separating the desert from the steppe.
- According to the same authors, Africa constitutes only a temporary habitat for this species, where winged swarms land after traveling several thousand kilometers.
- The distribution area of gregarious individuals covers Africa north of the Equator, the Mediterranean, the Middle East, the Arabian Peninsula, and the Indo-Pakistani region.
- This distribution area corresponds to a rectangle approximately 12,000 km long and 5,000 km wide.
- This immense distribution forms a desert belt: the Algerian Sahara, Mauritania and Niger, the Libyan Desert, the Arabian Desert in Egypt, the Rub' al Khali in Saudi Arabia, and the Thar Desert in India.