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Comparative study on the various species of locusts with special reference to its population fluctuation from Thar Desert, Sindh

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Abstract

Thar Desert is most favorable for life of human throughout the deserts of the world. It is rain fed land, some patches are cultivated by farmers in the form of fields for producing sources of economy, other large part of desert remains untouched for natural vegetation for livestock, but unfortunately little yield of desert is also affected by variety of insect including locusts. During present study four species of locusts; belonging to four genera *Anacridium*, *Cyrtacanthacris*, *Locusta* and *Schistocerca*, two subfamilies Cyrtacanthacridinae and Oedipodinae and one family Acrididae were reported from Thar Desert from June 2015 to May 2016. Comparative study revealed that two species *Schistocerca gregaria* and *Locusta migratoria* are swarming and destructive while, *Anacridium aegyptium* and *Cyrtacanthacridinae tatarica* are non-swarming but are larger in body size and graze more vegetation than both swarming species. Though these four species have ecological and morphological difference but the nature of damage is almost similar. All these species were recorded as pest of foliage of all crops and natural vegetation.

Keywords: Comparative morphology, geographic distribution, locusts, Thar Desert, damage to useful plants

1. Introduction

Thar Desert is 18th largest subtropical desert and densely populated desert of the world. 85% occupied by India and 15% by Pakistan. In Pakistan this desert form belt along the border of India in districts Ghotki, Sukhar, Khairpur, Sanghar, Umerkot and Tharparkar. Thar Desert get very short span of rainfall from start of the July month till the end of September throughout the year, despite of this very short period, precipitation may wet thirsty soil of this desert, if monsoon winds blow from Indian Ocean to Himalayan mountains, otherwise this miserable land yearns for a drop of water until next year monsoon shower blessings. Livelihood of more than 80% peoples of Thar Desert depends on the rain fed agriculture and livestock.

Locusts are short horned grasshoppers which are capable of producing swarms, migrating long distances and exhibiting phase polyphenism. Locusts are notorious pest and enemy of farmers because they can cause great devastation of natural and cultivated vegetation. There are 15 species of locusts belonging to family Acrididae [37], but a few locusts meets criterion of true locust defined by [29]. Locusts exhibit two phases: solitarious one that is harmless phase and gregarious one that is disastrous phase and solitarious phase may transform into gregarious phase. Whenever environmental conditions become favorable in any permanent breeding region the solitarious locusts are attracted to that region which results in outbreak [10]. These species has been affecting agro economy of the world adversely. So many plagues and outbreaks of locusts have been reported by various entomologists and organization (Anti-locust research center, National Resource Institute, Locust Watch under WHO) from long time, these plagues brought unwelcomed calamities to cultivated lands and livestock of the peoples. Deviation in Population densities of locusts due to Weather conditions and availability of food cause outbreaks, which in turn destroy vegetation and result into loss of agro- economy like, the outbreak of the Desert locust in 2003–2005, over 8 million African people victimized with 80 to 100% agro economy losses [8]. And over 1.5 billion US Dollars were invested to fight locust outbreak in 22 countries [7]. In Queensland 73 000 hectares being sprayed to combat outbreak of migratory locust in 1975 [14]. Outbreaks of migratory locust also reported from Africa in Middle Niger, the Sudan and Madagascar, and in Papua New Guinea [17], an outbreak of *L. migratoria* reported from Ladakh, India in 2006, affected pastures and

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crops adversely and also affected livelihood of peoples by causing accidents on roads ^[21] and so many other outbreaks and plagues of locusts are reported in literature. ^[3, 7-16, 20-22, 34-38, 40, 43-45] and Anti-locust research center, National Resource Institute, Locust Watch under WHO and *Schistocerca* information. These scholar and organizations worked out on different aspects of locusts throughout the world. ^[1, 5, 19, 24, 26, 28, 30-33] furnished the literature on locusts with some knowledge on various aspects from Pakistan. Yet, not comparative account regarding these four sibling species is available in literature. Therefore, this study is brought to spark new perception on unearthed aspects of locusts and add pebbles of knowledge to the world of science.

2. Material and Method

2.1 Collection

Authors collected different species of locusts from various localities of Thar Desert during early morning by hand because at dawn they were inactive, while they were captured by help of net after vigorous struggle due to their attentive nature to passersby in their surroundings in warmer part of the day. These specimens were captured from cultivated and natural vegetation, while authors were surveying various localities of Thar Desert time to time throughout the year. Collected material was fetched to laboratory in plastic jars, polythene bags and boxes then sorted out species wise in laboratory.

2.2 Killing and Preservation

Specimens were killed by application of potassium cyanide in laboratory. Tegmina and wings of some specimens were stretched out for study of morphological characteristics of genital and other taxonomic parts. Then specimens were pinned by inserting pins on pronotum, mounted in wooden boxes and preserved as permanent material for further taxonomic and comparative study. Naphthol balls were kept in boxes for preventing from ants and other destructive insects attack.

2.3 Identification

All collected specimens were identified with help of description of species and their identification keys available from literature and websites ^[47-48].

2.4 Photograph and Line Drawings

Photographs of these four species of locusts were taken by Nikon Coolpix P520 camera, taxonomic parts of the bodies were focused. Line drawings of various taxonomic parts of the locusts' body were drawn with help Adobe.Illustrator.CS5.v15.0.2.Lite.Portable software.

3. Result and Discussion

3.1 Anacridium Aegyptium (Linnaeus, 1764)

Description and Diagnosis

A. aegyptium are larger in size, female is very larger than male, and powerful locust found on trees that's why known as tree locusts, Olive brown in color and integument also shines like olive. It is a solitary species scattered in tree and shrubs, not harmful to crops but, consume enough vegetation. They are dull and remain calm in spite of movement of passersby but fly away or escape only at that time when, disturbed or teased by someone or something. Occurrence of this species is recorded throughout seasons of the year with same ratio but mating and oviposition observed only during monsoon season. Median carina of Pronotum is light orange or red in

color, this is peculiar character. Tegmina is olive brown in color spotted with very small, light dark concentrated dots. Antennae are robust and black in color.

3.2 Morphometry and Coloration

A. aegyptium males grow up to 32–55 mm long, while females reach 61–70 mm of length, the antennae are relatively short, robust and black in color. Tibiae of the hind legs are blue, spines on tibia large and sharp; base of spine is brown, subapical is red, while apices are black in color. The hind femora are orange having characteristic dark markings. It is easily distinguished by the characteristic eyes with vertical black and white stripes. The pronotum have a median orange carina, three transverse sulci and several white small spots and posterior end is slightly angular. The wings are clear with dark marks.

3.3 Distribution

A. aegyptium, the Egyptian Locust is found in Africa, Asia and Europe. It is known as one of the largest European grasshoppers.

Earlier, this species has been reported from Faisalabad, Bahawalpur, Cholistan, Kharan, Khuzdar, Badin, Jhelum, Kalat and Bhakkar by ^[39]; from Quetta, Pishin and Karachi by ^[11]; from Faisalabad by ^[1, 24] and from Chiniot by ^[26]. Recently we have collected from crop fields of Umerkot, Mahandrejo-jo-par, Khokhrapar, chachro, Nangarparkar, Pakistan. These localities are the new record for this species

3.4 Life Cycle

A. aegyptium is univoltine species, lays eggs in deep soil along spring season, hoppers grow during hot season, and take 52-89 days to develop into adult. Hoppers male pass into six instars, whereas female pass into 7-8 instars. Female may arrest in reproductive diapause

3.5 Useful Plants Attacked

Jujube tree (*Ziziphus nummularia*), kunbhat tree (*Senegalia senegal*), Roheero tree (*Tecomella undulata*), phog (*Calligonum polygonoides*), kandi tree (*Prosopis cineraria*), mustard tree (*Salvadora oleiodes*), snow bush (*Aerva javanica*), bekar grass (*Indigofera caerulea*), bhurat (*Cenchrus biflorus*), water melon (*Citrullus lanatus*).

4. Cyrtacanthacris Tatarica (Linnaeus, 1758)

4.1 Description and Diagnosis

C. tatarica are polyphytophagous found in scanty grasses especially in crop fields, are easy to spot from far away. They are larger in size, background color of body is half white or creamy with maroon stripes and spots. A creamy stripe runs on median of head, pronotum and tegmina posteriorly, two dark maroon bands on lateral sides of head and pronotum, dark maroon irregular shapes spots on the tegmina with creamy background that's why they are named as brown-spotted locust. You may be faked out by first glance at this species because it resembles *Schistocerca americana* superficially. But its significant character, Prosternal process which is large, widened in middle and gradually narrowing towards apex, strongly curved backwards, touching or nearly touching mesosternum, can distinguish *C. tatarica* from *S. americana*.

4.2 Morphometry and Coloration

Body of large size. Antennae filiform, creamy in color. Fastigium of vertex angular. Frontal ridge narrow, slightly

depressed at median ocellus. Dorsum of pronotum crossed by three transverse sulci; median carina low; lateral carina absent; posterior margin of pronotum angular. Mesosternal interspace open, lobes rectangular. Tegmina and wings fully developed. Hind femur slender having black line on upper and lower margin and very powerful. Spine of tibia are large and very sharp, base of each spine is yellow creamy, subacute apex is red and terminal of spine is black in color. A black spot on lateral sides of each segment of abdomen is present which may be its peculiar character.

4.3 Distribution

C. tatarica is pest of vegetation distributed in African countries; Ethiopia, Africa, Sudan, Chad, Madagascar, Asian countries, Nepal, Sri Lanka, Vietnam, Yemen, India, Pakistan. Earlier, [23] collected *C. tatarica* from India, Rajasthan, Udaipur, Rajasmand; [39] from Pakistan Bahawalpur, Cholistan, Dera Ghazi Khan; [1, 24] from Faisalabad; [30-31] from Karachi and [26] from Jhang. Recently we have collected from crop fields of Umerkot, Mahandrejo-jo-par, Khokhrapar, Chachro, and Nangarparkar, Pakistan. These localities are the new record for this species

4.4 Life Cycle

C. tatarica lay eggs deeply in sandy, loose and moist soil. These eggs hatch in about 29 days. Hoppers become adult in about 71-82 days and hoppers pass into 6-7 instar stages [4]. Longevity of *C. tatarica* is 38 days in male, 70 days in female.

4.5 Useful Plants Attacked

Pearl millet (*Pennisetum glaucum*), Phog (*Calligonum polygonoides*), Cluster bean (*Cyamopsis tetragonoloba*), jujube (*Ziziphus nummularia*), snow bush (*Aerva javanica*), bekar grass (*Indigofera caerulea*), water melon (*Citrullus lanatus*), bhurat (*Cenchrus biflorus*).

5. Schistocerca Gregaria (Forskala, 1775)

5.1 Description and Diagnosis

S. gregaria are beautiful, migratory and swarm producing locusts and disastrous pest, found in deserts from Mauritania to India. Adults appear in vegetation grown after seasonal rains, which may result from migration to vegetation or due to development of generation from a few adults. Color of desert locust varies in accordance with environment and background of habitat in which they live like pinkish sandy, beige, yellowish brown, wheat color. They are very curious, hop up or fly when someone passes in surrounding and escaped quickly from predators or collector. Mostly found on ground in pastures and crops fields but, during warm part of the day they hide in shades of herbs and shrubs or climb on stem of trees.

5.2 Morphometry and Coloration

Body of large size about 40-65mm in length, Antennae filiform, of same color that body possess, shorter than head and pronotum together. Fastigium of vertex trapezoidal, with shallow longitudinal depression. Eyes are oval in shape, striped by black and brown color alternately. Pronotum constricted, crossed by three transverse sulci, median carina low, sometimes indistinct in prozona, lateral carina absent, metazona about as long as prozona, posterior margin is rounded. Prosternal process cylindrical, moderately bent towards mesosternum but not touching it. Posterior of tibia is light pink, with medium spines, base of each spine is of same

color that integument possess but, terminal is black in color. Tegmina fully developed and dorsally spotted with concentrated dark dots, apex obliquely rounded.

5.3 Distribution

African countries: Algeria, Burkina Faso, Egypt, Ethiopia, Guania, Israel, Jordan, Lebanon, Mali, Mauritania, Morocco, Saudi Arabia Tehama, Yemen, Saudi Arabia, Egypt, Pakistan and India Northern Africa, Arabia and Indian subcontinent [38, 45].

It is a common species found throughout Pakistan. Earlier, [2, 31] reported this species all over Pakistan; [39] from Jhang, Multan, Kallar Kahar, Kohat, Dera Ghazi Khan, Dera Ismail Khan, Loral, Kharan, Khuzdar, Cholistan, Makran coast and Bhakkar; [1, 24, 26] from the Punjab; [19] from Lasbela (Baluchistan) and [46] from Sindh.

Recently we have collected from crop fields of Umerkot, Mahandrejo-jo-par, Khokhrapar, Chachro, and Nangarparkar, Pakistan. These localities are the new record for this species.

5.4 Life Cycle

Desert locust have 3 to 6 generations per year and lays 20-100 eggs per pod, each female lays 2-3 pods [41]. Eggs of desert locust hatch in 10 days at moderate temperature but in 65 days during winter and hoppers shed off 5-6 molts and take 24 days to become adult if conditions are favorable like temperature, humidity and vegetation but 95 days during winter.

5.5 Useful Plants Attacked

Pearl millet (*Pennisetum glaucum*), Phog (*Calligonum polygonoides*), Cluster bean (*Cyamopsis tetragonoloba*), jujube (*Ziziphus nummularia*), snow bush (*Aerva javanica*), Mustard tree (*Salvadora oleiodes*), bekar grass (*Indigofera caerulea*), water melon (*Citrullus lanatus*), bhurat (*Cenchrus biflorus*).

6. Locusta Migratoria (Linnaeus, 1758)

6.1 Description and Diagnosis

L. migratoria is serious pest of agricultural crop, pastures and non-crop fields. They are yellowish brown in color with light dark spots on tegmina. Size of head is large as compared to thorax, having blue or purple color mandibles, prosternal process is absent.

6.2 Morphometry and Coloration

L. migratoria grows about to 15-50 in length, yellowish brown in color and light black spots on posterior-lateral part of hind wings, antenna is filiform and yellow in color, and median of hind wings is not spotted. Pronotum is raised medially and form arch transversely, having one transverse sulcus, posterior end is angular. Head is larger in size as compare to body size, eyes are unstriped and not oval or rounded in shape. Femur is crested and having dark marks, tibia is yellow having small spines, base of each spine is yellow and apices is black. A transverse furrow on sternum.

6.3 Distribution

L. migratoria the only species of genus *Locusta* is most widespread throughout world, its nine subspecies are distinguished from various regions [18]. Its incidence prevail in Sub-Saharan Africa, Madagascar, southern Arabian Peninsula, Iran, Iraq, Sri Lanka, Bangladesh, China, India, southern Europe, Japan, Philippines, Australia and New Zealand [9, 16, 43-44] and [27] highlighted occurrence of this

species from Baluchistan. Recently we have collected from crop fields of Umerkot, Mahandrejo-jo-par, Khokhrapar, Chachro, and Nangarparkar, Pakistan. These localities are the new record for this species.

6.4 Life Cycle

L. migratoria can be found all the year but their incidence remains higher in favorable seasons of the year. Having 4 or 6 generations per year depending on the how long soil is moist throughout the year. Eggs hatch in 8-15 days and eggs may arrest in diapause up to 9-11 months or even 21-22 months. Hoppers take 3-4 weeks to become adult in summer season and 4-5 weeks in winter [27].

6.5. Useful Plants Attacked

Pearl millet (*Pennisetum glaucum*), Phog (*Calligonum polygonoides*), Cluster bean (*Cyamopsis tetragonoloba*), jujube (*Ziziphus nummularia*), snow bush (*Aerva javanica*), bekar grass (*Indigofera caerulea*), water melon (*Citrullus lanatus*), bhurat (*Cenchrus biflorus*).

7. Discussion

Four species of locusts belongs to three genera *Anacridium*, *Cyrtacanthacris*, *Schistocerca* of sub family Cyrtacanthacridinae and one genus *Locusta* of sub family Oedipodinae, family Acrididae, dug out from Thar Desert during present study table no 1. Out of these four species of locusts two species *Schistocerca gregaria* and *Locusta migratoria* are notorious and infamous pest of more than 400 species of plants [44]. Authors collected these specimens from cultivated field as well as natural vegetation. *S. gregaria* were mostly found in bajra crop (*Pennisetum glaucum*) and rarely from other crop or natural vegetation whereas [39] from cotton and other fodder crop, *C. tatarica* and *L. migratoria* were collected from guar crop (*Cyamopsis tetragonoloba*) and bekar grass (*Indigofera caerulea*) whereas [23] collected *C. tatarica* from grasses, herbs and shrubs near cotton fields and jowar and *L. migratoria* from grasses, while *A. aegyptium* from jujube tree (*Ziziphus nummularia*) in natural vegetation whereas [39] from maize, cotton and sorghum fields. Adults of *A. aegyptium* were observed all the year in trees with uniform ratio during different seasons. *L. migratoria* were come in collection after monsoon rains and vegetation but observed in winter and spring. *C. tatarica* were collected by authors in all seasons of the year but ratio was greater in late monsoon season, and out of collected specimen of *C. tatarica* mostly were female. While surveying localities of Thar Desert

authors spotted *S. gregaria* throughout year, but they were very rare in winter and their incidence in late winter and spring was little and observed after vigorous search in fields, whereas their occurrence had been increasing since first monsoon rain showered over desert. As vegetation grew after monsoon showers, the number of *S. gregaria* increased. During field survey of various localities, we noticed that the incidence of *S. gregaria* had been increasing at alarming rate in bajra crops in a locality of Mahandre-jo-par since 3rd or 4th rainfall but, they had not been gregarizing, instead of that alarming number they were scattered in bajra crops. Immature were also observed wandering in bajra crops. If environmental conditions remain same, they might have either gregarize or cause massive damage to crops but, people of that area were lucky enough because this happened lately. Farmers had harvested bajra crops and cold winds blew in earlier winter. These two conditions became barrier to the gregarization of *S. gregaria*. Authors carried out comparative study of these four species in laboratory as well. We examined these species and produced line drawing of different taxonomic parts for comparison which are given in fig. no. I and II. During comparative study we focused on descriptive characters of each species. Our description met with description on *S. gregaria* published by [6, 20, 39, 46], *A. aegyptium* by [6, 12], *L. migratoria* by [22, 25] and *C. tatarica* by [12, 20, 39, 42]. While, carrying out comparison of these species we noticed some comparative characters which were not common in these four species, which are shown in table no 2. In this study we concluded that out of above mentioned three species of subfamily Cyrtacanthacridinae one species namely *S. gregaria* is swarm causing destructive true locust, only species of subfamily Oedipodinae *L. migratoria* from this study is also swarm causing injurious true locust, but two other species of locust *C. tatarica* and *A. aegyptium* are not destructive. *C. tatarica* and *A. aegyptium* are larger in body size and very powerful and spines on tibia are larger and red and black in color only this character is similar in both. Spine on tibia of *S. gregaria* and *L. migratoria* are small and black in color, these both species also share this character only. Hopefully this paper reveals that these four species are destructive to same vegetation, in spite of having different morphology, ecology and biology and also disclose that two swarm causing destructive locusts species exist in this area (Thar Desert). Authors recommend that agriculture organizations should keep an eye on activities of these species during monsoon season so that agro economy of Thar Desert could be protected from calamity.

Table 1: Population dynamics of locusts from various localities of Thar Desert.

Locality	Latitude	Longitude	Collection of locusts			
			<i>A. aegyptium</i>	<i>C. tatarica</i>	<i>S. gregaria</i>	<i>L. migratoria</i>
Umerkot	25° 22' 22''N	69° 55' 15''E	12	04	31	05
Khokhrapar	25° 44' 53''N	70° 15' 31''E	17	07	36	03
Mahandre-jo-par	25° 35' 14''N	70° 09' 39''E	26	11	87	08
Chachro	25° 06' 48''N	70° 14' 33''E	13	03	42	04
Nangarparkar	24° 38' 23''N	70° 32' 18''E	11	06	39	03
All together			79	31	235	23

Table 2: Description of some taxonomic characters of locusts for comparative study.

Comparative character	Species			
	<i>A. aegyptium</i>	<i>C. tatarica</i>	<i>S. gregaria</i>	<i>L. migratoria</i>
Color antennae	Black	Light yellow or creamy	Beige, grey, sandy	Yellow
Shape and color of eye	Oval and white and black stripe	Oval and white and black stripe	Oval and white and black stripe	Angular and unstriped black
Pronotum	Raised Three sulci	Raised Three sulci	Compressed Three sulci	Arched One sulcus

	Posterior end is slightly angular	Posterior end is angular	Posterior end is rounded	Posterior end is angular
Prosternal process	Straight, larger	Larger, bent apically touching mesosternum	Straight	Absent

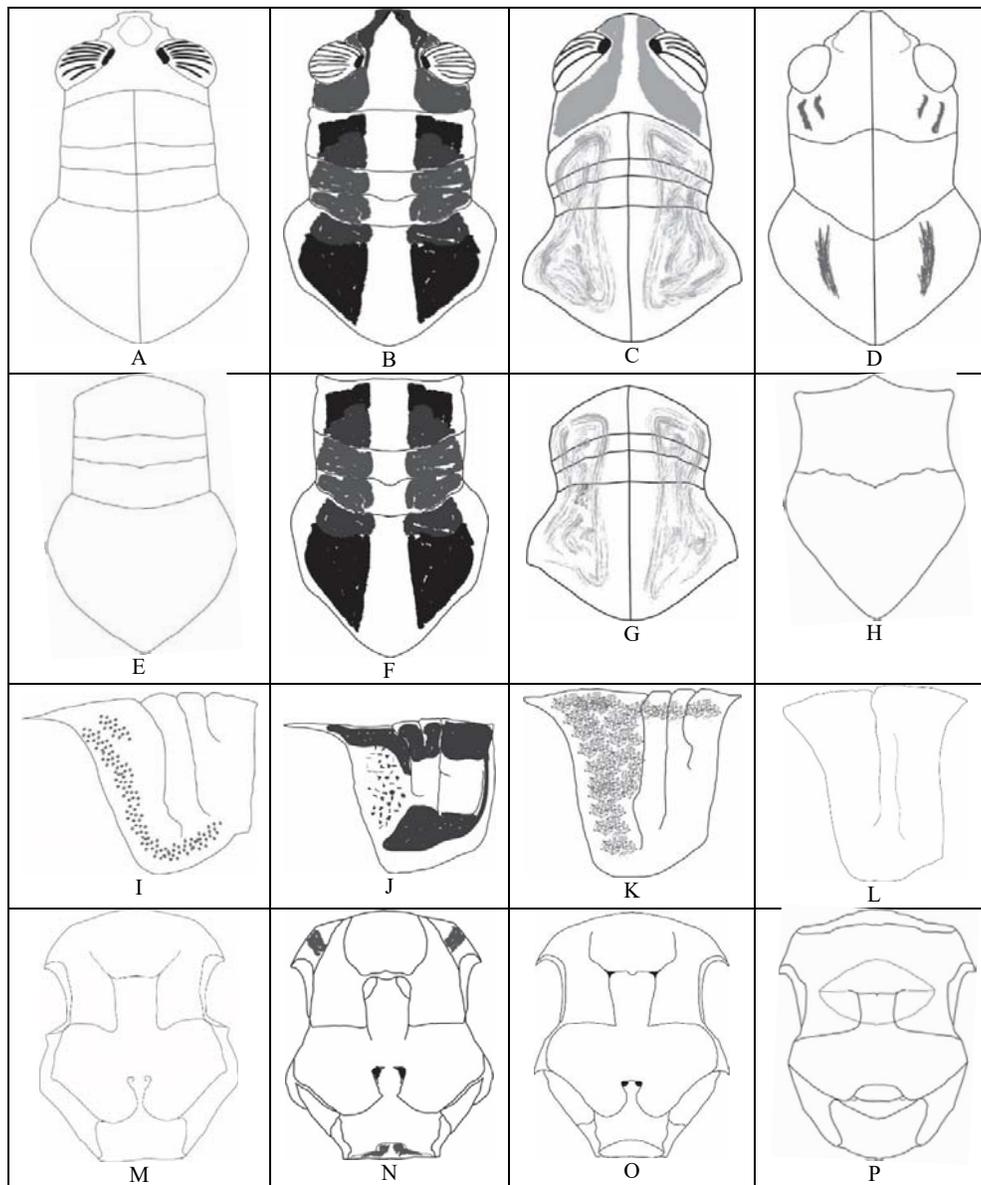
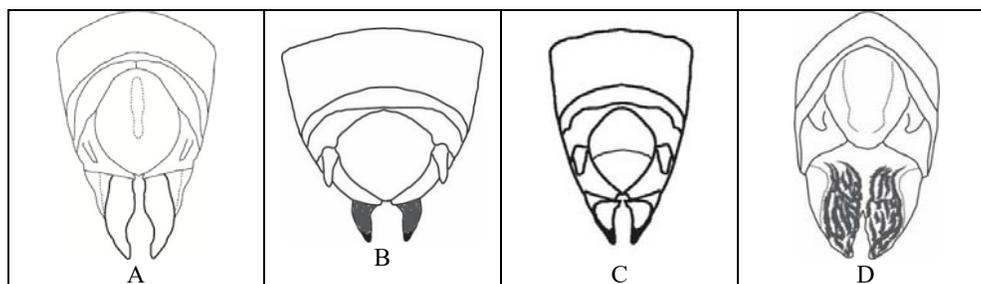


Fig 1: Showing comparison between different body parts of various species of locusts. Head (A) *A. aegyptium* (B) *C. tatarica* (C) *S. gregaria* (D) *L. migratoria*, Pronotum (E) *A. aegyptium* (F) *C. tatarica* (G) *S. gregaria* (H) *L. migratoria*, lateral view of Pronotum (I) *A. aegyptium* (J) *C. tatarica* (K) *S. gregaria* (L) *L. migratoria* and sternum (M) *A. aegyptium* (N) *C. tatarica* (O) *S. gregaria* (P) *L. migratoria*



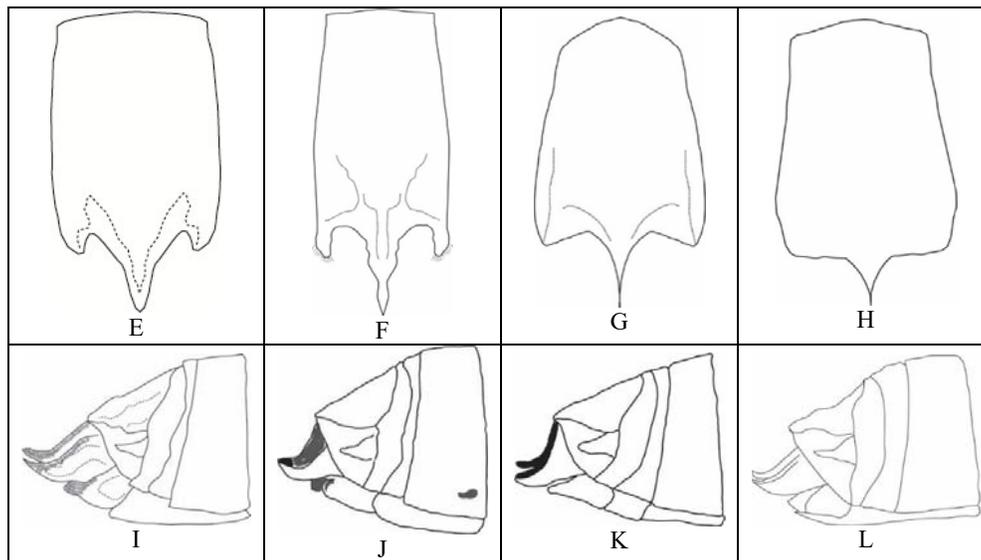
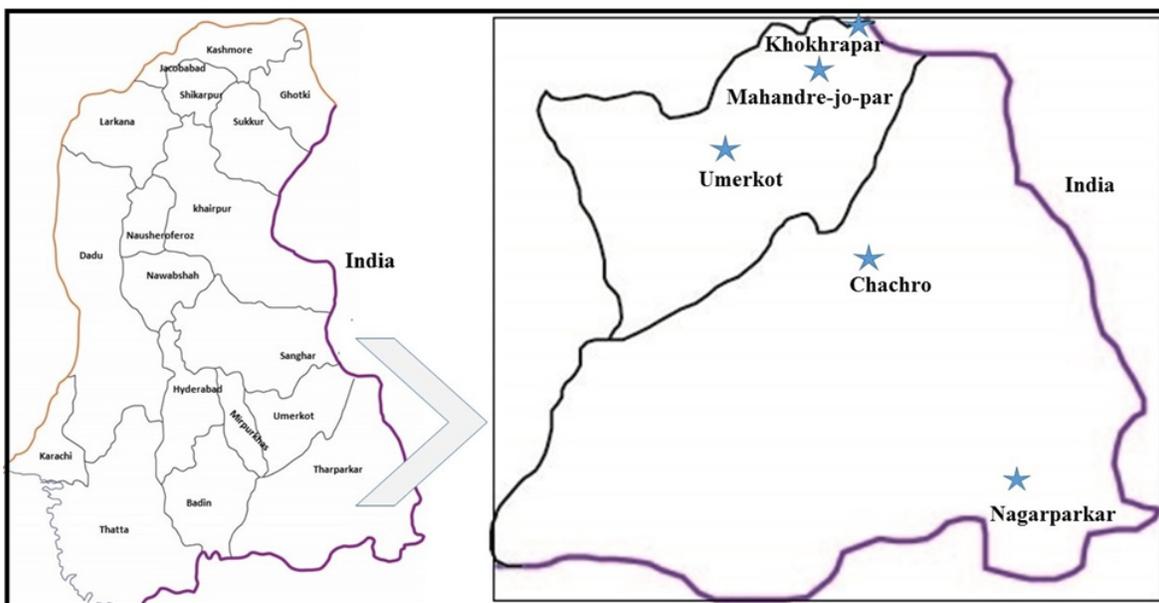


Fig 2: Showing comparison between different body parts of various species of locusts. Supragenital plates (A) *A. aegyptium* (B) *C. tatarica* (C) *S. gregaria* (D) *L. migratoria*, subgenital plates (E) *A. aegyptium* (F) *C. tatarica* (G) *S. gregaria* (H) *L. migratoria*, lateral view of genital plates (I) *A. aegyptium* (J) *C. tatarica* (K) *S. gregaria* (L) *L. migratoria*





Fig 3: Photographs of locusts with dorsal, ventral and lateral views and their tibias



Map 1: Indicating various localities of Thar Desert.

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