

The Locust (*Tropidacris* spp) within the Ejido “El Cuayo”

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Abstract

Tropidacris spp. represent the largest known group among acridoids. Their presence ranges from southeastern Mexico and has so far been confirmed only in tropical habitats. This publication seeks to highlight the current and potential challenges associated with their presence. For decades, the use of chemical insecticides has been the primary method for controlling locust populations, though these substances pose significant risks to human health and the environment. Recent research efforts are directed toward developing control methods that are less detrimental to both ecological and human health, such as biopesticides derived from pathogenic fungi, plant extracts, and strategically prescribed burns. Satellite surveillance enables the monitoring of the origination and progression of outbreaks to inform control strategy selection.

Keywords

Ejido “El Cuayo”, Locust Infestation, *Tropidacris* *Collaris*

1. Introduction

During community planning activities in the ejido El Cuayo, carried out in July 2016 by scientists from the Territorial Management Network for Sustainable Rural Development (REDGTD), an unusual population of a locust species, known as Tucura, was identified. This species has been causing significant damage to the agricultural crops in the area. Residents of “El Cuayo” describe the rapid spread and voracity of the locusts as alarming.

The lead researcher of the project initiated an additional line of inquiry due to the tangible threat of the issue spreading to other regions with similar ecosystems, specifically in the Huasteca areas of Veracruz, San Luis Potosí, and Tamaulipas. Farmers in these areas have reported crop losses attributed to insects.

Classified as a species within *Tropidacris* spp or *Tucura*, these insects are the largest known within the Acrididae family. They have a geographical range extending from southeastern Mexico to Argentina, inhabiting tropical environments.

The farmers of the ejido “El Cuayo” report that they first identified the insect a couple of years ago, though its appearance was very sporadic and usually involved only a few individual specimens.

The issue escalated in 2016, when the presence of the specimens became more frequent, often occurring in pairs.

As noted by Bulacio [1], the *Tucura* has a life cycle of 240 days. It is often mistaken for *T. cristata* due to similarities, but they can be distinguished by the color of the hind wings: *T. collaris* exhibits bluish wings, whereas *T. cristata* shows reddish wings. *Tucura* lays its eggs in the soil, though eggs have also been discovered within the pith of plants. Adult insects perish between August and September, leaving the eggs to endure until the following season.

The National Moth Program run by Argentina’s National Service of Agrifood Health and Quality (Senasica) monitors the *Tucura*, mainly due to its impact on agricultural crops.

The aim of this publication is to: a) identify the problem and initiate actions.

There is an awareness of at least two institutions that may be consulted for international support:

1) CIRAD© (Agricultural Research for Development) is an entity composed of researchers specializing in matters concerning locusts or similar pests. These include entomologists, botanists, ecologists, and engineers who form the “Prifas” team¹. This organization provides support to countries facing such challenges, as these issues tend to be more prevalent in poorer nations [2].

2) The Food and Agriculture Organization (FAO) supplies comprehensive information on the overall locust situation to all countries and also offers training programs.

2. Background

Orthopterans represent a significant group within terrestrial insects and are known to include some of the most voracious pest species (such as locusts, grasshoppers, crickets, and certain cicadas)². The significant disasters attributed to these insects are well-documented, which justifies the concern seen among farmers who anticipate their arrival.

At the outset, it is essential to present information regarding the planet’s most destructive locusts, which have notably ravaged numerous countries, particularly across Africa. The discussion will then focus on the species *Tucura*.

Both desert locusts and species of the genus *Tropidacris* belong to the Acrididae family (refer to section 5 for taxonomy). They are distinguished by certain

¹El equipo Prifas del Cirad se encarga también de formar e informar a las personas afectadas por la langosta.

²Fuente: <http://locust.cirad.fr/generalites/index.htm> Consultado el 26 de octubre de 2016.

morphological traits and their ability to alter behavior according to their habitat, with both being capable of extensive migratory travel [3].

During periods of inactivity, referred to as recessions, African locusts generally inhabit the semi-arid and arid regions of the African deserts, the Near East, and southwestern Asia, areas receiving less than 200 mm of annual rainfall. This encompasses approximately 16 million square kilometers and includes around 30 countries [4]. In the event of a plague³, desert locusts can proliferate across a vast expanse of roughly 29 million square kilometers, impacting or covering parts of 60 countries. This region accounts for more than 20% of the global land surface area. During such plagues, desert locusts pose a threat to the livelihood of one-tenth of the global population. *Idem*.

Desert locust females deposit their eggs in pods, primarily in sandy soils, at a depth of 10 - 15 centimeters below the surface. A solitary female can produce between 95 - 158 eggs, while a gregarious female typically lays fewer than 80 eggs per pod. These females may lay eggs at least three times in their lifespan, generally at intervals ranging from 6 to 11 days. In some cases, up to 1,000 egg pods have been observed per square meter [5].

Desert locusts generally travel with the wind at speeds of 16-19 km/h, contingent upon wind conditions. Locust swarms have been documented to cover distances ranging from 5 to 130 km or more in a single day. These insects are capable of remaining airborne for extended periods.

Noteworthy instances of migration include remarkable swarming events, such as their travel from West Africa to the Caribbean, covering approximately 5,000 km in about 10 days in 1988. Desert locusts, outside of a plague phase, tend to fly nocturnally, whereas gregarious adults (in swarms) predominantly fly during daylight hours [4].

Most herbaceous ecosystems worldwide, and even some forests, are inhabited by insects from the Order Orthoptera, which includes over 20,000 species globally distributed, such as desert locusts, migratory crickets, grasshoppers, katydids, and cicadas. Of these, approximately 500 species are known to cause agricultural damage. These insects are primarily phytophagous, although many species exhibit omnivorous feeding habits. Females from most species deposit clutches of eggs, either in the soil or on vegetation [4].

During plague outbreaks, locust swarms can vary dramatically in size, covering areas from less than one square kilometer to hundreds of square kilometers. An individual adult locust consumes nearly its own weight in fresh food daily, approximately two grams per day. A swarm occupying one km², consisting of 40 million locusts, consumes a quantity of food equivalent to the daily intake of approximately 3000 humans, 20 camels, or six elephants. This calculation is based on an average human food consumption of 2.3 kg per day, as estimated by the USDA. *Idem*.

³Fuente: <http://www.fao.org/ag/locusts/en/info/info/index.html> sitio web actualizado al 21 de octubre de 2016.

The CIRAD© [2] report discusses instances of disasters caused by locust invasions, which are detrimental as these insects consume plant materials (phytophagous). When locusts invade a country, they attack natural vegetation, including both pastures and crops, leading to significant damage due to the resultant crop losses. A chronological list of affected territories includes:

- In 1944, Libya experienced the loss of 7 million vine stocks, equivalent to 19% of its vineyards.
- In 1954, Sudan lost 55,000 tons of cereals.
- In 1957, Senegal faced losses of 16,000 tons of millet and 2,000 tons of other cereals.
- In 1958, Ethiopia lost 167,000 tons of cereals, which would have provided food for one million people for an entire year.
- In 1974, an estimated 368,000 tons of cereals were lost in the African Sahara due to a locust infestation.

Farmers who experience locust infestations on their land often face the complete loss of their crops. If control measures and mitigation efforts are not implemented promptly, crop destruction compels farmers to abandon their land, leading to famine situations. The countries most susceptible to these invasions are among the poorest globally. The majority of these countries do not have the resources to manage large locust populations. They rely on assistance from international organizations or wealthier countries that bear the full or partial cost of pest control operations.

In 2005, researchers documented the presence of a large insect, measuring between 10 to 13 centimeters in length, in the province of Córdoba, Argentina. This insect resembled the “desert locust” and represented a particularly high population of *Tropidacris* spp [1].

The locust *Tropidacris* spp, notably *T. collaris*, is prevalent in Argentina and is known to consume the leaves of native forests, with a preference for white quebracho.

This species is often mistaken for other genera within the Order Orthoptera, including *Arecaceae* sp, *Citrus* sp, *Gossypium hirsutum* L., *Musa* sp., *Ricinus communis* L., and *Saccharum officinarum* L. In Córdoba, instances of isolated damage to maize, olive, and citrus crops have been noted. Idem (see **Figure 1**).

The adult stage of the grasshopper (*Tropidacris* spp) is characterized as an arboreal insect, with a body length ranging from 10 to 13 centimeters and a wingspan of 24 cm, enabling flight akin to that of birds.

Emergence takes place in October and November; within warmer regions, reproduction is continuous across a single generation annually, allowing for the concurrent presence of adults and nymphs. These nymphs exhibit gregarious behavior, forming clusters on low-lying trees. The development of nymphs is facilitated by high temperatures, absence of frost, and low precipitation levels. In the absence of white quebracho, the insect gradually expands into new areas and plant species, demonstrating a previously unrecorded pattern of slow migration [1].



Figure 1. *Tucura quebrachera*. Source: http://www.produccion-animal.com.ar/produccion_y_manejo_pasturas/pasturas_combate_de_plagas_y_malezas/78-tucura_quebrachera.pdf.

The phylogenetic relationships within Orthoptera remain controversial. The prevailing view supports the monophyletic hypothesis⁴ for the Orthoptera order as proposed by Hennig in 1981 and endorsed by Gorochov in 1995 [6]⁵. However, numerical analyses of orthopteroid features reveal that the collected data present the Caelifera alongside Blattodea-Mantodea as a clade⁶, contradicting their classification as a sister group to Ensifera as per Kamp (1973). In terms of taxonomy, while Kukalova Peck (1991) [7] cast doubt on the group's monophyly, both Gorochov (1995) [6] and Uvarov (1966) [8] confirm its monophyletic nature. Kristensen (1991) [9] highlighted that wing venation traits are not synapomorphies⁷. Molecular evidence indicates that Orthoptera is a cohesive group closely related to a lineage comprising Phasmida and Embiidina [10] [11]. The recognition of all extant groups as monophyletic is aligned with numerical analyses of morphological traits in insects, as shown in the studies by Blackith and Blackith Kamp in 1968 and 1973.

2.1. Control of *Tropidacris* spp

Through history, a variety of techniques have been employed to manage crop pests, including vegetation burning, construction of barriers, and fumigation. Efforts have also included the use of poultry to manage these insect populations. However, in El Cuayo, it has been reported by farmers that domestic birds do not prey upon these insects.

⁴Phylogenetic relationship that consists of grouping organisms of all descendants of a single common ancestor and whose evolutionary history stands out for sharing derived characteristics. **Source:** U.S. National Agricultural Library Thesaurus 2013.

⁵In the Bibliography, for each Author there is a Link that opens the original work.

⁶Descended from a common ancestor

⁷Apomorphy or apomorphy1 (gr. "separate form") is an evolutionarily novel biological trait or character, an evolutionary novelty derived from another trait belonging to a phylogenetically close ancestral taxon. The concept of apomorphy is opposed to that of plesiomorphy, which refers to historically older traits, from which apomorphies are derived.

There is an ongoing comprehensive investigation into biological control and other non-chemical methods for managing locusts. The current focus is predominantly on pathogens and the regulation of insect growth. At present, control by natural predators and parasites is restricted since locusts can quickly migrate away from most natural enemies. While approaches such as enormous nets, flamethrowers, lasers, and large vacuums have been suggested in the past, they are not currently deployed for locust control. Humans and birds commonly consume locusts, but this generally fails to satisfactorily decrease population densities over expansive areas [4].

Satellite surveillance facilitates the monitoring of outbreak origins and their evolution, which is crucial for selecting appropriate control strategies. Surveillance networks are tasked with managing locust population levels. Understanding factors like climate (precipitation, wind patterns) and vegetation growth is key to detecting the onset of invasions. Satellites offer enhanced assessment capabilities for remote areas that are often inaccessible by land [2]. Contemporary research is directed towards less harmful interventions, including biopesticides derived from pathogenic fungi, plant extracts, and prescribed burning [12].

2.1.1. Insecticide-Based Control

Since the emergence of insecticides and sprayers, chemical insecticides have been preferred due to their greater effectiveness. Small areas are typically treated with manual sprayers. During major invasions, aerial spraying gained popularity with the introduction of small aircraft, albeit with subsequent ecological damage.

Currently, the primary method for controlling the expansion of locust swarms and insect bands involves non-systemic organophosphate insecticides⁸. These are predominantly applied in small, concentrated doses, known as ultra-low volume (ULV) formulations, using airborne vehicles and sprayers. To a lesser extent, application is also done using backpack and manual sprayers.

An experiment was conducted on 59 isolates of entomopathogenic fungi native to Argentina to evaluate the relationship between their enzymatic activity and fungal virulence. The isolate LPSC 1067 was found to cause the highest mortality rate in *T. spp* nymphs, achieving $97.7\% \pm 1.22\%$ mortality. While nine isolates did not cause any mortality, the other 49 isolates exhibited mortality rates ranging from $6.6\% \pm 0.3\%$ (LPSC 770) to $91.06\% \pm 1.51\%$ [13].

2.1.2. Biological Control

Insects are vulnerable to a wide range of acute and fatal diseases caused by pathogens, which can serve as significant short-term regulators of insect populations.

The principal characteristics of insect pathogens include:

- They are typically specific to particular pests.
- Their effectiveness relies on environmental conditions and the host's population density.
- The level of control achieved by these pathogens is unpredictable.

⁸Source: http://illinoispoisoncenter.org/ipc_media/pdf/Organos_Spa.pdf

- Their action is relatively slow, often requiring several days to achieve effective control.
- They are considered environmentally safe.

Entomopoxviruses have proven effective for managing the Order Orthoptera, functioning through cytoplasmic viral replication within the host. Viral entry into the host cell occurs via the binding of viral proteins to host glycosaminoglycans (GAG), facilitating the virus's endocytosis into the host cell [14] [15]. as cited by Nicholls [16].

Fungal control strategies are employed for regulating large locust populations. In the United States, Mycotech has innovated a fermentation process for the production of *Beauveria bassiana* as a biocontrol agent. The *Beauveria bassiana* strain GHA (Mycotrol GH-OF and Mycotrol GH-ES) is utilized to manage grasshopper, locust, and cricket populations in crops such as alfalfa, pastures, corn, potatoes, sunflowers, soybeans, and sugar beets.

The responsibility for the study and control of locusts primarily falls on the Ministry of Agriculture in countries affected by these pests, with anti-locust units conducting the operations. Additionally, several regional organizations are involved in combating locust infestations, providing support for control and monitoring efforts. During outbreaks of diseases and pests, external assistance from the international donor community and other international organizations is typically needed [16].

3. Methodology

The methodological process included characterizing the study site, conducting introspective interviews with farmers, collecting specimens and relevant information, and taking photographs of the locusts found at the site.

3.1. Location

The Ojital Cuayo community is situated in the southern region of the municipality of Madero, in the state of Veracruz (see **Figure 2**). This municipality is bordered

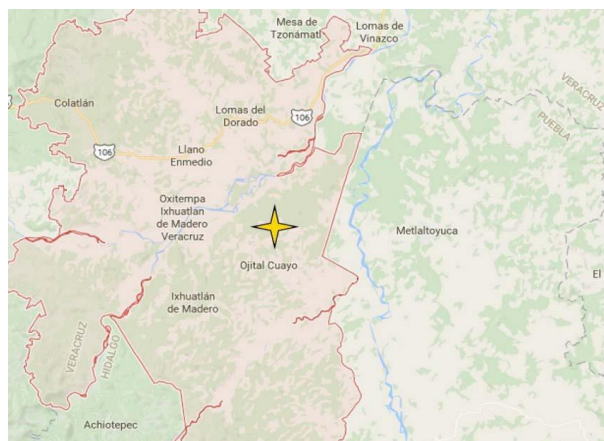


Figure 2. Location of the community Ojital Cuayo. Source: [17].

to the east by Metlatoyuca in the state of Puebla, to the southeast by the municipality of Pantepec, Puebla, and to the southwest by Huehuetla in Hidalgo. To the west, it is flanked by the Veracruz municipalities of Tlachichilco and Benito Juárez, while to the north, it adjoins Chicontepec and Álamo Temapache. Covering an area of 669.156 square kilometers, Ixhuatlán de Madero had a total population of 49,820 in the year 2010, resulting in a population density of 74.45 inhabitants per square kilometer. This density surpasses that of Chicontepec, measured at 58.71 inhabitants per square kilometer, yet remains lower than that of Álamo Temapache, which is 81.82 inhabitants per square kilometer [17].

3.2. Climatic, Topographic, and Edaphological Characteristics of the Site

According to INEGI, the locality has a warm humid climate, characterized by abundant rainfall during the summer and consistent precipitation throughout the year, as reflected in the average monthly temperature and rainfall data (see **Figure 3**).

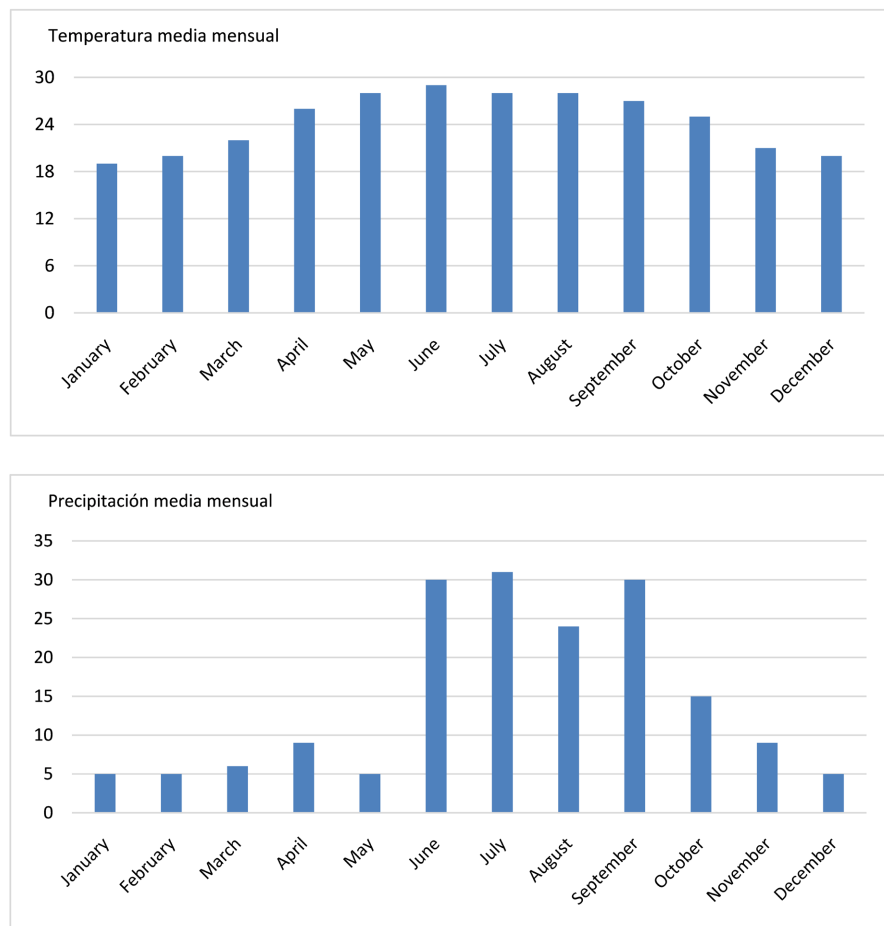


Figure 3. Climatic data of El Ejido “El Cuayo”. Source: [17].

3.3. Land Use and Vegetation

This ecosystem is classified as subtropical, characterized by prolonged summer

periods that frequently result in conditions of drought or water scarcity, particularly following the spring and summer rainy seasons.

The land use within this area is primarily agricultural and livestock-oriented; notable impacts have been observed resulting from the conversion of forest land to agricultural land, and subsequently to livestock purposes. This has led to the presence of induced grassland regions.

The communal land is deeply influenced by the cultural values of the Náhuatl people, prominently known as the Huasteca culture. The region's musical scene is defined by the Huasteco son and features ensembles comprised of both men and women performing dances of pre-Hispanic origins, such as the Montezontini dance.

3.4. Ecosystem Conditions

Field observations indicate that the natural ecosystem has been affected by agricultural and livestock production systems. Negative impacts on natural resources have been identified due to inadequate agricultural management practices, including the planting of crops on slopes without employing contour farming techniques (see **Figure 4**).



Figure 4. Planting on high slopes. Source: [17].

Additionally, poor management of cattle in grazing areas has been noted. These areas often consist of induced pastures, which historically supported a vegetative cover of forest species such as cedar, ceiba, and mahogany, among others.

3.5. Expert Consultation and Information Management

The initial identification of the insect took place during a participatory workshop involving over 30 community members, including young people, adults, men, and women.

During this event, two juvenile specimens were exhibited and photographed. These photographs were then forwarded to various scientific and specialized

research entities to ensure correct identification and taxonomy⁹.

The preliminary identification was completed directly with the locals, who noted that the “crickets” were large and highly voracious, consuming a wide range of foods, and that chickens would not eat them. This observation was particularly concerning as it indicates the absence of natural or domestic predators within the Cuaya’s rural units.

Local residents have reported observing the insect feeding on various vegetation, including grass, lentil flowers, corn plants, bean plants, banana leaves, chili plant leaves, and papatilla. Additionally, observations were made of the insect on trees identified locally as “aguachile”¹⁰.

Key informants include Mr. Zeferino Cuervo, Ms. Mariana Tesillos, Mr. Heriberto Hernández, and Ms. María Antonia García. This data was collected via an interview with Anadely Cuervo, a resident of El Cuayo.

3.6. Specimen Collection

Dr. Carlos Menéndez and Licenciada Anadely Cuervo conducted the image documentation and specimen collection within the community (see **Figure 5**). The captured images were forwarded to several expert biologists and entomologists for taxonomic identification. This identification process, facilitated by MC. Francisco Compeán, involved consultation with Forest Health specialists at the National Forestry Commission (CONAFOR) in Durango. The research team, led by Dr. Menéndez of UNAM, underscores the significant contribution and value of their collaborative work.



Figure 5. Specimens collected. Source: Collected by the team.

⁹It was only determined that the insect belongs to the genus *Tropidacris*. By recommendations of entomologists, the species should be classified taking into account more factors due to mutations and mimics of the insect.

¹⁰No taxonomic identification.

4. Taxonomy of the *Tropidacris* Species

4.1. Taxonomy and Habits

Ecology: These organisms are terrestrial phytophages, with an unspecified number of species being omnivorous.

Historical: *Gryllus rugosus*; holotype associated with the synonym *Gryllus rugosus* (Thunberg, 1824).

4.2. Taxonomic Hierarchy

- Domain: **Eukaryota**
- Regnum: **Animalia**
- Phylum: **Arthropoda**
- Subphylum: **Hexapoda**
- Classis: **Insecta**
- Subclassis: **Pterygota**
- Infraclassis: **Neoptera** (continúa la jerarquía)
- Superordo: **Polyneoptera**
- Ordo: **Orthoptera**
- Subordo: **Caelifera**
- Superfamilia: **Acridoidea**
- Familia: **Romaleidae**
- Subfamilia: **Romaleinae**
- Genus: **Tropidacris**
- Species: ***Tropidacris* spp (Stoll, 1813)**¹¹

Species within the genus *Tropidacris* are arboreal and include some key forest pests in Brazil and Venezuela. These insects can cause occasional and localized damage to tropical crops including banana, cassava, citrus, coconut palm, coffee, corn, sorghum, and sugarcane.

The adult *Tropidacris* spp. is an arboreal insect measuring between 10 and 13 centimeters in body length and having a wingspan of 24 centimeters, enabling it to fly similarly to a bird. This locust is notably larger compared to other species commonly found in our region, such as the orchard locust, **Cromacris miles** (Drury) [1].

The emergence occurs in October and November; in warm regions, reproduction is continuous, with one generation per year, allowing for the overlapping presence of adults and nymphs. Nymphs are gregarious and can be found in small groups on low vegetation. High temperatures, the absence of frost, and low precipitation rates promote nymphal development.

The *Tucura* spp has been expanding to other areas and plant species, exhibiting a previously undocumented behavior (see **Figure 6**).

¹¹This page was last modified on 8 Dec 2014 at 01:18. Text is available under the Creative Commons Attribution-Share Alike License 3.0; additional terms may apply. See Terms of Use for details. See page 27 of this publication.

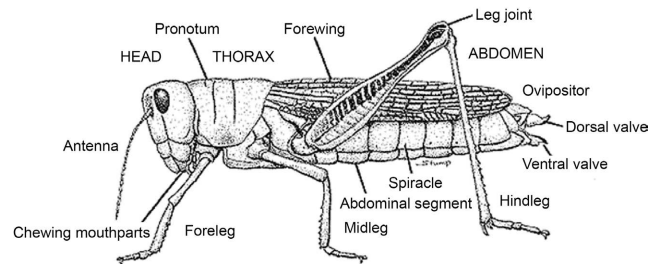


Figure 6. Anatomy and morphology of *Tropidacris* spp. Source: unspecified, Google search result with the word “pronotum”.

Despite being recognized as the most crucial locust species due to its extensive migratory capabilities and rapid population growth, the desert locust is not the only significant species. There exists a variety of important locust species globally:

- African migratory locust (*Locusta migratoria migratorioides*), found in Africa;
- Oriental locust (*Locusta migratoria manilensis*)—prevalent in Southeast Asia;
- Red locust (*Nomadacris septemfasciata*)—located in East Africa;
- Brown locust (*Locustana pardalina*)—inhabits Southern Africa;
- Italian locust (*Calliptamus italicus*), ranging from Western Europe to Central Asia;
- Moroccan locust (*Dociostaurus maroccanus*)—spans from Northwest Africa to Asia;
- Bombay locust (*Nomadacris succincta*)—distributed in Southwest southeast Asia;
- Australian plague locust (*Chortoicetes terminifera*)—native to Australia;
- Tree locusts (*Anacridium* spp.)—occur in Africa, the Mediterranean, and the Near East.

According to the FAO [4], the Order Orthoptera was reported to comprise more than 20,000 species with a global distribution. By October 2016, this number had increased to nearly 27,500 species (**Figure 7**).

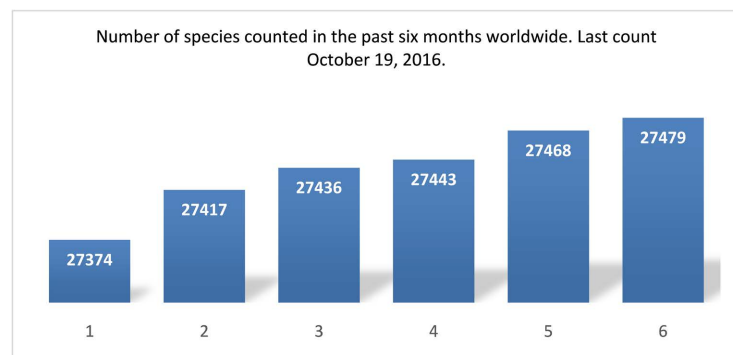


Figure 7. Number of species counted in the past six months worldwide. Last count October 19, 2016. Source:

<http://orthoptera.speciesfile.org/HomePage/Orthoptera/HomePage.aspx>
<http://orthoptera.speciesfile.org/HomePage/Orthoptera/HomePage.aspx>
<http://orthoptera.speciesfile.org/HomePage/Orthoptera/HomePage.aspx>

At present, the geographic distribution maps for *Tropidacris* spp indicate a moderate presence in Mexico, whereas in certain South American countries, the species is experiencing a pest phase. Predictive models suggest a scenario of growth, with Mexico expected to be severely impacted (Figure 8).

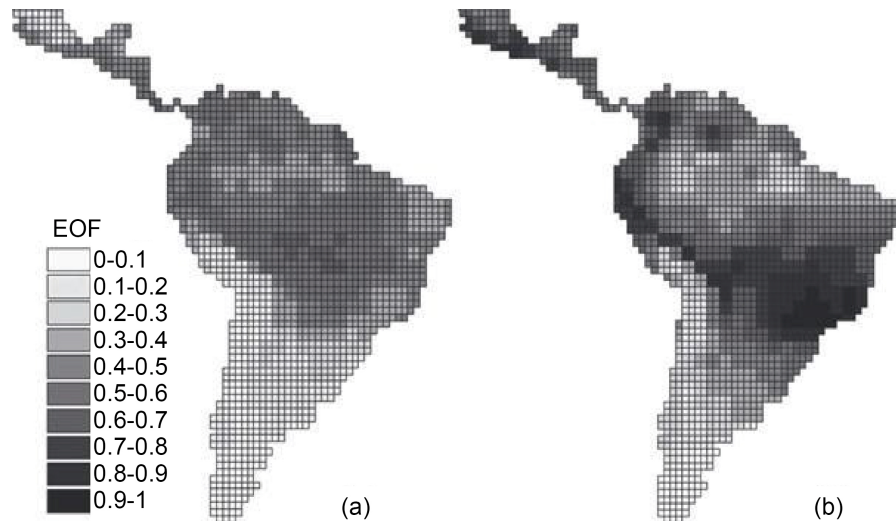


Figure 8. Calculation of the frequency of occurrence for *Tropidacris cristata* in the neotropics, based on the consensus of 30,000 models with different niche modeling methods (Atmosphere-Ocean, general circulation models) for the present (a) and for future scenarios considering climate change (b).

Source: https://www.researchgate.net/figure/228337668_fig4_Figure-2-Estimated-frequencies-of-occurrence-EOF-for-Tropidacris-cristata-in

5. Conclusions

1. The *Tropidacris* spp is a large and voracious grasshopper that has exhibited pest-like behavior in recent years. It has successfully adapted to the tropical regions of South America. In the northeastern part of Mexico, particularly in the “huastecas,” its invasion has spread to increasingly larger areas. Despite the high population numbers, it has not yet reached the pest phase. Its behavioral patterns vary according to the infested region, creating an uncertain outlook; this risk should not be underestimated (See Figure 4).

2. The species exhibits variations in its reproductive cycle. In Argentina, which is likely its place of origin, it lays its eggs in the soil. However, evidence from other regions indicates oviposition within the pith of plants (Refer to Figures A6-A11 in Appendix).

3. The number of *Tucura* species is on the rise, necessitating further research to elucidate this phenomenon (Figure 3).

4. There exists an underlying risk that the insect could shift from a recession phase to a plague phase, which could result in famine and human migration for the regions affected.

5. When gregarization achieves densities such that only a single group is visible, it results in the formation of larval bands or large swarms of winged individuals

(Figure 5).

6. The Tucura exhibits behavior similar to that of a desert locust, likely due to evolutionary modifications. The warning signal occurs when there is swarming, specifically, when winged locusts, referred to as “allochthonous” (originating from different locations), form “clouds.” These migrating groups convene in environments that favor large and destructive progeny.

7. At high densities, the Tucura tends to regroup, thus becoming gregarious; this seems to be the current situation of the insect within the “El Cuayo” Ejido, where it has been subject to ongoing surveillance.

Many researchers highlight the connection between areas that are poorly managed, disturbed, or degraded and the prevalence of the Tucura. They also consider regions that have been subjected to land use changes. Forest ecosystems should not be converted into areas for agriculture, livestock, etc.

In “El Cuayo,” conditions conducive to the emergence of pests are prevalent, affecting not only Tucura but also other groups of phytophagous insects and fungi.

8. Certain agricultural and industrial practices contribute to the proliferation of locusts: these include excessive grazing, deforestation, irrigation, the introduction of novel cultivated plant varieties, dam construction, and ecosystem degradation. Such activities can enhance the destructive potential of locusts, and may even transform a previously harmless locust population into a predatory one.

9. The threat of Tucura migration remains a significant concern, as Mexico possesses regions that are conducive to hosting this insect: notably, the tropical zones along the Pacific Ocean and the microclimates of the Sierra Madre Occidental.

10. Two principal institutions are essential for both prevention and preparedness in response to potential emergencies: the FAO [4] and CIRAD© [2]:

a) The FAO manages a centralized information service on desert locusts within the locust group situated at its headquarters in Rome, Italy. Countries impacted by locust infestations have the capability to send their data to the FAO. This data is subsequently analyzed by the FAO in conjunction with climate, habitat data, and satellite imagery to assess the current locust situation, offer forecasts of up to six weeks, and issue warnings on an as-needed basis. Monthly bulletins are compiled by the FAO and distributed via email, fax, and postal mail.

The FAO also maintains a repository of locust specimens at its headquarters in Rome, Italy. Additionally, it offers training sessions and produces publications on various locust-related topics. The FAO undertakes field evaluation missions and orchestrates control and monitoring efforts, alongside providing assistance during locust outbreaks (Figure 9).

b) Another institution of significance is CIRAD, which focuses on three primary research areas:

- Investigating the biology and ecology of locusts, with the goal of understanding. For each country and its unique conditions: the triggers of locust swarms and their developmental processes. This research involves examining the environments where locusts inhabit and analyzing their life patterns and behaviors.



Figure 9. Alert status due to the high density of *Tucura* spp. Source: [2].

- Constructing ecological models and surveillance frameworks. While transitioning from one country to another, certain commonalities or similarities may be observed, such as identical vegetation, environments, locust species, or comparable climates.
- Analyzing and enhancing surveillance methodologies and control strategies to improve pest management. This includes experimenting with novel insecticides and evaluating their effects.
- Furthermore, CIRAD employs researchers specialized in locust studies, including entomologists, ecologists, and engineers, who constitute the Prifas team. This team is dedicated to researching locust behavior in their natural habitats to aid in refining surveillance techniques and methods for locust invasion prevention. They have recently conducted activities in regions such as Madagascar, the Near East, South America, China, Indonesia, Russia, and the United States, among others [2].

Recommendations

1. The primary recommendation pertains to the objective of this publication and the engagement of the REDGTD. It is imperative to secure technical support and resources from both the FAO and CIRAD. These institutions are dedicated to providing aid to countries affected by this issue.

2. The farmers in the ejido “El Cuayo,” as well as in other nearby areas facing the same challenge, will receive support from the FAO. They will be included among the countries that are continuously monitored via satellite technology. This will enable real-time awareness of the locust situation, and alerts will be provided in case of a shift from recession to plague phase. Furthermore, comprehensive training will be offered to ensure that Mexican technicians and producers are adequately prepared for any eventualities.

The CIRAD is another entity that should be engaged, focusing on three core

research domains: a) the biology and ecology of locusts, b) creating ecological models and monitoring systems, and c) enhancing surveillance techniques and control strategies to more effectively manage pest populations. This may include, for example, experimenting with novel insecticides and evaluating the outcomes of their application.

3. REDGTD should also undertake the task of collaborating with universities that have Academic Bodies specializing in research areas pertinent to solving the issue. This initiative should be extended to other Higher Education Institutions (IES) that have faculty specializing in entomology or related fields. Collaboration with competent Research Centers, such as INIFAP and CINVESTAV, is essential to ensure that this topic is incorporated into their annual work agendas. Lastly, foreign institutions should be invited to contribute to the research of affected regions.

4. Recent research concentrates on developing less detrimental methods, including biopesticides derived from pathogenic fungi, plant extracts, and the application of controlled burns. Although the conclusions provide information on biological control, it is deemed insufficient because *T. spp* exhibits unique adaptation traits, requiring targeted management strategies. Hence, experimental approaches are critical to efficiently managing populations.

5. In regions susceptible to potential infestation, implementing sanitary barrier strategies is necessary to prevent such occurrences.

Special Acknowledgment

We acknowledge the high quality of information provided by the organization with the most significant contribution concerning the Tucura. This refers to the website: <http://orthoptera.speciesfile.org/HomePage/Orthoptera/HomePage.aspx>

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

- [1] Bulacio, V., Vignaroli, L. and Gonsebatt, G. (2007) Tucura quebrachera presente. Revista agromensajes.
- [2] CIRAD© (2009) Agricultural Research for Development. CIRAD's Official Website. <http://www.cirad.fr/en>
- [3] Pedgley, D.E. (1981) Desert Locust Forecasting Manual. Vol 1. London, Centre for Overseas Pest Research. 115 pp.
- [4] FAO (1994) Desert Locust Guidelines (Five Volumes). In: FAO Pedgley, D., Ed., *Desert Locust Forecasting Handbook*, Overseas Pest Research Centre, 268 pp.
- [5] Steedman, A. (1990) Locust Handbook. Natural Resources Institute, Chatham, United Kingdom. U.S. Congress, Office of Technology Assessment 1990. A Plague of Locusts. Special Report, OTA-F-450. Government Printing Office, Washington, DC, U.S.A.
- [6] Gorochov (1995) Nota: Utilizado en la figura Género tipo: Regiata Whalley.

Zoologicheskii Zhurnal, **74**, 40.

- [7] Kukulová-Peck, J. (1991) Fossil History and the Evolution of Hexapod Structures. 2nd Edition, Melbourne University Press, Melbourne, 141-79.
<https://www.cabidigitallibrary.org/doi/full/10.5555/19930517656>
- [8] Uvarov, B.P. (1966) Grasshoppers and Locusts. A Handbook of General Acridology. Vol. 1, Cambridge University Press, 481 p.
- [9] Kristensen, R.M. (1991) A New Tanarctid Arthrotardigrade with Buoyant Bodies. *Zoologischer Anzeiger*, **240**, 425-439.
- [10] Rowell, C.H.F. (2013) In the Grasshoppers (Caelifera) of Costa Rica and Panama. The Orthopterists' Society. 611 pp.
- [11] Flook, P.K., Klee, S. and Rowell, C.H.F. (1999) Combined Molecular Phylogenetic Analysis of the Orthoptera (Arthropoda, Insecta) and Implications for Their Higher Systematics. *Systematic Biology*, **48**, 233-253.
<https://doi.org/10.1080/106351599260274>
- [12] Cadena-Castañeda, O.J. and Cardona, J.M. (2015) Introducción a los Saltamontes de Colombia (Orthoptera: Caelifera: Acrididea: Acridomorpha, Tetrigoidea & Tridactyloidea). 1-534. <https://www.gbif.org/species/8355967>
- [13] Pelizza, S.A., Eliades, L.A., Saparrat, M.C.N., Cabello, M.N., Scorsetti, A.C. and Lange, C.E. (2011) Screening of Argentine Native Fungal Strains for Biocontrol of the Grasshopper *Tropidacris collaris*: Relationship between Fungal Pathogenicity and Chitinolytic Enzyme Activity. *World Journal of Microbiology and Biotechnology*, **28**, 1359-1366. <https://doi.org/10.1007/s11274-011-0935-8>
- [14] Granados, R.R. (1981) Entomopoxvirus Infections in Insects. In: Davidson, E.W., Ed., *Pathogenesis of Invertebrate Microbial Disease*, Allanheld Osmun.
https://scholar.google.com/scholar_lookup?&title=Entomopoxvirus%20infections%20in%20insects&publication_year=1981&author=Granados%20CRR
- [15] Arif, B.M. (1984) The Entomopoxviruses. In: *Advances in Virus Research*, Elsevier, 195-213. [https://doi.org/10.1016/s0065-3527\(08\)60409-1](https://doi.org/10.1016/s0065-3527(08)60409-1)
- [16] Altieri, M.A. and Nicholls, C.I. (2008) Scaling up Agroecological Approaches for Food Sovereignty in Latin America. *Development*, **51**, 472-480.
<https://doi.org/10.1057/dev.2008.68>
- [17] Menéndez-Gámiz, C.R. (2016) Plan Comunitario Sustentable Ojital Cuayo 2030. REDGTD.
https://www.academia.edu/30986783/PLAN_COMUNITARIO_SUSTENTABLE_ODS_2030_La_experiencia_Ojital_Cuayo_1

Appendix

The developmental stages from egg to lobster¹².



Figure A1. Eggshell tree 3 mm inside the pith of a host plant stem.



Figure A2. Close-up of the top of a Forbes locust egg tree shows the intricate mesh-like pattern of the CAP.



Figure A3. Arrangement of tree eggs within the medulla of a tree.

¹²Source: <http://www.oecanthinae.com/3994.html>

Disclaimer: This site was developed by an amateur of the subject. The information provided is based on personal encounters. It does not come from a scientific project. Students are allowed to use images for school projects. Educators have permission to use images for given presentations. For the purposes of this publication, they are presented for illustrative purposes only.



Figure A4. Interior of an egg. Larva parasitized in late summer or fall 2010. Note the ectoplasm with appearance inside the egg.

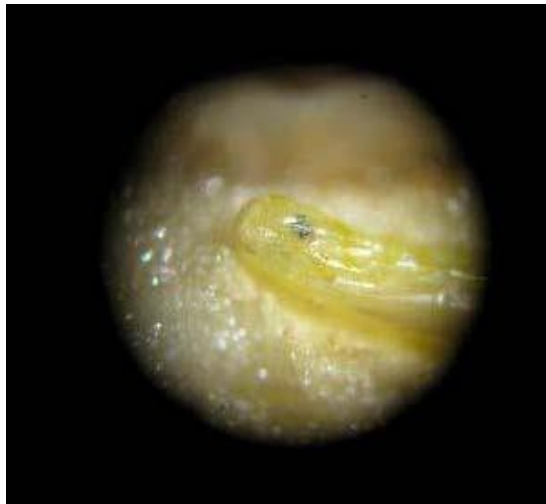


Figure A5. Change from larva to embryo, lobster eye becomes visible.



Figure A6. Metamorphosis from embryo to pupa, nymph (Photo) and finally to lobster.

Morphology of the Toucura (*Tropidacris* spp.).



Figure A7. Vista lateral de la Tucura quebrachera (*Tropidacris collaris*).

Fuente:

https://commons.wikimedia.org/wiki/Tropidacriscollaris#/media/File:2005-11-01_Tropidacris_collaris.JPG



Figure A8. Male *Tropidacris* spp, lateral view (holotype of *Gryllus rufosus*). **Source:** Cigliano citing: Carbonell, Cigliano & C.E. in: Lange. 2006. Acridomorph (Orthoptera) species of Argentina and Uruguay/Acridomorph (Orthoptera) especies 27 de Argentina y Uruguay.



Figure A9. Specimen of *Tropidacris* spp. collected in Venezuela. **Source:** © Christoph Röhrs (Ucksmucks).



Figure A10. Specimen of the *Tucura quebrachera* (*Tropidacris* spp) from Brazil, Pera Pernambuco. **Source:** C.S. (Carbonell, 2007).



Figure A11. Two views of the same male specimen of *Tropidacris* spp. Location: Kaw Road, PK40, French Guiana. **Source:** https://commons.wikimedia.org/wiki/File:Tropidacris_spp_MHNT_dos_%26_flanc.jp



Figure A12. Dorsal view of the *Tucura quebrachera* (*Tropidacris* spp). **Source:** https://commons.wikimedia.org/wiki/Tropidacris_spp

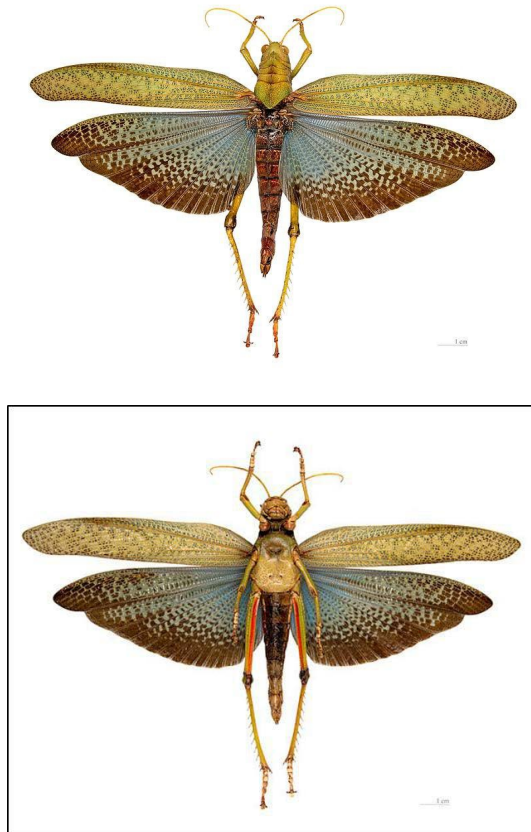


Figure A13. Pectoral view of the *Tucura quebrachera* (*Tropidacris* spp). Source: https://commons.wikimedia.org/wiki/Tropidacris_spp

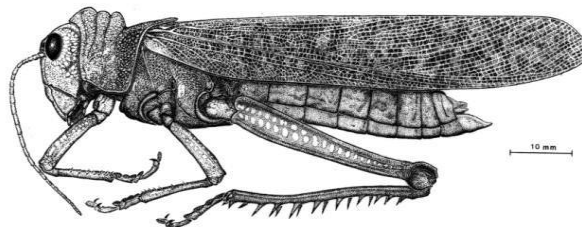


Figure A14. Female *Tropidacris* spp, lateral view (holotype of *Gryllus rugosus*). Source: Naturhistoriska Riksmuseet Stockholm male (NHRS), Image (Carbonell, 2007), C.S.

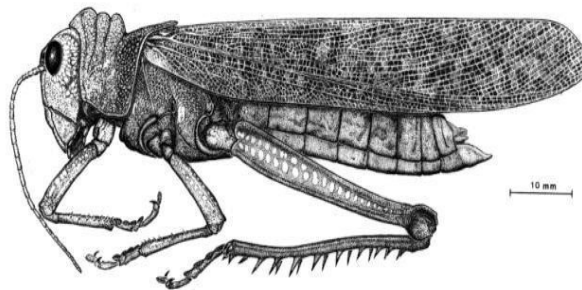


Figure A15. Male *Tropidacris* spp, external habitus (without in-depth analysis). Source: Carbonell. 1986. Proc. Acad. Nat. Sci. Philad. 138(2):366-402, **Figure 8**.



Figure A16. Head and pronotum of *Tropidacris* spp, specimen from Venezuela. Source: © Christoph Röhrs (Ucksmucks) 31.



Figure A17. *Tropidacris* spp male, head and pronotum, lateral view (holotype of *Gryllus rugosus*). Source: Naturhistoriska Riksmuseet Stockholm (NHRS), Image (Carbonell, 2007), C.S.



Figure A18. *Tropidacris* spp. nymph (Pirané, Formosa, Argentina, 25°42'13.29"S, 59°2'4.34"W February, 2012). Source: © Martina Pocco.

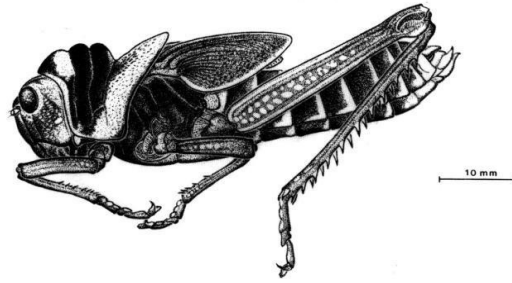


Figure A19. Female nymph of *Tropidacris* spp. Source: Carbonell. 1986. Proc. Acad. Nat. Sci. Philad. 138(2):366-402, **Figure 9**.



Figure A20. Lateral view of a female *Tropidacris* spp. Source: Museum National d'Histoire Naturelle, Paris, France. Source: Museum National d'Histoire Naturelle, Paris, France Image: (Carbonell, 2007), C.S.



Figure A21. Lateral view of a male *Tropidacris* spp. Source: Museum National d'Histoire Naturelle, Paris, France. Image: (Carbonell, 2007), C.S.



Figure A22. Dorsal view of a female *Tropidacris* spp (holotype of *Gryllus rugosus*). Source: Naturhistoriska Riksmuseet Stockholm (NHRS), Image Carbonell, C.S.

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