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# Jordan Country Study on Biological Diversity

# Arthropods of Medical Importance in Jordan

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# Arthropods of Medical Importance in Jordan

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# CHAPTER 1
# INTRODUCTION

Medical entomology is a growing branch of entomology. The science of medical entomology deals with the arthropods that are capable of transmitting diseases or can inflict injury or envenomation to man. Several groups of arthropods can act as vectors for viral, bacterial, protozoans and ricketessial diseases or can act as intermediate hosts for roundworms (Nematodes), flat worm (Digenitic trematods) and ribbon worms (Cestodes).

Medical entomology investigates into the etiologic agents, life cycles, and the epidemiology of disease transmission. It is also involved in finding practical means for controlling the target arthropod to reduce the risk of acquiring infections. Methods in controlling the different arthropods changed dramatically over the past two decades, where environmentally safe strategies are followed, by using natural enemies, natural products as well as biodegradable insecticides.

Dipterans (two-winged insects), are by far the most important arthropods incriminated in diseases transmission. Malaria is the most debilitating arthropod-borne disease that causes high mortality reaching up to 2 million annually.

Jordan is considered a part of the subtropical region. Arthropod-borne diseases are very much related to several socioeconomic, cultural and environmental factors.

The first attempt to define arthropods of medical importance in Jordan was the carried out by Amr (1988). For many years working in the field, consultant for the Ministry of Health and other private agencies, and conducting original research, the present author reached the dire need to compile all materials and published work on the medical entomology in Jordan. Certainly, more research is needed to define all aspects of medical entomology in Jordan. This requires cooperative efforts of health officials and scientists involved in various domains related to health and entomology.

In this book, the major human arthropods of medical importance occurring in Jordan are discussed based on available literature and the author's personal experience.

**References**

Amr, Z. S. 1988. Arthropods of Medical Importance in Jordan. *Jor. Med. J.*, 22 (2):125-137.

# CHAPTER 2
# ARTHROPODS AND DISEASES

Phylum Arthropoda includes the highest number of species among all other known phyla. Arthropods are adapted to feed on a great variety of food items that ranges from decaying materials, other arthropods or animals and tissue fluids of other animals. Also, arthropods exhibit a wide range of forms and many show peculiar adaptations for their survival. Some are winged and can travel long distances, while other are localized on the host's body.

In Medical Entomology, only a small fraction of the arthropods are considered of medical and veterinary importance. They affect human welfare either directly (Bites, stings, or living on human body) or indirectly (Disease transmission).

Arthropods can affect man and animals in many different ways; annoyance, accidental injury to exposed sense organs, dermatitis, envenomization, blood loss and allergy. Also, as indicated earlier, they can act as mechanical, biological or intermediate host for pathogens (Herms & James, 1968).

Direct exposure to arthropods such as scorpion and wasp stings or spider bites involve injection of toxins within the human body. Essentially, direct or immediate response is observed, and sometimes the clinical symptoms become very complicated. In the Middle East, serious direct exposure is exemplified in scorpion stings. We will examine this topic in Chapter 12. Very little is known about the magnitude of wasp and bee's envenomization. Other arthropods that may inflict serious stings or bites are the centipedes. The Sarcoptid mite, *Sarcoptes scabiei*, infest human skin, and cause discomfort and itching sensation that leads to secondary skin bacterial infection. This is true for other blood-sucking insects that are not involved in disease transmission (e.g. bed bugs).

The role of arthropods in disease transmission is by far the most important indirect mean that affects human health. Many arthropods cause significant sickness and death in many countries in the world. For example, 1 to 2 million people die annually due to malaria. Still many other diseases causing death or severe complications (e.g. East River blindness, African sleeping sickness and Elephantiasis) are transmitted by arthropods.

The relationship between the etiologic agent (disease causing organism) and the arthropod (vector) is very complicated. Such relationship evolved over a very long period of time, where as the internal environment of the vector allows the etiologic agent to survive, and propagate or develop and then transfered into the suitable host. Some vectors act as mechanical or biological vehicles for the etiologic agent (Azad & Beard, 1998).

**Mechanical Transmission:**

In this mode of transmission, the vector's external body may become contaminated with the pathogen (appendages, mouthparts etc.) or regurgitated. The pathogens will not undergo biological development or multiplication while on or in the vector. It is only the pathogen that can survive such circumstances will be transmitted if the vector contaminates food items consumed by man. The pathogen is carried while the flies are walking or feeding on contaminated materials.

Houseflies and cockroaches act as mechanical carries for several bacterial, protozoan and nematodes. For example, the housefly has been incriminated as a carrier for several gastrointestinal diseases (*Shigella* sp., *Salmonella* sp., *Vibrio* sp.).

## Biological Transmission

In this mode, the pathogen may undergo developmental, propagative or both cycles within the body of the vector. In the developmental cycle (Cyclo developmental), the pathogen differentiates into different stages that are distinct from each other. These changes may occur in different tissues of the vector, and subsequently produce the infective stage to the final host. Elephantiasis caused by *Wuchereria bancrofti* is an example of Cyclo-developmental transmission. However, in the propagative cycle (Propagative transmission), the pathogen multiplies and increases in number within the vector's body. This insures the production of a maximum number of the pathogen to infect the final host. Multiplication of *Yersenia pestis*, the etiologic agent for bubonic plague, in the flea is considered as propagative transmission.

In the cyclo-propagative transmission, the pathogen undergoes both developmental and multiplication cycles. *Plasmodium* is the best example, where as the malaria parasite exhibits several forms (gametocyte, zygote, sporozoite) and at the same time multiplies within the vector's body.

## Maintenance of Pathogens within the Vector

Pathogens can remain within the arthropod body despite the fact that arthropods molt and acquire different stages during their life history. Some insects and acarines molt several times during their life cycle, and the pathogen could be maintained when ever it gained entrance to the vector body. In some arthropods, the pathogen can be transferred from one stage to the following one; this is known as the transstadial transmission. *Borrelia* can be transmitted from the larval, nymphal and to the adult stages of some ixodid ticks. On the other hand, pathogens could be transferred from the female into its eggs (Trans-ovarial transmission). Several viruses transmitted by mosquitoes can remain in the mosquito's eggs and then in the larval stages. Some pathogens (*Borrelia* sp.) is maintained by both trans-ovarial and transstadial transmission.

## References

Azad, A. F. & Beard, C. B. 1998 . Rickettsial pathogens and their arthropod vectors. *Emerg. Infect. Dis.*, 4(2):179-186.

Herms, W. & James, M. 1968. *Medical Entomology*. The Macmillan Co. 616 pp.

# CHAPTER 3
# MOSQUITOES

Mosquitoes are considered by far the most important insects known for transmitting arthropod-borne diseases. Mosquitoes are dipterans and included in the Family Culicidae. About 3500 mosquito species and subspecies are known worldwide inhabiting almost all types of habitats. The female mosquito seeks a blood meal prior to ovipoistion, this blood is obtained from a large variety of terrestrial vertebrates, including man. This feeding habit resulted in transmitting many diseases to humans, domestic and wild animals. The most important disease associated with mosquitoes is malaria in its different forms. At least 2 million fatalities are attributed to malaria annually, with 200 million new cases. Viruses and nematodes are also transmitted by mosquitoes.

## Morphology

Adult mosquitoes are recognized by the presence of scales on their wings as well as the long proboscis that extends forwardly. They are usually 3-6 mm long. Males are distinguished from females by their brush-like antenna.

The body is divided into three regions (**Figure 3.1**):

1. The head: globular in shape and harboring a pair of compound eyes, a pair of antenna, a pair of palps and a projecting proboscis. Narrow, wide and erect scales cover the head. The proboscis is modified for piercing and consists of a pair of mandibles, a pair of maxillae, and a hollow hypopharynx.

2. The thorax: It consists of three fused segments; prothorax, which bears the first pair of legs, mesothorax with a pair of wings and the second pair of legs and the metathorax carries the third pair of legs and the balance organ, the halters.

3. The abdomen: This region consists of 10 segments, only the first seven or eight are visible, while the last three are modified as a reproductive structure.

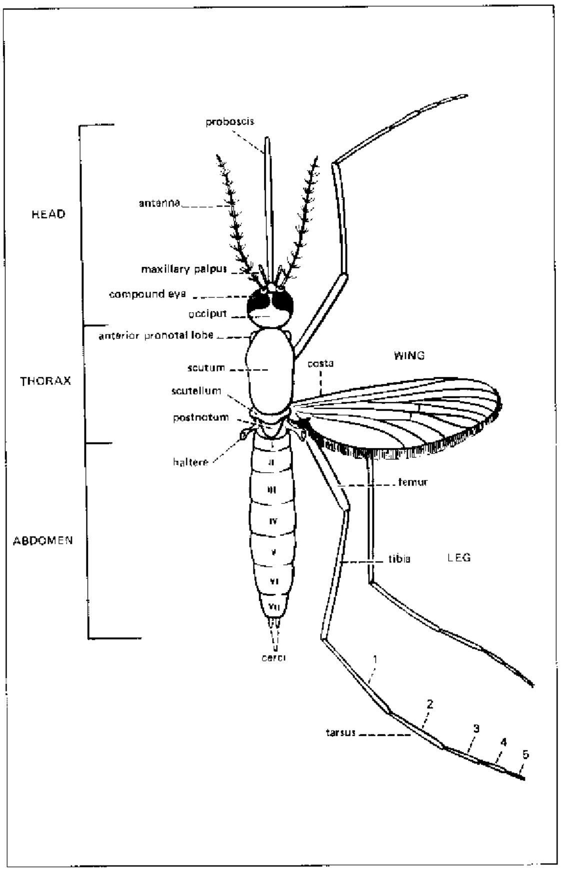



*Figure (3.1) : Morphology and body parts of a mosquito*

## Life Cycle

Mosquitoes undergo complete metamorphosis; they have several stages in their life cycle (Eggs, larval stages, pupa and adult). After taking a blood meal, the female mosquito will lay its eggs on the surface of an aquatic habitat. Eggs are deposited either singly or as an egg raft (**Figure 3.2**). The egg hatches into the first instar larva, and depending on the species,

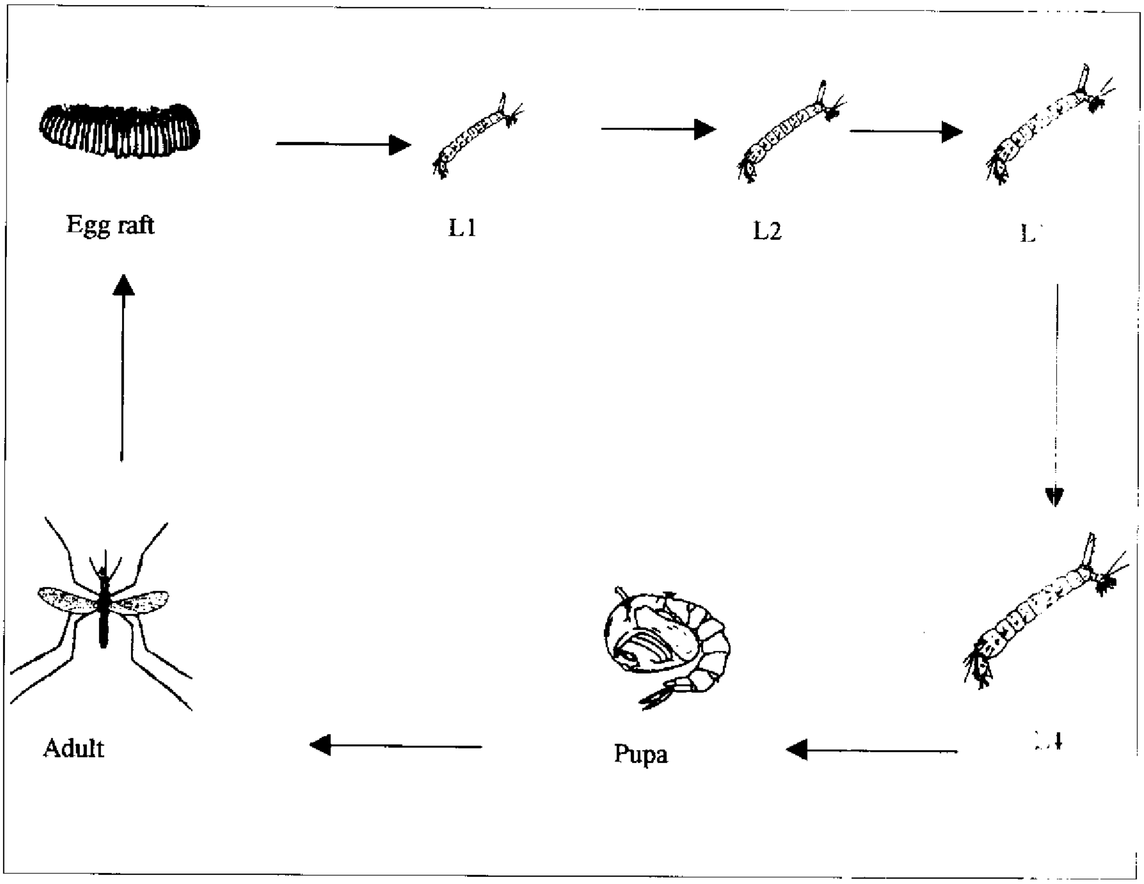



*Figure (3.2): Life cycle of a culicine mosquito*

another series of moltin occurs, yielding three other larval stages. Larvae feed on small aquatic organisms as well as on decaying organic materials. The period between molting depends on the species and the environmental factors. After the fourth instar molts, the pupal stage emerges and within a week, it molts into the adult.

## The Status of Malaria in Jordan

The Jordan Valley was known for its malaria hyperendemecity. Elsewhere in Jordan the disease was in the meso-hyperendemic range. Anon (1944) and Lumsden & Yofe (1950) elaborated on the magnitude of malaria in Jordan. It seems that malaria was endemic in most parts of the country and particularly the Jordan Valley. Amadouny (1997) gave a comprehensive historical perspective on the campaign against malaria during 1926-1946. He discussed the epidemiology and distribution of malaria during this period. Alicata & Dajani (1954) reported on drugs used in malaria treatment.

After launching a malaria eradication program in the late 1950's, the country was declared malaria free in 1970 (De Zulueta & Muir 1972). Due to high receptivity and vulnerability especially in the lowlands, a vertical malaria control program still exists despite the malaria free status. Since 1970, most *Anopheles* breeding sites all over the country are still under weekly larviciding using temphos (Amr *et al.*, 1997).

Three species of *Anopheles* are considered as either major or important vectors for malaria in Jordan. *Anopheles superpictus* and *Anopheles sergenti* are quite common in the Jordan Valley and the eastern mountains, while *Anopheles sacharovi* has a limited distribution in Irbid area. Anopheline mosquitoes require close-up studies in relation to their seasonal abundance, habitat preference and biology (Amr *et al.*, 1997). In 1990 a malaria outbreak took place in the Karak lowlands resulting in 33 *Plasmodium vivax* cases among the locals.

*Table (3.1): Main vectors for malaria in Jordan*

| Species | Category | Status |
|---|---|---|
| *Anopheles sacharovi* | Important | Rare |
| *Anopheles superpictus* | Major | Common |
| *Anopheles sergentii* | Major | Common |

## Mosquitoes of Jordan

The mosquito fauna of Jordan consists of 26 species representing 5 genera (*Anopheles*, *Aedes*, *Culex*, *Culiseta* and *Uranotaenia*). The genus *Anopheles* is represented by 13 species belonging to two subgenera; *Anopheles* and *Cellia*. Mosquitoes of the genus *Culex* are represented by 9 species belonging to three subgenera (*Culex*, *Maillotia* and *Neoculex*). Two *Culiseta*, one *Aedes* and one *Uranotaenia* species are reported in Jordan (Al-Khalili, 1997; Amr *et al.*, 1997).

Al-Khalili (1997) gave a key for the fourth instar larvae for Jordan and the surrounding countries.

## Anopheline Mosquitoes

Anophelines larvae are characterized by the absence of the siphon (**Figure 3**).

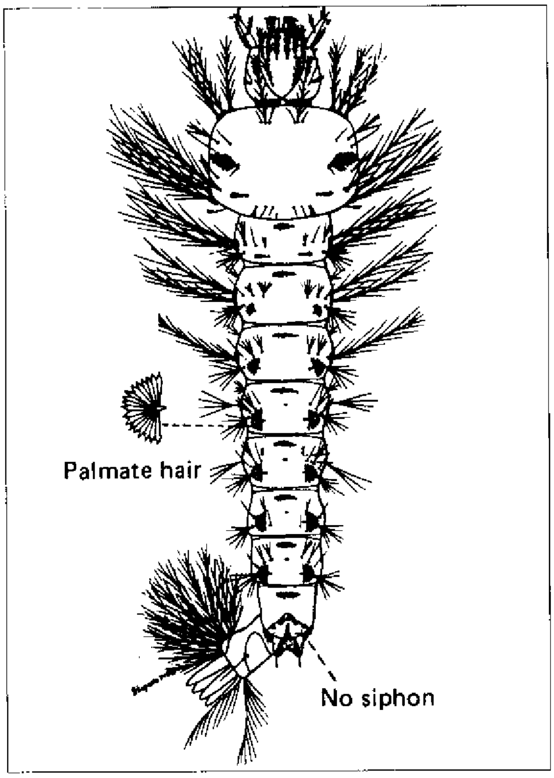



*Figure (3.3): Anopheline larvae*

Usually, larvae are suspended horizontally along the water surface.

### Genus *Anopheles*

#### *Anopheles (Anopheles) algeriensis*

Streams, springs, ponds and wells are the preferred habitats for this species. This species is considered as a swamp mosquito that is common among reed beds. Currently, *Anopheles algeriensis* is considered as a rare species with very limited distribution in Jordan. Perhaps this species is being replaced by other *Anopheles* species after the drastic habitat changes in the Jordan Valley.

#### *Anopheles (Anopheles) claviger*

It was collected from stagnant and semi-stagnant water formed around seepages and banks of small streams. Larvae were found hangin to vertical vegetation growing in water bodies, making it difficult to control (Al-Khalili, 1997).

#### *Anopheles (Anopheles) coustani*

The only record for this species appeared in Anon (1944), without exact locality. No further specimens were collected in recent studies. However, the difficulty to separate fourth instar larvae of *A. coustani* and *A. hyrcanus* may caused misidentification by previous workers.

#### *Anopheles (Anopheles) hyrcanus*

This species prefers open habitats with very few aquatic vegetation (Lumsden & Yofe, 1950). Farid (1954) observed adult females feeding on man in the Jordan Valley. Since 1954, no recent localities were recorded for this species.

#### *Anopheles (Anopheles) marteri*

*An. marteri* prefers streams and springs. This is a rare species, and was found to associate with *An. claviger*.

### *Anopheles (Anopheles) sacharovi*

Twelve larvae were collected from Ain Al-Moalaka (Irbid Govn.). It was found along with *An. superpictus*, *Cx. pipiens*, *Cx. theileri* and *Cx. perexiguus*. Farid (1954) recorded a considerable number of adults in premises in the northern parts of the Jordan Valley.

### *Anopheles (Cellia) cinereus*

Although this species was common in Jordan (Lumsden and Yofe, 1950), only a single specomen was collected recently (Al-Khalili, 1997). *Anopheles cinereus* prefers aquatic habitats with algal growth, among stones in small pools, seepages with subaquatic vegetation (Lumsden & Yofe, 1950).

### *Anopheles (Cellia) dthali*

This is a rare species, with a distribution that extends from India, across Arabia and the Middle East, Sudan, Ethiopia to Algeria. This is a common species in the Dead Sea area and areas south of the Dead Sea (Al-Khalili, 1997).

### *Anopheles (Cellia) fluvitilis*

The presence of this species is based on a single larvae collected from Al-Kittah, Jarash area (Al-Khalili, 1997).

### *Anopheles (Cellia) multicolor*

This is a rather common species inhabiting relatively saline water bodies. It was collected from several localities in the Jordan Valley where salt marches are frequent (Amr *et al.*, 1997).

### *Anopheles (Cellia) pharoensis*

This species was collected previously from irrigation canals (Farid, 1954). No further records were reported for the last 40 years.

### *Anopheles (Cellia) sergentii*

This species is widely distributed in North Africa, Middle East to Pakistan. This is the second most abundant anopheline in Jordan. It breeds in a variety of habitats ranging from shaded to open habitats, along the margin to the middle of springs.

### *Anopheles (Cellia) superpictus*

This is the most common anopheline in Jordan. Larvae were collected from temporary irrigation ponds and side pools formed by springs. This species was found along with *An. sacharovi*, *An. sergentii*, *Cx. mimeticus*, *Ur. unguiculata* and *Cx. perexiguus* (Amr *et al.*, 1997).

## Culicine Mosquitoes

Culicine larvae are characterized by the presence of the siphon **(Figure 3)**. Usually, larvae are submerged under the water surface.

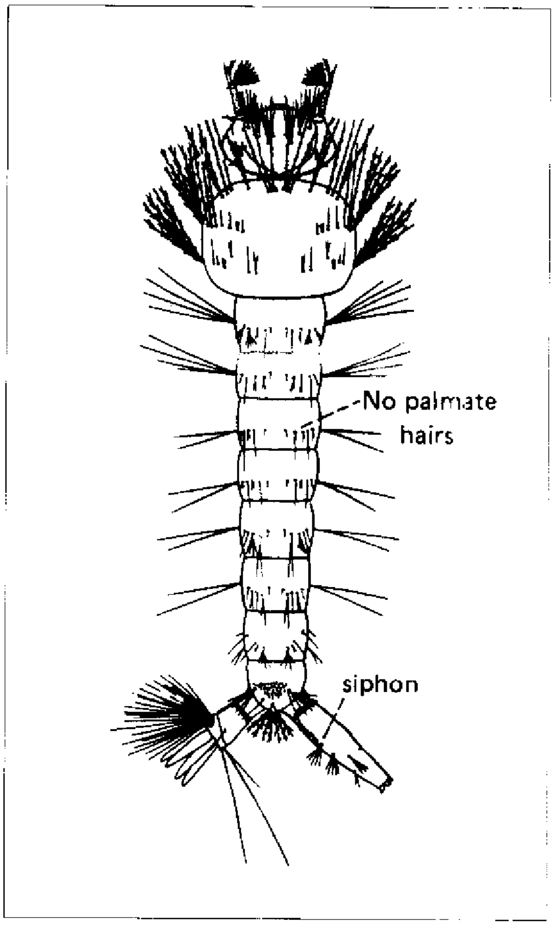



*Figure (3.4): Culicine larva*

## Genus *Aedes*

### *Aedes (Ochlerotatus) caspius*

Larvae were collected from slow running saline streams under thick vegetation very close to the Dead Sea. This species is associated with saline habitats. It seems to be a rare species in Jordan (Amr *et al.*, 1997).

### Genus *Culex*

***Culex (Culex) antennatus***

Breeds in stagnant water, stream pools, seepages as well as ditches (Harbach, 1988). This species was found to breed along with several species of *Anopheles* and *Cx. pipiens*, *Cx. theileri* and *Cx. perexiguus*.

***Culex (Culex) laticinctus***

This is a rather common species inhabiting a wide variety of habitats in different climatic zones (Al-Khalili, 1997).

***Culex (Culex) mimeticus***

Larvae prefer areas with dense aquatic vegetation and algal growth and were found along with *An. superpictus* (Amr *et al.*, 1997).

***Culex (Culex) perexiguus***

It was found in a variety of habitats including; stream pools, irrigation ponds, seepages, and ditches. Other associated species that were found along with *Cx. perexiguus* are: *Cx. pipiens*, *An. sacharovi*, *An. superpictus* and *Cs. longiareolata*.

***Culex (Culex) pipiens***

This is the most common mosquito species. It was collected from various localities representing all types of habitats in Jordan. Other species that shared the same habitats include: *Cx. theileri*, *Cx. perexiguus*, *An. sacharovi*, *An. superpictus*, *Cs. longiareolata* and *Ur. unguiculata* (Amr *et al.*, 1997).

***Culex (Culex) sinaticus***

This species is mainly confined to the Dead Sea area and Wadi Araba (Al-Khalili, 1997). It is widely distributed in eastern Africa, Arabian Peninsula and some countries in the Middle East.

***Culex (Culex) theileri***

This is one of the most common culicine mosquito. Larvae were found in large numbers in Zarka River associated with *Cx. perexiguus*, *Cx. pipiens*, *Cs. longiareolata*, *An. sacharovi*, and *An. superpictus*. This species is distributed throughout southern and eastern Africa, Mediterranean countries, and across southern states of the former Soviet Union to China (Harbach, 1988).

***Culex (Culex) tritaeniorhynchus***

This is a rare species in Jordan with few known localities (Harbach, 1988). This mosquito is distributed over southeastern and eastern Asia and east Africa (Harbach, 1988).

***Culex (Maillotia) deserticola***

This is a mainly North African species. Larvae of this mosquito were taken from natural and man-made water bodies (Al-Khalili, 1997).

***Culex (Neoculex) territans***

This is a very rare species with only a single locality (Amr *et al.*, 1997). Earlier, Amr *et al.* (1997) considered this species as *Culex judaicus*. Perhaps the reliance of Amr *et al* (1997) on the revision of mosquitoes of the Palaearctic Diptera by Minar (1991) was the main reason to use the name "*judaicus*". They were aware that Kitron & Pener (1986) considered *Cx. territans* & *Cx. martinii* as the species of the subgenus *Neocluex* in the area, however, Minar (1991) referred to this complex as "*judaicus*" and the form occurring in northern Palestine as the subspecies *Cx. territans judaicus*. Now the author (ZA) realized that using *Cx. territans* instead of *Culex judaicus* is a better choice to avoid complications.

### Genus *Culiseta*

***Culiseta (Allotheobaldia) longiareolata***

One of the most common and abundant species. It was collected from irrigation pools and Zarka river. It was found in association with *Cx. theileri*, *Cx. perexiguus*, *Cx. pipiens*, *Cx. tritaeniorhynchus* and *Ur. unguiculata*. The distribution of this species ranges from the southern Palaearctic region covering North Africa to India.

***Culiseta (Culiseta) annulata***

Only a single specimen was collected from a small pool under a shady area in Ain Al-Moalaka (Amr *et al.*, 1997).

### Genus *Uranotaenia*

***Uranotaenia (Pseudoficalbia) unguiculata***

Collected from the Jordan Valley and

Jarash area (Amr *et al.*, 1997). It was found to share the same habitat along with *Cx. perexiguus, Cx. pipiens, Cx. territans, An. sergentii* and *An. superpictus*.

**Studies on the Mosquitoes of Jordan**

Perhaps the classical work of Lumsden & Yofe (1950) is still the main reference on the anopheline mosquitoes of Jordan. Other earlier reports such as Barraud (1921), Buxton (1924), Lumsden (1944), Berberian (1946) and Farid (1954) included some records of anophelines breeding in freshwater habitats of Jordan. Recently, Harbach (1988) presented a comprehensive study on the subgenus *Culex* in southwestern Asia. Very little information is available on the culicine mosquitoes of Jordan, since they are no longer considered of medical importance. Recently, Al-Khalili (1997) and Amr *et al.* (1997) reported on the mosquitoes of Jordan based on field surveys for many parts of the country.

For the past forty years, Jordan has witnessed environmental changes, including habitat modification due to agricultural development in the Jordan Valley and the Eastern Desert, in the form of water extraction and changes in water courses, construction of dams and irrigation canals. All these changes drastically affected the mosquito fauna and its distribution

Agricultural development and other man-made changes affected the spatial distribution and abundance of several anopheline species in the Jordan Valley. Also, the intensive use of insecticides for malaria eradication by the malaria control program as well as changes of aquatic habitats is reflected in the mosquito assemblage in Jordan. Earlier reports indicated the presence of species such as *An. hyrcanus* (Pallas), *An. pharoensis* Theobald) and *An. cinereus* Theobald (=*An. hispaniola* (Theobald)) that were not recorded in recent studies. Also, additional species that were not known to occur in Jordan are reported such as *Cs. annulata* and *Ur. unguiculata* (Amr *et al.*, 1997).

In Jordan, the role of culicine mosquitoes in disease transmission has been undetermined. Several studies implicated several species of *Culex* (*Cx. pipiens, Cx. antennatus* and *Cx. tritaeniorhynchus*) and *Culiseta* sp. in transmitting viral agents such as Sindbis and West Nile viruses and the Rift Valley fever (Nir *et al.* 1968, 1972; Meegan *et al.* 1980).

*Table (3.2): Present and past recorded Anopheles species in Jordan*

| Species | Status | |
|---|---|---|
| | **Currently present** | **Not recorded for over 40 years** |
| *Anopheles (Anopheles) algeriensis* | • | |
| *Anopheles (Anopheles) claviger* | • | |
| *Anopheles (Anopheles) coustani* | | • |
| *Anopheles (Anopheles) hyrcanus* | | • |
| *Anopheles (Anopheles) marteri* | • | |
| *Anopheles (Anopheles) sacharovi* | • | |
| *Anopheles (Cellia) cinereus* | | • |
| *Anopheles (Cellia) dthali* | • | |
| *Anopheles (Cellia) fluvitilis* | • | |
| *Anopheles (Cellia) multicolor* | • | |
| *Anopheles (Cellia) pharoensis* | | • |
| *Anopheles (Cellia) sergentii* | • | |
| *Anopheles (Cellia) superpictus* | • | |

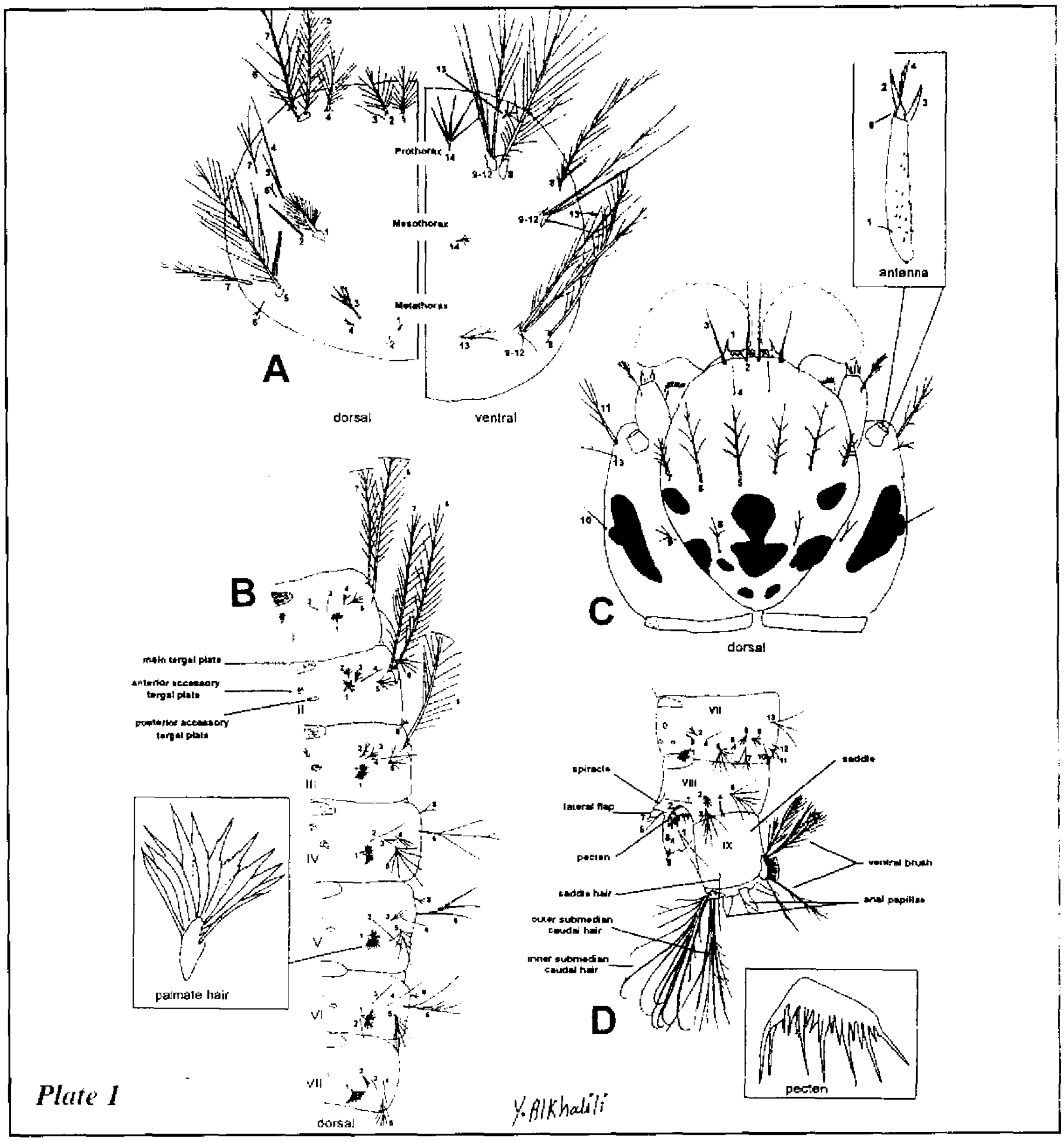



*Plate 1*

*A-Thorax of Anopheles larva (ventral and dorsal views of prothorax, mesothorax and metathorax). Prothorax: 1-3 submedian or shoulder hairs, 4-7, dorsal hairs. 8, dorsolateral hair. 9-12, prothoracic pleural hairs. 13, ventrolateral hair. 14, median ventral hair. Mesothorax: 1-7, dorsal hairs. 8, dorsolateral hair. 9-12, mesothoracic pleural hairs. 13, ventrolateral hair. 14, median ventral hair Metathorax: 1-2, dorsal hairs. 3, metathoracic palmate hair.*

*4-7, dorsal hair. 8, dorsalateral hair. 9-12, metathoracic pleural hairs. 13, median ventral hair.*

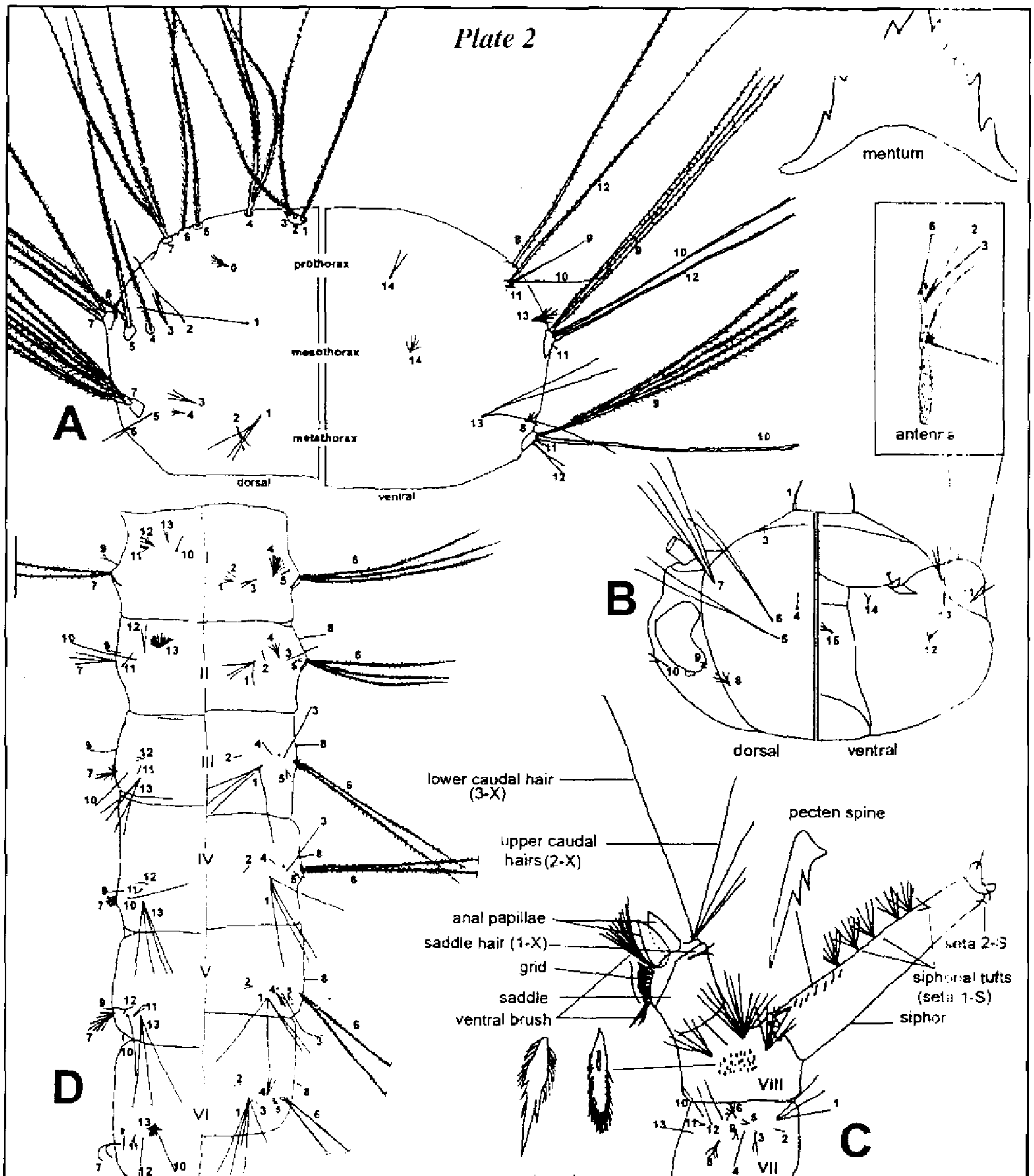
*B-Abdominal segments I to VI of Anopheles larvae (dorsal view).*

*1, palmate hair. 2, antepalmate hair. 3-5, dorsal hairs. 6 and 7, upper and lower lateral hairs. 8, anterior dorsolateral hair.*

*C- Head of Anopheles larva (dorsal view). 1, inner preclypeal spine. 2, inner clypeal hair. 3, outer clypeal hair. 4, postclypeal hair. 5, inner frontal hair. 6, middle frontal hair. 7, outer frontal or preantennal hair. 8, sutural hair. 9, transsutural hair. 10, supraorbital hair. 11, basal hair. 13, subbasal hair. Antenna: 1, antennal hair. 2, dorsal sabre or blade. 3, ventral sabre or blade. 4, terminal antennal hair. 6, finger-like process.*

*D-Terminal segments of abdomen of Anopheles larva (lateral view). Segment VII: 1-5, dorsl hairs. 6-7, upper and lower lateral hairs. 8, anterior dorsolateral hair. 9, postenor ventrolateral hair. 10-13, ventral hairs. Segment VIII: 1, first pentad. 2, second pentad. 3, third pentad. 4, Fourth pentad. 5, fifth pentad.*

*Spiracular Lobe on seg. VIII: 1, postspiracular hair. 2, pecten hair. 6, proximal dorsal valve hair. 7, distal dorsal valve hair. 8, proximal ventral valve hair. 9, distal ventral valve hair.*




*A-Thorax of culicine larva (dorsal and ventral view). Prothorax: 0, accessory dorsal hair. 1-3, submedian shoulder hairs. 4-7, dorsal hairs. 8, dorsolateral hair. 9-12, prothoracic pleural hairs. 14, median ventral hair. Mesothorax: 1-7 dorsal hairs. 8, dorsolateral hair. 9-12, mesothoracic pleural hairs. 13, ventrolateral hair. 14, median ventral hair.*

*Metathorax: 1-7, dorsal hairs. 8, dorsolateral hair. 9-12, metathoracic pleural hairs. 13, median ventral hair.*

*B-Head of culicine larva (dorsal and ventral view). 1, inner preclypeal spine. 3, outer clypeal hair. 4, postclypeal hair. 5, upper frontal hair. 6, lower frontal hair. 7, preantennal hair. 8, sutural hair. 9, transsutural hair. 10, supraorbital hair. 11, basal hair. 12, infraorbital hair. 13, subbasal hair. 14, postmaxillary hair. 15, submental hair.*

*C-Terminal segments of culicine larva (lateral view).*

*D-Abdomen of culicine larva from segment I toVI (dorsal and ventral view).*

### *Key to the mosquito larvae of Jordan and the surrounding countries:*

1. Siphon absent (Plate 1,D) (subfamily Anophelinae)......2
   Siphon present (Plate 2, C) (subfamily Culicinae)......20

2. Inner clypeal hairs with their bases proximate, the distance between the bases of the inner clypeal hairs less than the distance between the bases of the inner and outer clypeal hairs on one side of the head (subgenus *Anopheles*)......3
   Inner clypeal hairs with their bases distant, the distance between the bases of the inner clypeal hairs more than the distance between the bases of the inner and outer clypeal hairs on one side of the head (subgenus *Cellia*)......8

3. Outer clypeal hairs simple or only slightly branched......4
   Outer clypeal hairs thickly branched and dendroid......6

4. Palmate hairs of abdomen with leaflets shouldered and narrowed at about half the total length, terminal part filimentous...... *Anopheles* (*Anopheles*)
   Palmate hairs of abdomen with leaflets uniformly tapering to apex, terminal part not filimentous (Plate 1-B)......5

5. Inner clypeal hairs frayed (with small fine short hairs), head markings consisting of a dark traverse band behind the frontal hairs...... *An.* (*An.*) *algeriensis*
   Inner clypeal hairs simple, head markings consisting of separate spots behind the frontal hairs...... *An.* (*An.*) *claviger*

6. The antennal tuft arising at basal fourth of antenna...... *An.* (*An.*) *sacharovi*
   The antennal tuft arising near the middle of antenna......7

7. Inner shoulder hair branching, the branches coming off near the base...... *An.* (*An.*) *coustani*
   Inner shoulder hair branching or not. If branched the branches are coming off near the tip......*An.* (*An.*) *hyrcanus*

8. Outer clypeal hairs with 4 or more branches......9
   Outer clypeal hairs simple, frayed or with less than four branches......10

9. Outer clypeal hairs with 4-12 branches but not bushy, palmate hairs on abdominal segments III to VII......*An.* (*Cellia*) *pulcherrimus*
   Outer clypeal hairs bushy, palmate hairs on abdominal segments I to VII......*An.* (*C.*) *pharoensis*

10. Posterior clypeal hairs short, not reaching or just overreaching the bases of the inner and outer clypeal hears......11
    Posterior clypeal hairs long, extending beyond the bases of the inner and outer clypeal hairs......13

11. First abdominal segment with a rudimentary palmate hair......*An.* (*C.*) *stephensi*
    First abdominal segment without a rudimentary palmate hair......12

12. Anterior tergal plates on abdominal segments III to VII very large, with the posterior border convex, reaching the middle of the segment and enclosing the rounded anterior accessory plate......*An.* (*C.*) *fluviatilis*
    Anterior tergal plates on abdominal segments III to VII moderately large, with the posterior border concave, the rounded anterior accessory plate free...... *An.* (*C.*) *culicifacies*

13. Both long mesothoracic pleural hairs (9 and 10 of mesothorax) simple...... *An.* (*C.*) *dthali*

One long mesothoracic pleural hairs (9 and 10) branched........................................................ 14

14. Both long mesothoracic pleural hairs (9 and 10) branched.......................................................15
One of the two long mesothoracic pleural hairs (9 or 10) simple, one branched ............................16

15. Palmate hairs exist on abdominal segments II to VII, hairs on segment 2 rudimentary.......................
.................................................................................................................*An. (C.) cinereus*
Palmate hairs exist on abdominal segments III to VI ..............................................*An. (C.) turkhudi*

16. Both long metathoracic pleural hairs (9 and 10 of metathorax) branched....................................17
One of the two long metathoracic pleural hairs (9 and 10) simple, one branched............................18

17. Head markings forming a dark band enclosing the bases of the frontal hairs and some times covering all the clypeal area of the head; metathorax without palmate hairs ...........*An. (C.) multicolor*
Head markings consisting of separate spots never enclosing the bases of the frontal hairs, metathorax with palmate hairs..........................................................................*An. (C.) superpictus*

18. Outer clypeal hair barbed ...................................................................................*An. (C.) apoci*
Outer clypeal hair simple (Plate 1,C)...................................................................................19

19. The width of the main tergal plate on segment V equal to at least 3/4 distance between the palmate hairs on that segment, inner clypeal hairs simple ..........................................*An. (C.) sergentii*
The width of the main tergal plate is less than 3/4 the length between the palmate hairs on that segment, inner clypeal hairs often slightly frayed...................................*An. (C.) rhodesiensis rupicola*

20. Apical 1/2 of siphon narrowed and modified for piercing aquatic plant tissue ( genus *Coquillettidia*)......................................................................................................................21
Siphon cylindrical and uniform, not modified for piercing aquatic plant tissue................................22

21. Pentad hairs with fewer than 4 branches.............................................*Coquillettidia (C.) richiardii*
Pentad hairs with more than 4 branches...................................................*Coquillettidia (C.) buxtoni*

22. Head longer than wide; abdominal segment VIII with a sclerotized plate bearing spines on its posterior border...........................................................*Uranotaenia (Pseudoficalbia) unguiculata*
Head at least as wide as long; abdominal segment VIII without a sclerotized plate but with normal scales (Plate 2,C)...........................................................................................................23

23. Siphon with one pair of setae 1-S arising near base or middle of siphon.....................................24
Siphon with at least 3 pairs of setae 1-S on the siphon (Plate 2,C) (genus *Culex*).............................33

24. Seta 1-S arising near the base of siphon (genus *Culiseta*).........................................................25
Seta 1-S arising near the middle of siphon adjacent to last pecten spine (genus *Aedes*) .....................28

25. Antenna short, with small antennal tuft (seta 1) or a single hair; siphon short, at most three times as long as broad.........................................................................................................26
Antenna long, with large and many branched antennal tuft (seta 1); siphon long, at least five times as long as broad (subgenus Culicella)........................................................*Culiseta (Culicella) morsitans*

26. Siphon with 6-10 stout and widely spaced pecten spines, tips of spines not drawn out into long hairs (subgenus *Allotheobaldia*) ..........................................*Culiseta (Allotheobaldia) longiareolata*
Siphon with a recognizable pecten, most teeth long, hair like (subgenus *Culiseta*)..........................27

27. Distance between bases of left and right seta 4 (postclypeal hairs) equal to, or greater than dis-

tance between bases of left and right seta 5 (upper frontal hairs)...........*Culiseta (Culiseta) annulata*
Distance between bases of left and right seta 4 (postclypeal hairs) much less than distance between bases of left and right seta 5 (upper frontal hairs)..............................*Culiseta (Culiseta) subochrea*

28. Antennal tuft (seta 1) represented by a single minute hair; antenna devoid of spines (smooth).. 29
Antennal tuft (seta 1) at least 2-haired; antenna with numerous spines (spiculate) (subgenus *Ochlerotatus* in part)..........................................................................................................30

29. Antenna long; dorsal surface of abdomen with stellate tufts (hairs with many equal-lengthed branches coming from the base of hair) (subgenus *Finlaya*)................. *Aedes (Finlaya) geniculatus*
Antenna short; dorsal surface of abdomen without stellate tufts (subgenus *Stegomyia*) ..........................................................................................................*Aedes (Stegomyia) aegypti*

30. Comb scales on segment VIII of abdomen arranged in only a single row................................. ..........................................................................................*Aedes (Ochlerotatus) pulchritarsis*
Comb scales arranged in several rows..........................................................................................31

31. Upper and lower frontal hairs of head (setae 5 and 6) two or more forked........ *Aedes (O.) detritus*
Upper and lower frontal hairs of head (setae 5 and 6) simple.........................................................32

32. Siphonal index (length/ width) 1.5, upper caudal hair of dorsal brush (Plate 2,C) as long as siphon ..........................................................................................................*Aedes (O.) mariae*
Siphonal index (length/ width) 2 or more; upper caudal hair much shorter than siphon................... ..........................................................................................................*Aedes (O.) caspius*

33. Seta 5 and 6 of head very short and inconspicuous, about same thickness and length as seta 4........ (subgenus Lasiosiphon)...........................................................................*Culex (Lasiosiphon) adairi*
Seta 5 and 6 of head long and conspicuous, much thicker and longer than seta 4 (Plate 2,B).........34

34. Ventral brush with 1 or more setae born anterior to grid...............................................................35
Ventral brush with all setae born on grid.........................................................................................38

35. Seta 3 of prothorax nearly as long as setae 1 and 2 of prothorax; Siphon with 2 or more (usually-more) anterolateral setae on each side; seta 1-S of siphon unpaired, occurring in a single median posterior row (subgenus *Maillotia*)..........................................................................................36
Seta 3 of prothorax much shorter than 1 and 2 of prothorax (about 1/2 as long); siphon without anterolateral setae; seta 1-S of siphon more or less paired, occurring in 2 posterolateral rows (subgenus *Neoculex*). .........................................................................................................37

36. Abdominal hair 8 simple or double; prothoracic submedian hairs (seta 1,2 and 3 of prothorax) of formula (1-1-1) or in some cases (1-1-2).............................................*Culex (Maillotia) deserticola*
Abdominal hair 8 simple; prothoracic submedian hairs of formula (1-1-2) ...*Culex (Maillotia) hortensis*

37. Distal sixth of siphon slightly but distinctly expanded..........................*Culex (Neoculex) territans*
Apex of siphon slightly expanded; siphon very long, index close to 8......*Culex (Neoculex) martinii*

38. Seta 1-S of siphon in single row, with all elements arranged in more or less straight line, siphon-devoid of lateral setae (subgenus *Barraudius*)...............................................................................39
Seta 1-S in 1 or 2 rows, with 1-3 elements distinctly out of line with the others (laterally) (subgenus *Culex*)...................................................................................................................................40

39. Siphon very short, siphonal index 3; pecten spines reaching 1/2 length of siphon ..........................................................................................................*Culex (Barraudius) pusillus*
Siphon longer, siphonal index 3.5-5, or if index is not greater than 3.5 then pecten spines not

reaching 1/2 of siphon ........................................ *Culex (Barraudius) modestus*

40. All scales of comb evenly fringed at sides and apex ........................................ 41
Some or all scales of comb spine like, with pointed apex and fringe at sides proximally ........ 49

41. Distal pecten spines with 7 or more ventral denticles of similar size arising along entire length; seta 1 of head stout, distinctly thicker than branches of setae 5 and 6 ........................................ 42
Distal pecten spines with 2-5 ventral denticles of different sizes arising proximally; seta 1 of head thin, scarcely if at all thicker than branches of setae 5 and 6 ........................................ 43

42. Seta 5 of head with 3 or 4 branches; seta 1-S of siphon only slightly longer than diameter of siphon at point of attachment; saddle hair with 2-4 branches; siphon index more than 5.5 ........................................ *Culex (Culex) tritaeniorhynchus*
Seta 5 of head with 6-8 branches; seta 1-S of siphon nearly twice as long as diameter of siphon at point of attachment; saddle hair single; siphon index less than 5.5 ........ *Culex (Culex) sitiens*

43. Siphon with 6-8 pairs of seta 1-S, with one pair arising laterally and 5-7 irregular pairs arising relatively close to posterior midline; with 2 pairs arising relatively close to posterior midline with 2 pairs arising within pecten ........................................ 44
Siphon with 3-6 pairs of seta 1-S, with 1-3 pairs arising laterally and 2-4 pairs arising posterolaterally; sometimes with one pair arising within pecten ........................................ 45

44. Upper caudal hair (seta 2-X) with 4 or 5 branches; seta 6-VI of abdomen single; ventral brush with 13 or 14 setae, usually 14 ........................................ *Culex (Culex) laticinctus*
Seta 2-X only double or triple; seta 6-VI of abdomen double; ventral brush with 11-13 setae, usually with 12 ........................................ *Culex (Culex) mattinglyi*

45. Seta 1-S not longer than diameter of siphon at point of attachment, usually in 5 pairs; seta 6-VI of abdomen normally single; seta 5 of head usually double or triple (occasionally with 4 branches) 46
Seta 1-S longer than diameter of siphon at point of attachment, usually in 4 pairs; seta 6-VI of abdomen normally double; seta 5 of head with 4-8 branches) ........................................ 47

46. Seta 1 of head long and slender, length about 0.1 mm; siphon with 3 lateral pairs of seta 1-S; seta 1 of metathorax usually double or triple, sometimes single ........ *Culex (Culex) antennatus*
Seta 1 of head not as long, slightly stouter; siphon with 2 lateral pairs of seta 1-S; seta 1 of metathorax usually single, sometimes double ........................................ *Culex (Culex) perexiguus*

47. seta 1-III, IV, and V of abdomen with 3-6 branches (usually 4 or 5), sum of their branches on one side of abdomen 10 or more (usually more); seta 1 of metathorax normally double or triple; saddle hair (1-X) usually double ........................................ *Culex (Culex) torrentium*
Seta 1-III, IV, and V of abdomen with 1-4 branches (usually 1 or 2), sum of their branches on one side of abdomen not exceeding 10 (usually 6 or less); seta 1 of metathorax single; saddle hair (1-X) usually single ........................................ 48

48. Siphonal saddle index less than 3.45; seta 1-III, IV, and V of abdomen usually single ........................................ *Culex (Culex) quinquefasciatus*
Siphonal saddle index more than 3.45; seta 1-III, IV, and V of abdomen usually double ........................................ *Culex (Culex) pipiens*

49. Seta 7-I distinctly shorter than 6-I, usually double; seta 14 of head with 2 or more branches, rarely single; seta 1 of head slender, usually not thicker than branches of setae 5 and 6 ........ 50
Seta 7-I about as long as 6-I, single or double; seta 14 of head single; seta 1 of head stout, usually much thicker than branches of setae 5 and 6 ........................................ 51

50. Seta 5 of head with 3 or 4 branches; siphon with most elements of seta 1-S arising relatively close

to posterior midline, these with 4-11 branches; seta 14 of prothorax single; all comb scales spine-like ........................................................................ *Culex (Culex) theileri*

Seta 5 of head with 1 or 2 branches (usually single); siphon with all elements of seta 1-S arising laterally posterolaterally, these with 1-4 branches; seta 14 of prothorax double on at least one side some anterior scales of comb evenly fringed at sides and apex .................. *Culex (Culex) sinaiticus*

51\. Comb with more than 25 scales; seta 2-S of siphon long and curved; most elements of ventral-brush with 4 branches; anal papillae twice as long as the saddle .............. *Culex (Culex) mimeticus*

Comb with no more than 10 scales; seta 2-S long or short , always straight; most elements of ventral brush with more than 4 branches........................................................................ 52

52\. Anterior margin of siphon distinctly curved in lateral view; length of seta 1-S from 2.5 to 3.0 times the diameter of siphon; pecten spines with 4-9 basal denticles; setae 2 and 3 of antenna inserted at apex of antenna........................................................................ *Culex (Culex) poicilipes*

Anterior margin of siphon more or less straight; length of seta 1-S not more than 1.5 the diameter of siphon; pecten spines with complete ventral row of denticles; setae 2 and 3 of antenna inserted subapically on antenna........................................................................ *Culex (Culex) pseudovishnui*

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# CHAPTER 4
# PHLEBOTOMINAE SANDFLIES

Sandflies are small hairy dipterans. They are distinguished from other dipterans by the dense hairy and pointed wings. At least 700 species have been described and mainly distributed in tropical and subtropical regions. About 10% of the total species are incriminated in disease's transmission (viruses, bacteria and protozoan) to human, especially leishmaniasis.

Leishmaniasis is caused by different etiologic agents, transmitted by a number of sandflies vectors, and is manifested in several forms: cutaneous, mucocutaneous, diffused cutaneous and visceral leishmaniasis. This disease is affecting several millions in tropical, semitropical and arid regions. In the Middle East, cutaneous leishmaniasis is the most prevalent form, where as several species of sandflies act as vectors.

## Morphology

Adult sandflies are recognized by their hairy bodies and pointed wings. They are small in size (5 mm long). Wing venation is parallel, consisting of five major veins. The most striking features known among Phlebotomines is the V-shaped wing while alive (Lane, 1995).

## Life Cycle

Females lay eggs in several clutches and deposit them in small crevices, cracks, rodent burrows, poultry houses etc. Eggs hatch within two weeks, yielding strongly mandibulated larvae. The larva molts four times, and all larval stages feed on organic materials. After four to six weeks from egg laying, the pupal stage emerges and molts into an adult within 10 days.

## Leishmaniasis in Jordan

In Jordan, cutaneous leishmaniasis is an endemic disease. This disease is widely distributed in arid and semi-arid regions of the country. The first study that pointed out the magnitude of the disease was published in 1982 (Oumeish *et al.*, 1982). Afterwards, several reports were published on the epidemiology of cutaneous leishmania (**Table. 4.1**) in different provinces of the Kingdom (Saliba *et al.*, 1985; Kamhawi *et al.*, 1995; Khoury *et al.*, 1996; Jumaian *et al.*, 1998).

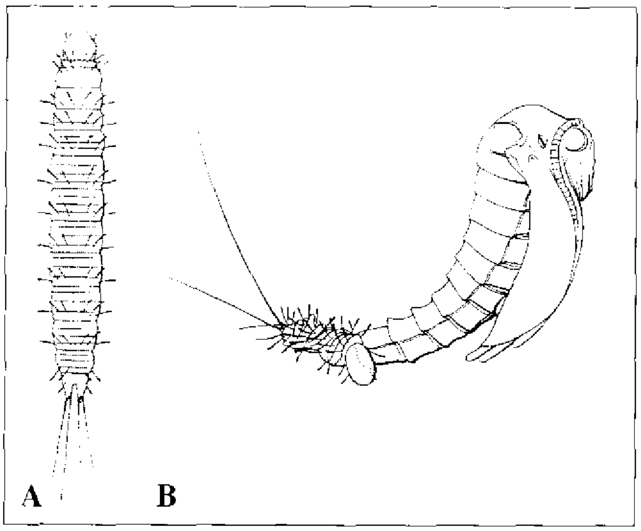


*Figure (4.1): Sandfly larva (A) and nymph (B)*

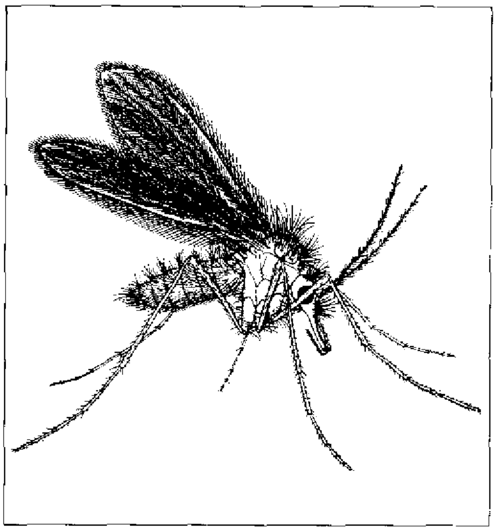

*Figure (4.2): Adult sandfly*

*Table (4.1): Number of leishmaniasis cases reported from Jordan (1973-1995)*

| Year | Area | Leishmania sp. | Number of Reported Cases | Source |
|---|---|---|---|---|
| 1973-1981 | Jordan Valley, | *Leishmania sp.* | 731 | Oumeish *et al.*, 1982 |
| 1983-1992 | All the country | *Leishmania sp.* | 2295 | Khoury *et al.*, 1995 |
| 1994 | Bani Kinana | *L. tropica* | 55 | Kamhawi *et al.*, 1995 |
| 1993-1995 | Salt (Eira -Yarqa) | *L. tropica* | 9 | Saliba *et al.*, 1997 |
| 1995 | Wadi Araba | *Leishmania sp.* | 36 | Jumaian *et al.*, 1998 |

So far in Jordan, two species of *Leishmania* (*Leishmania major* and *Leishmania tropica*) are known as the causative agents for cutaneous leishmaniasis. The former is the most common and has been isolated from both human patients and a rodent reservoir (Saliba *et al.*, 1987), and seems to be associated with arid and semi-arid regions (Jordan Valley, and Mowaqqar). It is known as the zoonotic cutaneous leishmaniasis, since the reservoir host is identified, and transmitted by *Ph. papatasi* (Oumeish *et al.*, 1982; Saliba *et al.*, 1985).

Schlein & Jacobson (1996) gave evidences that man is an unsuitable reservoir for *L. major*. They found that sandflies feed on human blood containing the promastigote stage were retained in 48% in the sandflies, while only 6.6% developed heavy infection. Contrary, 76.9% and 58.5% of the sandflies retained and developed heavy infection after being feed on the reservoir host blood respectively. Also, they demonstrated that the amastigote stage of the parasite did not survive in culture medium containing 50% human blood. They concluded that vector potential and the chances of transmission are drastically decreased when man is the source of the parasite.

On the other hand, several reports indicated the presence of *L. tropica* in other areas in Jordan that are within the Mediterranean bio-climate (Salt, Tafeleh and Bani Kinana). This form is referred to as the anthroponotic cutaneous leishmaniasis, and transmitted by *Ph. sergenti* (Saliba *et al.*, 1997; Kamhawi *et al.*, 1995).

Apparently, *Phlebotomus* (*Phlebotomus*) *papatasi* (Scopoli) is the major vector for *L. major* in the Jordan Valley. Indeed, Janini *et al.* (1995) found that 2% of *Ph. papatasi* infected with *Leishmania* promastigotes, which were collected from *Psammomys obesus* burrows. By far this is the most common sand fly species in the Jordan Valley. It is usually found close to human habitations. *Phlebotomus* sergenti is the proven vector for *L. tropica* in Bani Kinana District (Abdel Hafez, per. com.).

**Reservoir Host's for Cutaneous Leishmaniasis in Jordan.**

Zoonotic cutaneous leishmaniasis caused by *L. major* was isolated from the Sand Fat Jird, *Ps. obesus* (Saliba *et al.*, 1988; Saliba *et al.*, 1994; Saliba & Oumeish, 1999). 23% of 170 fat sand jirds were positive for the *Leishmania* amastigote in their ears (Saliba *et al.*, 1994). This rodent is widely distributed in arid and semi-arid environments with Chenopod vegetation (*Anabasis* sp.). Other rodents including, *Meriones libycus*, *Meriones tristrami*, *Meriones crassus* and *Allactaga euphratica* and other gerbils were not found infected by the parasite (Saliba *et al.*, 1994). Sandflies were recovered from burrow entrance of the Fat Sand jird (Saliba *et al.*, 1985).

In the Middle East, other known reservoir hosts includes *Meriones crassus*, *Meriones libycus* and *Gerbillus pyramidium*, from which *L. major* was isolated.

On the other hand, the natural reservoir for *L. tropica* is not yet fully known in affected areas, it is speculated that dogs, hyraxes or other wild animals may serve as reservoirs. Kamhawi *et al* (1995) suggested an anthropontic transmission.

Recent evidence indicated the role of hyraxes as reservoir host in Bani Kinana District (Abdel Hafez, per. com.) Near Jerusalem, Klaus *et al.* (1994) implied that hyraxes close to human habitation are involved in the transmission of both *L. tropica* and *L. major*, where both forms of cutaneous leishmaniasis occur.

## Sandflies of Jordan

Up-to-date, a total of 29 species of sandflies has been reported or suspected to occur in Jordan (Kamhawi *et al.*, 1988; Lane *et al.*, 1988; Janini *et al.*, 1995;). Seventeen species belong to the genus *Phlebotomus*, while 12 are of the genus *Sergentomyia*. The genus *Phlebotomus* is subdivided into four subgenera; *Phlebotomus*, *Paraphlebotomus*, *Larroussius* and *Adlerius*. The sandflies of Jordan are distributed according to the climatic zones, some are more common in extremely dry regions as most species of the *Sergentomyia*, while others are associated with humid Mediterranean habitats (Lane *et al.*, 1988; Kamhawi *et al.*, 1995).

*Table (4.2): Distribution of sandflies based on climatic zones (After Kamhawi et al., 1995).*

| Species | Climatic Zone | | | | | |
|---|---|---|---|---|---|---|
| | CM | WM | CS | WS | CD | WD |
| *Phlebotomus (Phlebotomus) bergeroti* | | | | | | |
| *Phlebotomus (Phlebotomus) papatasi* | • | • | • | • | • | • |
| *Phlebotomus (Paraphlebotomus) sergenti* | • | • | • | • | • | • |
| *Phlebotomus (Paraphlebotomus) alexandri* | | • | • | • | • | • |
| *Phlebotomus (Paraphlebotomus) kazaruni* | • | • | • | | • | • |
| *Phlebotomus (Paraphlebotomus) jacusieli* | • | • | • | • | • | |
| *Phlebotomus (Larroussius) major syriacus* | • | • | • | • | • | • |
| *Phlebotomus (Larroussius) mascitti* | • | | • | • | | • |
| *Phlebotomus (Larroussius) tobbi* | | • | | • | • | |
| *Phlebotomus (Larroussius) perfiliewi* | | • | | • | | |
| *Phlebotomus (Adlerius) arabicus* | • | | • | • | • | |
| *Phlebotomus (Adlerius) halepensis* | • | | • | • | • | |

CM:Cool Mediterranean, WM:Warm Mediterranean, CS: Cool steppe, WS: Warm steppe, CD: Cool desert, WD: Warm desert

*Table (4.3): List of sandflies reported or suspected to occur in Jordan*

| Species | Species |
|---|---|
| *Phlebotomus (Phlebotomus) bergeroti* | *Phlebotomus (Adlerius) halepensis* |
| *Phlebotomus (Phlebotomus) papatasi* | *Phlebotomus (Adlerius) simici* |
| *Phlebotomus (Paraphlebotomus) sergenti* | *Sergentomyia adleri* |
| *Phlebotomus (Paraphlebotomus) alexandri* | *Sergentomyia africana* |
| *Phlebotomus (Paraphlebotomus) kazaruni* | *Sergentomyia antennata* |
| *Phlebotomus (Paraphlebotomus) saevus* | *Sergentomyia christophersi* |
| *Phlebotomus (Paraphlebotomus) jacusieli* | *Sergentomyia clydei* |
| *Phlebotomus (Larroussius) major syriacus* | *Sergentomyia dreyfussi* |
| *Phlebotomus (Larroussius) mascitti* | *Sergentomyia fallax* |
| *Phlebotomus (Larroussius) orientalis* | *Sergentomyia palestinensis* |
| *Phlebotomus (Larroussius) tobbi* | *Sergentomyia squamipleuris* |
| *Phlebotomus (Larroussius) perfiliewi* | *Sergentomyia taizi* |
| *Phlebotomus (Larroussius) kandelaki* | *Sergentomyia theodori* |
| *Phlebotomus (Larroussius) wenyoni* | *Sergentomyia tiberiadis* |
| *Phlebotomus (Adlerius) arabicus* | |

For identification, taxonomic keys given by Lane *et al.* (1988) and Lewis (1978 & 1982) are highly recommended. **Table (4.2)** shows the distribution of sandflies based on climatic zones. This table is adapted after Kamhawi *et al.* (1995).

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# CHAPTER 5
# TABANIDAE: HORSEFLIES

Tabanids are dipterans equipped with cutting mouthparts. They have a wide range of distribution with about 4150 species. they include horseflies, deer flies etc. Tabanids are robust and large flies reaching 30 mm in length. Although they feed primarily on wild animals, they are annoying to man and do not constitute a major vector for human diseases. Human loiasis caused by *Loa loa* is the most important disease transmitted cyclically by tabanids. Most known animal diseases are transmitted mechanically. In Jordan, this group is poorly known, and a comprehensive survey for tabanids is needed. The role of tabanids in transmitting diseases to wild and domestic animals is another avenue for future studies.

## Morphology

Tabanids are relatively large flies. Females have large eyes that are well separated, while in males are adjacent. Antennae are short consisting of three segments. The mouthparts are adapted for cutting, where as the mandibles and maxillae serves as cutting organs.

## Tabanids and Diseases

Tabanids are mostly associated with mechanical transmission of some pathogens. They are vicious biters, with only very few diseases that they can transmit. Anthrax and tularemia were reported to be mechanically transmitted, while only human loiasis caused by *Loa loa* is cyclically transmitted (Chainey, 1995). On the other hand, tabanids are involved in the transmission of several diseases to wild and domestic animals. Foil (1989) gave a summary of diseases naturally or experimentally transmitted by tabanids, including Equine Infectious Anemia Virus (EIAV), several species of *Trypanosoma*, and bacterial agents.

In Jordan, Abo Shehada *et al.* (1999) reported on *Trypanosoma evansi* among

*Table (5.1): Suspected species to occur in Jordan (Based on Theodor, 1965).*

| Species | Distribution |
|---|---|
| *Chrysops flavipes punctifr* Loew, 1856 | Jordan Valley |
| *Haematopota coronata* Austen, 1908 | Dead Sea area |
| *Haematopota innominata* Austen, 1920 | Upper Jordan Valley |
| *Haematopota minuscula* Austen, 1920 | Near Jericho, south of the Dead Sea |
| *Haematopota sewelli* Austen, 1920 | Jordan Valley |
| *Tabanus (Atylotus) agrestis* Wiedemann,1828 | Widely distributed in the Mediterranean |
| *Tabanus (Atylotus) farinosus* Szilady, 1915 | Widely distributed in the Mediterranean |
| *Tabanus (Tabanus) accensus* Austen, 1920 | Dead Sea area |
| *Tabanus (Tabanus) albifacies* Loew, 1856 | Dead Sea area |
| *Tabanus (Tabanus) leleani* Austen, 1920 | Dead Sea area |
| *Tabanus (Tabanus) lunatus* Fabrizius, 1794 | Northern Jordan Valley |
| *Tabanus (Tabanus) pallidipes* Austen, 1920 | Dead Sea area |
| *Tabanus (Tabanus) rupinae* Austen, 1920 | Dead Sea area |
| *Tabanus (Tabanus) sufis* Jaennicke, 1867 | Dead Sea area |
| *Tabanus (Therioplectes) decorus* Loew, 1858 | Northern Jordan Valley |
| *Tabanus (Therioplectes) mendicus* Villeneuve, 1912 | Endemic in the Middle East |

horses and camels near the Dead Sea area, Jordan Valley. Although they did not incriminate a tabanid vector, at least 8 different species are known to occur in the Dead Sea area.

### Tabanids of Jordan

Theodor (1965) updated the previous records of Austen (1920 & 1924) and Buxton (1924), covering Palestine and the Jordan Valley. Only four species (*Atylotus pulchellus* Loew, *Haematopota minuscula* Austin, *Tabanus autumnalis brunnescens* Szilady and *Tabanus polygonus* Walker) collected from Azraq oasis are the only records from Jordan (Saliba, 1977). However, at least additional 16 species (**Table 5.1**) are suspected to occur along the Jordan Valley based on Theodor (1965).

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# CHAPTER 6
# MYIASIS CAUSING DIPTERANS

Myiasis is defined as the infestation of dipteran maggots in tissues or organs of man or animals. Principally, there are two forms of myiasis: obligatory and accidental. In obligatory myiasis, the dipteran fly requires a living host to develop and later become an adult fly, while in accidental myiasis, the fly accidentally deposits its eggs in living tissues.

By tissue or organ infestation, there are several forms of myiasis, including ophthalomyiasis, dermal, intestinal, nasal, auricular and urinary.

There are several families of dipterans that cause myiasis, the most important and known in our area are: Muscidae, Calliphoridae, Gastrophilidae and Ostridae. Some species of these families cause myiasis for man and domestic animals, causing severe injury and economic loss in animals.

### Myiasis in Jordan.

Our knowledge on human myiasis in Jordan is limited to two species (*Oestrus ovis* and *Lucilia cuprina*). Other forms of animal myiasis were personally observed among sheep by *Wohlfahrtia* sp. and *O. ovis*.

### • Ophthalmomyiasis

Ophthalmomyiasis is a frequent infestation in many Middle Eastern countries. Human infestation by the nasal bot fly *Oestrus ovis* seems to be common in Jordan. Nabeel & Saliba (1978) and Amr *et al.* (1993) reported on ophthalmomyiasis externa encountered in ophthalmology clinics in Amman and Ajloun respectively.

Symptoms include chemosis or edema of the conjunctiva, edema of the upper and lower eye lids, cellulitis, lacrymation and conjuctival hyperemia (Amr *et al.*, 1993). It seems that ophthalmomyiasis exhibits two seasons, one in early spring and the second in early autumn.

### • Intestinal Myiasis

Jumaian *et al.* (1995) reported on the first record of intestinal myiasis in Jordan caused by *Lucilia cuprina*. Infestation was attributed to the consumption of raw meet contaminated by eggs or larval stages of this fly.

Other dipterans known to cause human intestinal myiasis include *Psychoda* sp. *Fannia* sp. and *Calliphora* sp. (Zumpt, 1965). From the surrounding countries, **Table (6.1)** gives a summary to major dipetrans causing myiasis.

*Table (6.1): Other myiasis causing dipterans in the surrounding countries*

| Species | Tissue or organ | Host | Country | Source |
|---|---|---|---|---|
| *Cephalopina titillator* | Head | Camel | Egypt | Zayed, 1998. |
| *Cordylobia anthropophaga* | Skin | Human | Saudi Arabia | Omar & Abdalla, 1992 |
| *Wohlfahrtia magnifica* | Skin | camel | Sinai | Hadani *et al.*, 1989 |
| *Chrysomya bezziana* | Eye | Human | Saudi Arabia | Kresten *et al.*, 1986 |

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# CHAPTER 7
# BLATTARIA: COCKROACHES

Cockroaches are considered as on of the most ancient group of insects. Fossil records show very little differences between old and present cockroaches. Although about 400 species of cockroaches have been described, only few are considered of medical importance. This is due to the fact that these species live in close proximity to human settlements and are indirect contact to his food and other utensils. Also, they inhabit latrines, cesspools, sewer systems and garbage dumping sites.

**Cockroaches of Medical Importance**

In Jordan, three species of cockroaches are considered of medical importance.

These species were introduced to Jordan from different parts of the world via commercial commodities. This section is based mostly on Pratt *et al.* (1979).

**The Oriental Cockroach, *Blatta orientalis***

This is a medium-sized (20-27 mm) black cockroach. Female's posses a triangular wing pads, while males have truncate wings extending about two-thirds the length of the abdomen. The oriental cockroach has an offensive smell, since it is a sewer dweller.

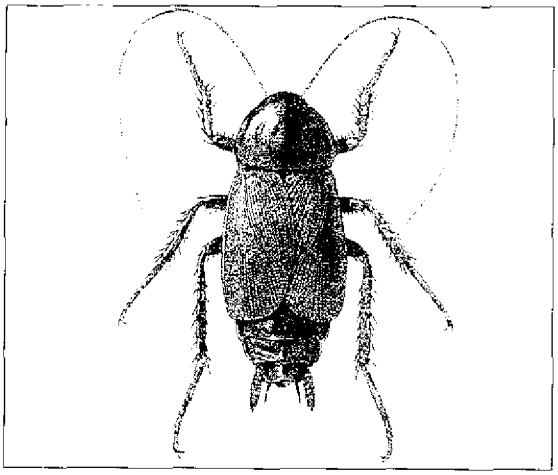

*Figure (7.1): The Oriental cockroach*

It prefers cool climates and is found mainly around houses, and rarely enters buildings.

**The American Cockroach, *Periplaneta americana.***

The American cockroach is the largest species reaching 35-40 mm in total length. It is characterized by its red or dark brown color. This species inhabits buildings, deserted storing areas, latrines, food preparation rooms in restaurants, sewer systems and manholes.

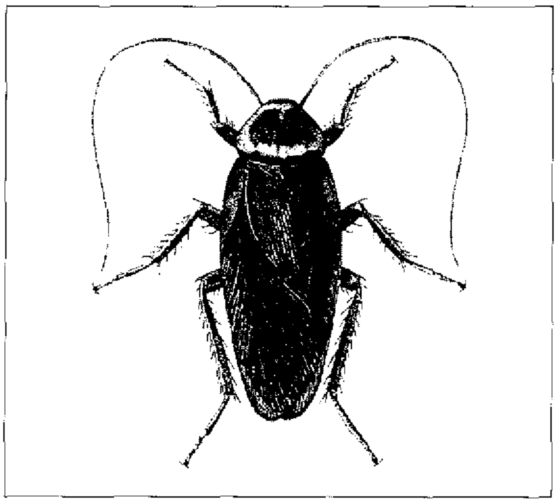

*Figure (7.2): The American cockroach*

This is the most common species in Jordan. It was seen and collected from houses, hotels, restaurants etc. It seems that the American cockroach is dispersed through the sewer systems. Thousands were seen in the main sewer system in Amman area, and in manholes leading to buildings and houses.

**The German cockroach, *Blattella germinaica***

This is a small cockroach (10-15 mm) long with a uniform gray color. It is cosmopolitan in its distribution, inhabiting buildings, kitchens, bathrooms etc.

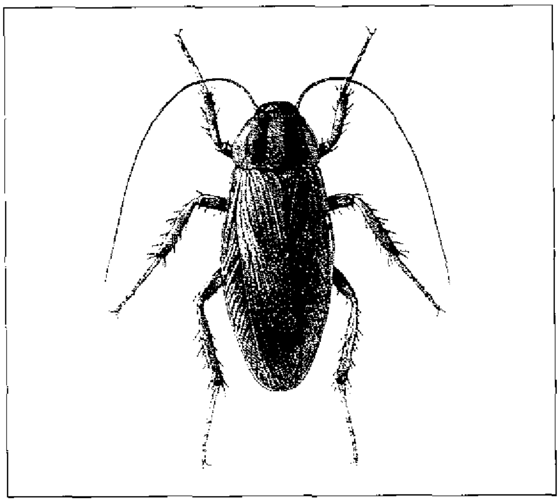

*Figure (7.3): The German cockroach*

Although very common in many parts of the world, the German cockroach is less abundant than the American cockroach.

**Cockroaches and Diseases**

As indicated earlier, cockroaches have no direct contact with man, but to his food and other utensils. The habit of living in dirty and contaminated habitats (sewer, latrines) and feeding on human or animal excreta, in addition of the habit of regurgitation on food items, makes cockroaches potential carries for gastrointestinal pathogens. Cockroaches may transmit bacteria, viruses, protozoa and helminthes mechanically and biologically (Mimioglu & Sahin, 1976).

Several bacterial, fungal, helminthic, protozoan and viral agents were found naturally infecting cockroaches (Burgess, 1995). They include *Escherichia coli*, *Mycobacterium leprse*, *Klebsiella pneumoniae*, *Psudomonas aeruginosa*, *Salmonella* sp., *Shigella* sp., *Staphylococcus* sp. and *Yersinia pestis*. Nematodes such as *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Enterobius vermicularis* were also found in cockroaches.

Exposure to cockroach has been reported to cause asthma in many parts of the world (El-Gamal *et al.*, 1995; Mungan *et al.*, 1998). This is due to the offensive and irritable odor they acquire while inhabiting sewers. They may pick up allergens that cause allergic reactions for sensitive individuals.

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# CHAPTER 8
# HEMIPTERA: BEDBUGS

Bedbugs belongs to the order Hemiptera within the family Cimicidae. They have a wide range of distribution and are associated with human settlements. Although bedbugs feed on human blood, nevertheless, they are not implicated in the transmission of any communicable disease. In this chapter, we included this group since it is considered as annoying and causes blood loss for man.

### Morphology

*Cimex lectularius* is the known bedbug species in our area. It has an oval and flattened body, with relatively long antennae that consist of four segments. Mouthparts are adapted for sucking blood. They have vestigial wings represented by triangular wing pads.

### Bedbug Infestation in Jordan

So far, no published reports indicated the magnitude of bedbug infestation in Jordan, however, I have been consulted several times on bedbug infestations in hospitals, residential houses, student's dormitories and hotels. *Cimex lectularius* was found in wooden furniture, under carpets and on curtains. In rural areas, the bugs were found in wall crevices and clothing boxes.

It seems that bedbugs can be transported from one area to another along with luggage and clothing. In newly constructed student dormitories, bedbugs infested the entire building after one year of construction. Indeed the bugs were brought along with student's luggages from distant places.

Bedbugs are intermittent feeders that start to feed at night time. They feed on the victim while asleep. Small spots of blood on the legs or around the waste are signs for the presence of bedbugs in the house.

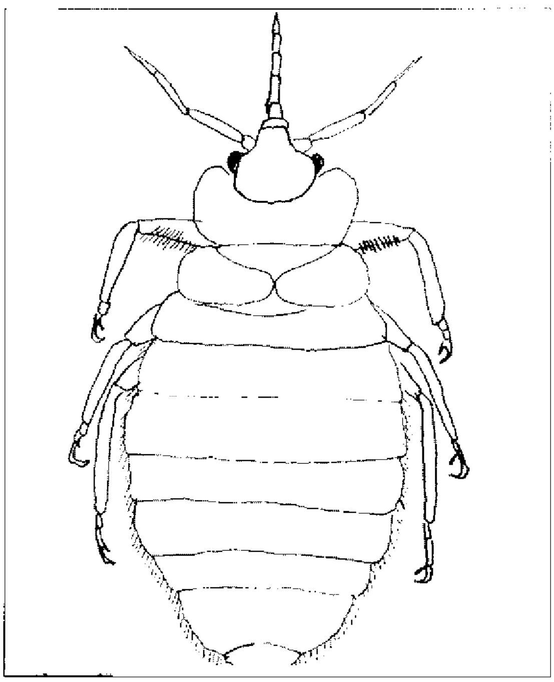


*Figure (8.1): The bedbug, Cimex lectularius*

# CHAPTER 9: SIPHONAPTERA: FLEAS

Fleas are wingless insects with laterally compressed bodies. They are adapted to live on their host's hair and feathers by having numerous spines covering their entire body. Fleas are ectoparasites that feed on blood of mammalian or avian hosts. Most flea species are associated with mammals, however, few are known to parasitize birds.

The fame of this group stems from their capacity to transmit bubonic plague, known in the middle ages as "the Black Death". Not only important in acting as intermediate host for some helminthic infections such as double-pored tapeworm (*Dipylidium caninum*) and other bacterial and viral agents, but also for their annoying bites that cause discomfort and secondary infections caused by itching.

## Morphology

### Adult morphology

Adult fleas are wingless with a laterally compressed body, equipped with three pairs of appendages modified for jumping (**Figure 9.1**). The body and appendages are covered with spines of various sizes. Males are recognizes by the presence of the aedeagus, while females posses a spermatheca (**Figure 9.2 & 9.3**). The body is divided into three distinct regions; head, thorax and abdomen.

1. The head: the head is conspicuous and curved. Several structures are located on the head that are used to identify genera and species. Most important structures are the frontal tubercle, genal combs, shape of the antenna and the eyes. The mouthparts are modified for piercing-sucking and consist of three parts; a pair of maxillary laciniae and a single epipharynx.

2. The thorax: The thoracic region includes three dorsal segments or sclerites; pronotum, mesonotum and metanotum. In some species, pronotal combs or ctenidium are present that are used in species identification. Legs extend downwards from the thoracic segments, the first pair are the shortest and the third is the longest.

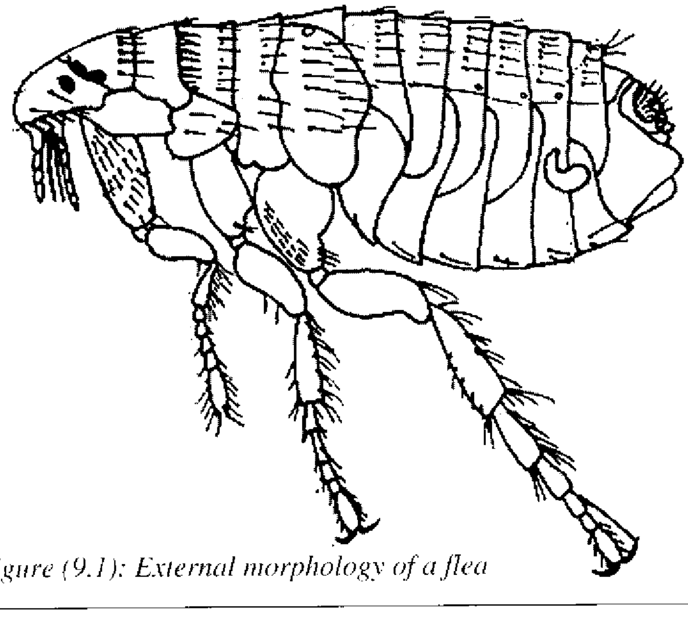
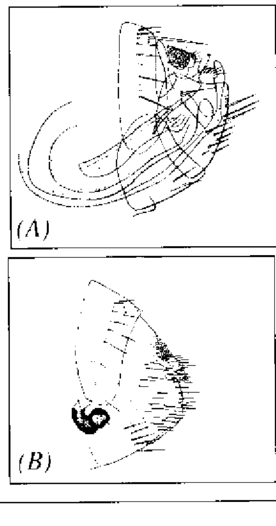


*Figure (9.1): External morphology of a flea*

*Figure (9.2): Male genitalia (A) and female spermatheca (B).*



3. The abdomen: It consists of dorsal and ventral segments (tergites and sternites). The last tergite bears a sensory structure known as the sensilium. Both male and female reproductive structures are located within the posterior end of the abdomen. As stated earlier, males possess a conspicuous aedeagus and females have a spermatheca of different shapes according to species.

## Life Cycle

Fleas have a complete metamorphosis, passing through the egg, larval, pupal and end as adult. A female flea deposits several clutches daily over 3-4 weeks period. Eggs are usually laid on the host. Within a week, eggs hatch into larvae, where they have chewing mouthparts. Larvae feed on organic debris and feces of adult fleas, since undigested blood is passed from adult female fleas to nourish the larva. Larvae molt twice or three times yielding the pupal stage. The pupa is enclosed in a cocoon and usually surrounded by debris and fine sand particles. It develops very quickly and sometimes the adult flea remains within the cocoon until it responds to an external stimulus. After emergence, the adult will seek a specific host, depending on the species, and reproduce either continuously or only once throughout the duration of their life cycle.

## Fleas in Jordan

Despite the importance of this group, only three publications dealt with the Siphonaptera of Jordan (Lewis, 1966; Burt, 1970; Saliba & Amr, 1985). The fleas of Jordan are represented in five families (Ceratophyllidae, Hystrichopsyllidae, Leptopsyllidae, Pulicidae and Vermipsyllidae), with a total of 23 species (**Table 9.1**). Family Ceratophyllidae is represented by one genus (*Nosopsyllus*) and six species, while family Hystrichopsyllidae includes a single genus with one species complex (*Stenoponia tripectinata* spp). Three species belonging to two genera (*Leptopsylla* and *Ophthalmopsylla*) represent family Leptopsyllidae. Family Pulicidae by far contains almost half the fleas known from Jordan, including five genera (*Cteno-cephalides*, *Parapulex*, *Pulex*, *Synosternus* and *Xenopsylla*), while family Vermipsyllidae is represented by a single genus (*Chaetopsylla*) and two species.

The fleas of Jordan are relatively still obscure and require further studies. For further details on the fleas of the Middle East (Lewis, 1967;1982; Lewis & Lewis, 1990) are the most related publications to Jordan.

## Plague in Jordan

Historically, Jordan as well as many other Middle Eastern countries was known as an endemic foci for Bubonic plague. In the Jordan Valley, the "Omwas" plague took its toll during the early period of the newly established *Al-Rashedeen Khalifs*. However, since the foundation of the modern state of Jordan, plague has never been reported. Gratz (1973) reviewed the status of plague in the Middle East.

In 1997, oro-pharyngeal plague occurred among 12 inhabitants of Azraq Ad-Druze village, northeastern Jordan (Arbaji *et al.*, in preparation). Oro-pharyngeal plague due to consumption of plague infested animals has been reported in Libya (Christie, 1980; Christie *et al.*, 1980). Camels and goats are the major red meat source in nomadic areas, and could acquire the causative agent for plague, *Yersinia pestis*, while foraging in deserts. It is believed that domestic animals become infected through feeding on rodent's feces contaminated forage, or biting by infested fleas

## Flea's Species Involved in Plague Transmission

Lewis (1993) gave a detailed account on fleas involved in plague transmission worldwide. Of the mentioned species, eight are present in Jordan (**Table 9.2**), and perhaps represents potential vectors for plague transmission if the disease reappears.

## Other Diseases Transmitted by Fleas

Although no flea's-borne diseases have been reported from Jordan, several species are involved in transmitting other bacterial, viral and helminthec infectious

*Table (9.1) Fleas and their hosts reported from Jordan**

| Families and Species | Host |
|---|---|
| **Family Ceratophyllidae** | |
| *Nosopsyllus geneatus* | *Acomys lewisi* |
| *Nosopsyllus heneleyi* | *Psammomys obesus* |
| *Nosopsyllus iranus* | *Gerbillus dasyurus, Meriones tristrami, Psammomys obesus* |
| *Nosopsyllus pumilionis* | *Gerbillus dasyurus, Meriones tristrami* |
| *Nosopsyllus pringlei* | *Gerbillus dasyurus* |
| *Nosopsyllus sincerus* | *Crocidura russula, Gerbillus dasyurus Microtus guentheri* |
| **Family Hystrichopsyllidae** | |
| *Stenoponia tripectinata spp.* | *Gerbillus dasyurus, Meriones tristrami* |
| **Family Leptopsyllidae** | |
| *Leptopsylla algira* | *Gerbillus dasyurus, Crocidura russula, Mus musculus, Meriones* sp. |
| *Leptopsylla segnis* | *Acomys cahirinus , Apodemus mystacinus* |
| *Ophthalmopsylla volgensis* | *Alactaga euphratica, Jaculus jaculus* |
| **Family Pulicidae** | |
| *Ctenocephalides canis* | Domestic cat, domestic dog |
| *Ctenocephalides felis* | Domestic cat, domestic dog, *Rattus rattus, Herpestes ichneumon* |
| *Parapulex chephrenis* | *Acomys cahirinus, Acomys russatus* |
| *Pulex irritans* | Man, domestic dog, *Vulpus vulpus* |
| *Synosternus cleopatrae* | *Meriones crassus, Meriones tristrami* |
| *Synosternus pallidus* | *Hemiechinus auratus, Vulpus vulpus* |
| *Xenopsylla cheopis* | *Acomys cahirinus, Rattus rattus, Rattus norvegicus,* domestic dog |
| *Xenopsylla conformis* | *Gerbillus dasyurus, Jaculus jaculus, Meriones crassus, Meriones libycus, Meriones tristrami, Psammomys obesus* |
| *Xenopsylla dipodilli* | *Gerbillus dasyurus, Meriones tristrami* |
| *Xenopsylla nubica* | *Alactaga euphratica, Jaculus jaculus,* |
| *Xenopsylla ramesis* | *Gerbillus dasyurus, Meriones crassus, Meriones tristrami, Mus musculus, Psammomys obesus* |
| **Family Vermipsyllidae** | |
| *Chaetopsylla joannae* | *Meriones tristrami, Gerbillus dasyurus* |
| *Chaetopsylla globiceps* | *Vulpus vulpus* |

* Subgenera and subspecies were not given in details

agents (**Table 9.3**). Murine typhus caused by *Rickettsia mooseri* is cosmopolitan in its distribution. Rats and mice are the known major reservoir.

Three tapeworm species, that may accidentally infect human are transmitted by several flea's species (The dog tapeworm, *Dipylidium caninum*, the dwarf tapeworm, *Hymenolepis nana*, and the rat tapeworm, *Hymenolepis diminuta*). Abo-Shehada & Ziyadeh (1991) found that 19.8% of dog's fecal deposits contained ova of *D. caninum*. Dogs examined from various parts

*Table (9.2): Flea's species involved in plague transmission*

| Species | Areas where it is implicated in plague transmission |
|---|---|
| *Ctenocephalides canis, Ctenocephalides felis* | Europe and Eastern USA |
| *Ophthalmopsylla volgensis* | European and Asiatic former Soviet Union |
| *Stenoponia tripectinata* | Asia Minor and European former Soviet Union |
| *Synosternus pallidus* | West Africa |
| *Xenopsylla conformis* | Asiatic former Soviet Union |
| *Xenopsylla cheopis* | Cosmopolitan |
| *Xenopsylla nubica* | North Africa |

of Jordan revealed 19% infection rate with the dog tapeworm (Ajlouni *et al.*, 1984). Eggs of *H. diminuta* were also recovered, in soil samples (Abo-Shehada, 1989).

Murine typhus was reported from the surrounding countries (Shaked *et al.*, 1988; Matossian & Ibrahim, 1974; Gratz, 1973), however, its presence and epidemiology is still unknown in Jordan.

*Table (9.3): Other diseases transmitted by fleas in adjacent regions*

| Species | Disease |
|---|---|
| *Ophthalmopsylla volgensis* | *Listeria* |
| *Leptopsylla segnis*<br>*Ctenocephalides felis*<br>*Xenopsylla cheopis* | Murine typhus |
| *Pulex irritans*<br>*Ctenocephalides felis*<br>*Ctenocephalides canis* | *Dipylidium caninum* |
| *Pulex irritans*<br>*Ctenocephalides felis*<br>*Ctenocephalides canis*<br>*Xenopsylla cheopis* | *Hymenolepis nana* |
| *Xenopsylla cheopis* | *Hymenolepis diminuta* |
| *Xenopsylla cheopis* | tick-borne encephalitis and erysipeloid |

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# CHAPTER 10: ANOPLURA: LICE

Lice are wingless insects with mouthparts adapted for sucking body fluids. They are dorso-ventrally compressed and covered by small spines and their appendages are equipped with claws, an adaptation to cling to their host. Lice of the order Anoplura are associated with mammals. Historically, lice were known since ancient times. They were considered as pests and a sign of filth.

Of this order, two genera are ectoparasites on human (*Pediculus* and *Pthirus*). The first includes head and body lice (*Pediculus capitis* and *Pediculus humanus*) and the second is represented by a single species (*Pthirus pubis*).

## Morphology

The head louse, *Pediculus capitis* **(Figure 10.1)**, is small in size with a longitudinal body that may reach up to 3 mm. Males differ from females by having a rounded abdomen, while in females the abdomen terminates in two posterior lobes. Appendages are equipped with backwardly curved claws. Body is yellow to dark brown yellow.

Adults are usually found on the scalp and the hair. And the nets are glued to hair shafts.

The crab or pubic louse, *Pthirus pubis* **(Figure 10.2)**, is recognized by its crab-shape appearance. Maximum length may reach 2 mm. The crab louse is sedentary in its habit, and as its name indicates, is mostly associated with the pubic region. However, it was observed on eyebrows and other parts of the body.

## Life Cycle of *Pediculus capitis*

Female lice lay each egg singly, and the deposited eggs are glued to hair shafts. Depending on body temperature (24° C to 37° C), the eggs hatch within 7 to 10 days, forming the first instar nymph, and start to feed immediately on blood. The nymphal stage molts three times before reaching the adult stage.

## Pedicluosis in Jordan

Little is known on pedicluosis capitis in Jordan. Very recently Rabi *et al.* (1996) reported on the prevalence of head louse among school children in Russeifa área,

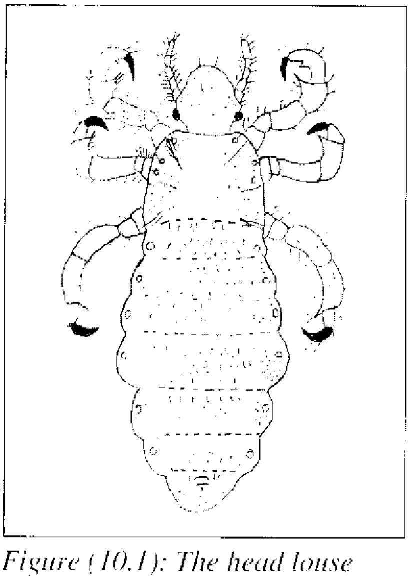

*Figure (10.1): The head louse*

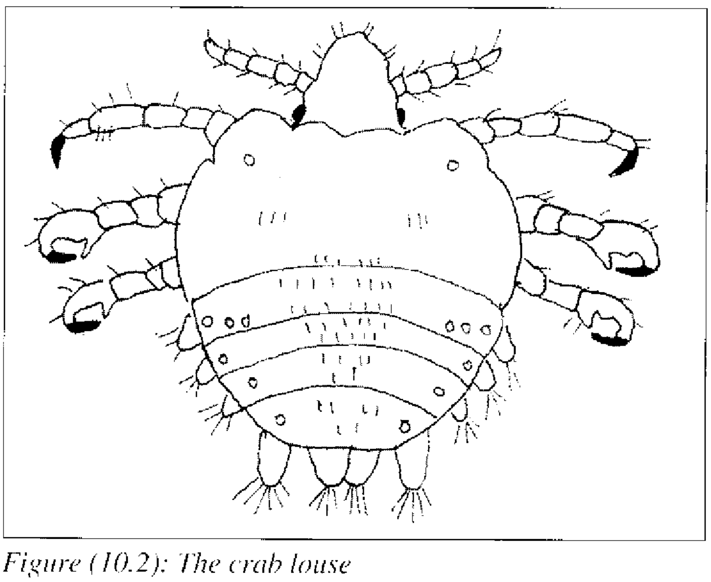

*Figure (10.2): The crab louse*

15 km east of Amman, with an overall infestation of 6.7%. Additionally, Daraghmeh (1993) investigated pedicluosis among kindergarten children in Irbid, with an overall prevalence of 13.2%.

In the past, it seems that infestations were limited, and prevalence was not significant. In the past three decades, Jordan witnessed radical changes in both its social and economic structures. The population increased dramatically due to mass immigration that occurred during the Arab-Israeli war in 1967, and the Jordanian returnees from Kuwait after its invasion in 1990, overcrowding in schools, and the massive employment of housemaids originating from countries with high pediculosis prevalence. All these changes resulted in transformation in patterns of ectoparasitic infections among the various socio-economic population categories.

In the Middle East, head louse infestation seems to be of a public issue; in Abha, Saudi Arabia, an infection rate of 19.8% was reported among schoolboys aged 11-19 years old (Bahamdan *et al.*, 1996). 8% of Lebanese public school students harbors pediculosis (Saab *et al.*, 1996), while 78.6% of school children in Libya are infested (Bharija *et al.*, 1988). Additionally, in a community near Jerusalem, 11.2 and 23.4% of children were infested by both living lice and eggs or only nits respectively (Mumcuoglu *et al.*, 1990).

Results of a study conducted in Ramtha and Irbid area (Amr & Nusair, in preparation) revealed a prevalence rate of 13.4%. The higher prevalence in northern Jordan is attributed to the lower living standards and awareness of the disease.

In this regard, it is noteworthy to mention several outbreaks that occurred among school children of the highest socio-economic classes in the capital Amman, in which the author was consulted. Children enrolled in private schools have routine inspection by the school private medical doctor. Most of these children's families have housemaids originating from Southeast Asia or Eritrea. Upon examining the housemaids, almost 100% were infested. Immediate mass treatment of school children as well as other family members with available shampoos is practiced. This is not the case among the low socio-economic classes, besides, parents deny such prevalence, since it is considered as a social stigma. In governmental schools, elementary classes are relatively crowded (40-50 students per class). Hence transmission of lice is more likely to occur.

No reports indicated on the prevalence of pubic louse infestation in Jordan. Such infestation is considered by far a social stigma than head louse.

**Diseases Transmitted by louse**

Although no records implicated head louse as vectors for communicable diseases in Jordan, the body louse, *P. humanus*, is an important vector in other parts of the world **(Table 10.1)**.

*Table (10.1) Disease transmitted by human louse**

| Louse Species | Disease | Etiologic agent |
|---|---|---|
| *Pediculus humanus* | epidemic typhus | *Rickettsia prowazekii* |
| | trench fever | *Bartonella quintana* |
| | relapsing fever | *Borrelia recurrentis* |
| *Pthirus pubis* | Sexually transmitted diseases | |

* Based on Roux & Raoult (1999), Brouqui *et al.* (1999), Opaneye *et al.* (1993).

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# CHAPTER 11: TICKS

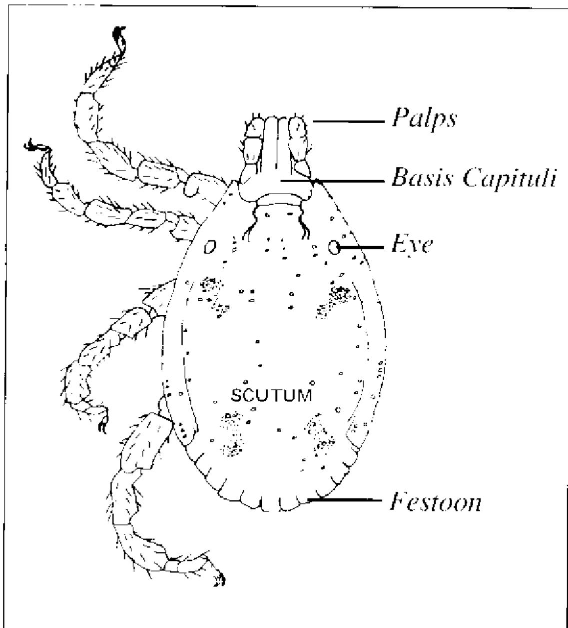
Ticks are classified as members of the class Arachnida. They are included in two families, Family Ixodiadae, known as the hard ticks and Family Argasidae, collectively referred to as soft ticks. Both families include species that are obligatory parasites feeding solely on vertebrate's blood. Ticks differ from other arthropods in that they do not have body segmentations, lack of head, thorax and abdomen. Additionally, both families exhibit different stages during their life cycle, with several variations in their body shape.

The importance of ticks in diseases transmission, is due to the fact that each tick may feed on several hosts, thus increasing the risk of transmitting pathogenic agents, including viruses, bacteria, recketessia and protozoan.

**Family Ixodiadae**

So far, some 650 species of ixodid ticks are known worldwide, of which at least 35 species are currently known or expected to occur in Jordan. All ixodid ticks are blood-feeding arachnids, where they obtain their blood meals from their vertebrate hosts.

Morphologically, hard ticks are characterized by the presence of a dorsal scutum or shield. In some genera, rudimentary eyes are located on the margins of the scutum. Above the scutum, the basis capituli is located. The anterior extension of the capituli ends with the hypostome, a holdfast organ fitted with backwardly directed teeth, which is inserted into the skin of its host (**Figure 11.1** and **2**). The hypostome is surrounded a pair of chelicera and palps. The stigmal plate, used for gas exchange is located ventrally. The anal and genital plates are present, in addition to other shields that may surround the anal plates. Sometimes, margins are segmented forming the festoons. The shape, and presence or absence of these structures is used in tick identification. Below is a key for genera known to occur in Jordan.



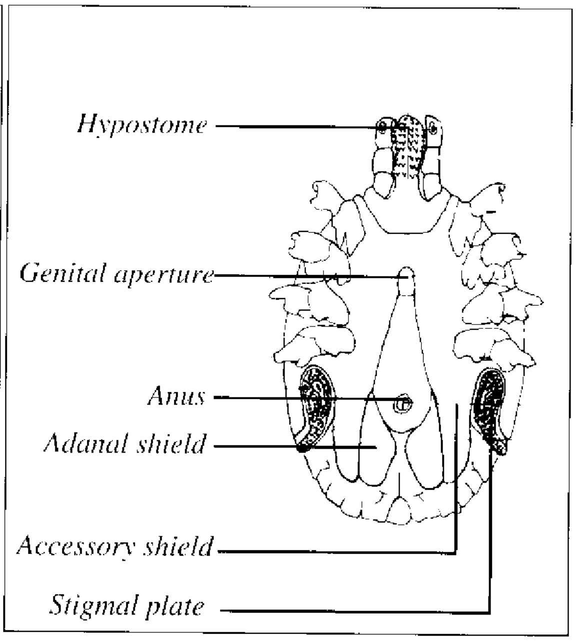




*Figure (11.1): Dorsal and ventral view for a male ixodid tick.*

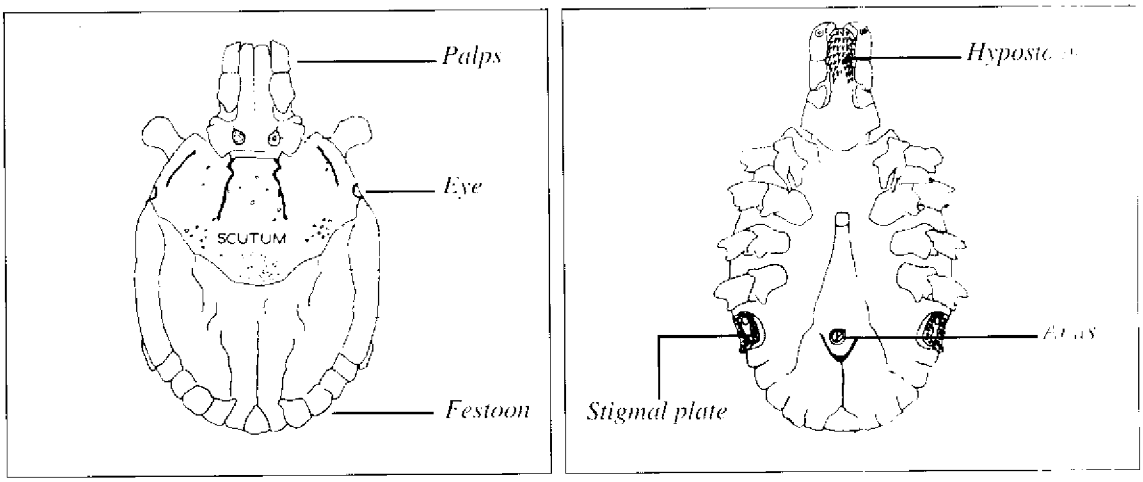



*Figure (11.2): Dorsal and ventral view for a female ixodid tick.*

## Stages of Ixodid Ticks

Ixodid ticks exhibits three stages in their life cycle, the larva, the nymph and the adult **(Figure 11.3)**. The larva is small in size, characterized by having three pairs of legs and the absence of a genital opening.

The nymph is larger than the larval stage. The nymphal stage has four pairs of legs, and the genital opening is absent. Both larvae and nymphs are sexless in this stage. Males and females emerge as the nymph's molt. A male ixodid tick is characterized by the large scutum covering almost the entire body, while females have a short scutum and a genital opening.

## Ixodid Ticks of Jordan

So far, a total of 20 species and sub-

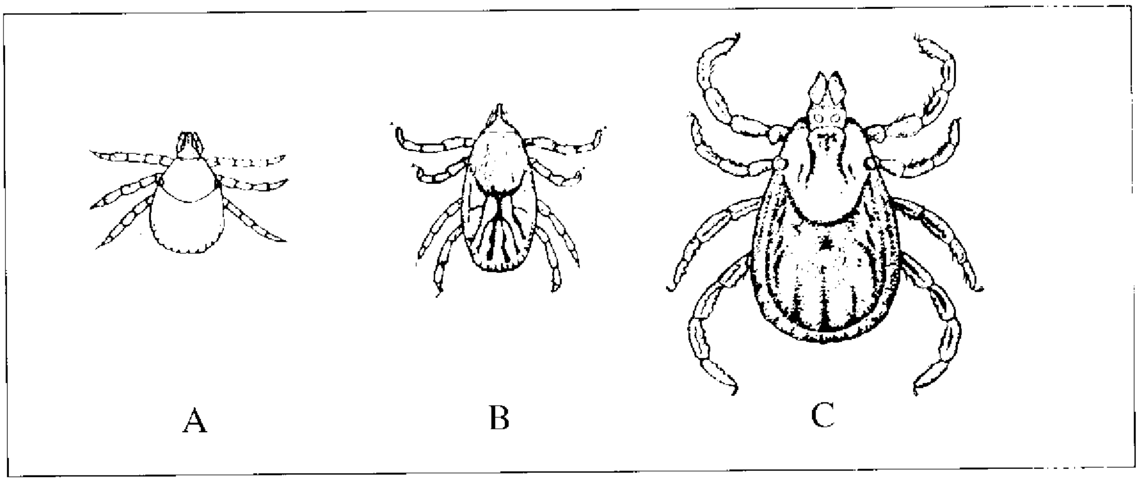



*Figure (11.3): Stages of ixodid tick . A. Larva. B. Nymph. C. Adult female*

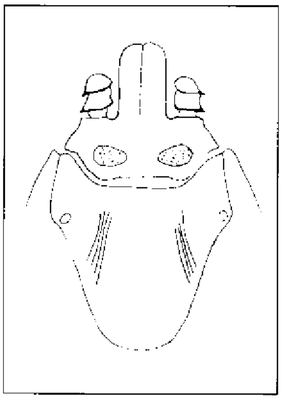
### *Key to the Genera of Family Ixodidae Known from Jordan*

1. Anal groove extends anteriorly around the anus........................................*Ixodes*
   Anal groove laying entirely posterior to the anus........................................2
2. Eyes are markedly or faintly located on scutum margins........................................3
   Eyes are absent........................................*Haemaphysalis*
3. Palps are long........................................*Hyalomma*
   Palps are short........................................4
4. Festoons are present, anal groove very distinct........................................*Rhipicephalus*
   Festoons are absent, anal groove is absent........................................*Boophilus*

species of ixodid ticks represented in five genera (*Boophilus*, *Haemaphysalis*, *Hyalomma*, *Ixodes* and *Rhipicephalus*) were recorded from Jordan (Hoogstraal & Kaiser, 1959 & 1960; Rabi *et al.*, 1990; Saliba *et al.*, 1990).

All species recovered were associated with domestic animals, birds, reptiles and other wild mammals. **Table (11.1)** gives a summary for hosts associated with each species.

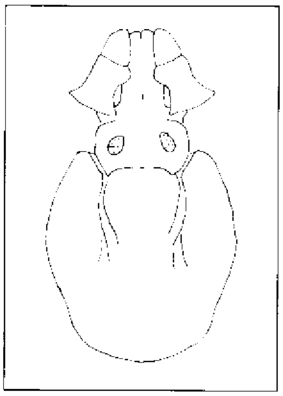
**Genus *Boophilus***



Palps are very short and compressed, with dorsal and lateral ridges. Eyes present. Festoons absent. Males with adanal shields and accessory shields. Ana groove indistinct or absent in females, while faint in males. A caudal process is present or absent in males.

The genus *Boophilus* is exemplified by two species, *Boophilus kohlsi*, which was described originally from Jordan (Hoogstraal & Kaiser, 1960) and *Boophilus annulatus*.

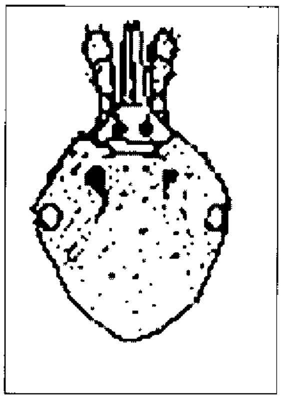
**Genus *Haemaphysalis***



Eyes are absent, festoons are present. The second segment of the palps projects beyond the margins of the basis capituli. Basis capituli is rectangular in shape. Stigmal plates are comma-shaped in males while rounded or oval in females. Adanal shields are absent in males.

The genus *Haemaphysalis* is represented in four species: *Haemaphysalis erinacei taurica*, *Haemaphysalis sulcata*, *Haemaphysalis otophila* and *Haemaphysalis parva*. Larval and nymphal stages are usually associated with small rodents and lizards, while the adults are found feeding on domestic animals and medium-sized wild mammals.

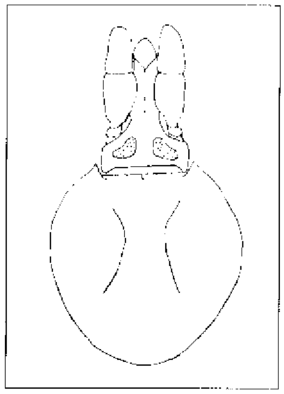
**Genus *Hyalomma***



Eyes are present, festoons are usually irregular. Palps are long, where as the second palpal segment is twice as long as the third one. Basis capituli is sub-triangular. Males posses adanal and accessory shields. Stigmal plates comma-shaped.

By far this genus includes the highest number of species and subspecies of ixodid ticks in Jordan. Nine species and subspecies were recorded (*Hyalomma aegyptium*, *Hyalomma anatolicum anatolicum*, *Hyalomma anatolicum excavatum*, *Hyalomma detritum*, *Hyalomma dromedarii*, *Hyalomma impeltatum*, *Hyalomma marginatum marginatum*, *Hyalomma marginatum turanicum* and *Hyalomma schulzei*).

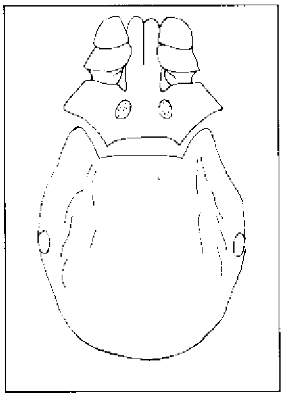
**Genus *Ixodes***



Eyes and festoons are absent. Anal groove curving around the anus anteriorly. Inornate tick. The ventral side of males posses seven non-projecting armor-like plates. A single specimen was taken from the Egyptian Mongoose. The identity to the species level was not confirmed (Saliba *et al.*, 1990). In the neighboring countries, *Ixodes ricinus* was reported.

**Genus *Rhipicephalus***

Eyes and festoons are present. The basis capituli is distinctive in its hexagonal appearance. Males have very distinctive adanal shields and other accessory shields. Stigmal plates are comma-shaped.



Four species were collected from various wild and domestic animals (*Rhipicephalus sanguineus*, *Rhipicephalus turanicus*, *Rhipicephalus camicasi* and *Rhipicephalus bursa*).

## Life Cycle of Ixodid Ticks

Generally, ixoidid ticks pass through several stages in their life cycle. A fully engorged female (female that is full with blood) lays eggs either on the ground or the host's body. A large number of eggs are deposited, ranging from 3000-15000, depending on the tick species. Within two weeks or two months, the larvae emerge and subsequently, they look for a small vertebrate host (rodents, lizards or ground nesting birds). Larvae feeds for 1-2 weeks then detach from their host. The larvae molt after four weeks or longer, depending on the species and transform into the nymphal stage. As in larvae, nymphs seek a small to medium sized animal (e.g. hares or carnivores) and feed for about 1-2 weeks. Nymphs detach after repletion and molt into the adult stage within 2 weeks or few months. Females were usually found to feed on large-sized animals for 2-4 weeks, and mate with males. After engorgement, females deposit their eggs and died afterwards.

## Family Argasidae

Argasid ticks, also known as soft ticks, are characterized by their leathery appearance. Their bodies are flattened, with the mouthparts located ventrally, and may extends beyond the anterior margin of the body. Scutum is absent in all genera. Sexual dimorphism is not obvious as in hard ticks. In Jordan, this family is represented by two genera (*Argas* and *Or-*

*Table (11.1): Hard ticks in Jordan and their respective hosts*

| **Species** | **Host(s)** |
|---|---|
| *Hyalomma aegyptium* | *Testudo gracea* |
| *Hyalomma marginatum marginatum* | *Oenanthe oenanthe*, *Sylvia curruca*, goats and cattle. |
| *Hyalomma marginatum turanicum* | Sheep |
| *Hyalomma anatolicum anatolicum* | Sheep |
| *Hyalomma anatolicum excavatum* | sheep and cattle |
| *Hyalomma dromedarii* | Camel |
| *Hyalomma impeltatum* | Camel, cattle. |
| *Hyalomma schulzei* | Domestic cow, camel. |
| *Hyalomma detritum* | Domestic cattle., Camel, Domestic cow |
| *Rhipicephalus sanguineus* | Dog, *Vulpes vulpes*, *Hemiechinus auritus*, cat, sheep, goat. |
| *Rhipicephalus turanicus* | Domestic sheep, *Meriones tristrami*,. *Vulpes vulpes* *Acomys cahirinus*, *Skekeetamys calurus*, domestic ex. |
| *Rhipicephalus camicasi* | *Lepus capensis*, domestic goat. |
| *Rhipicephalus bursa* | Sheep and goast. |
| *Haemaphysalis erinacei taurica* | *Meriones tristrami*, *Paraechinus aethiopicus*, *Vulpes vulpes*. |
| *Haemaphysalis sulcata* | *Agama stellio*, cattle. |
| *Haemaphysalis otophila* | Sheep and goats |
| *Haemaphysalis parva* | goat and sheep. |
| *Boophilus annulatus* | Sheep, goat and cattel |
| *Boophilus kohlsi* | Domestic cow, domestic horse, domestic cattle and domestic buffalo. |
| *Ixodes* sp. | *Herpestes ichneumon*. |

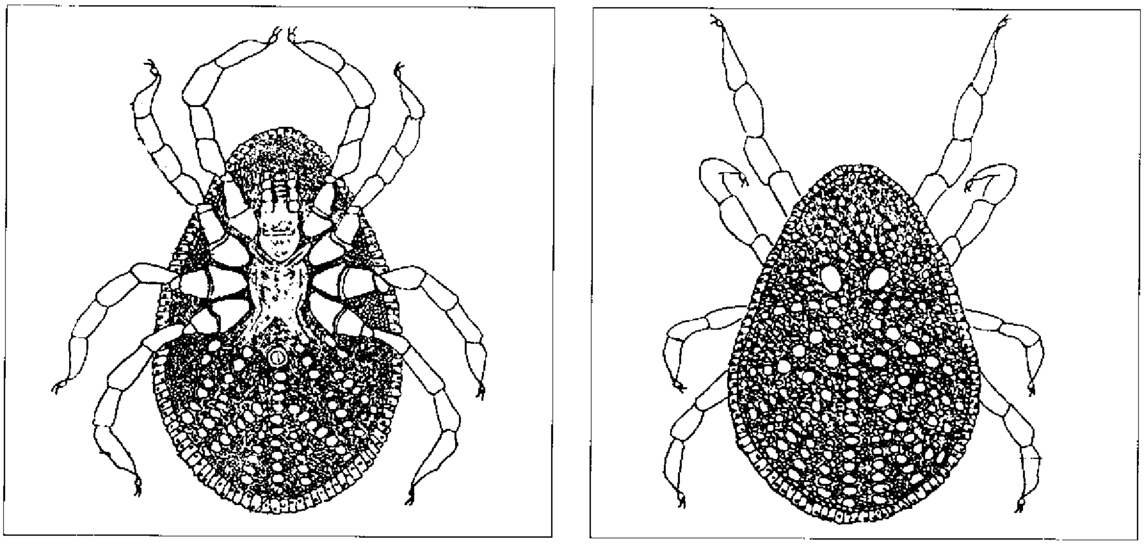


*Figure (11.4): Dorsal and ventral view soft tick.*

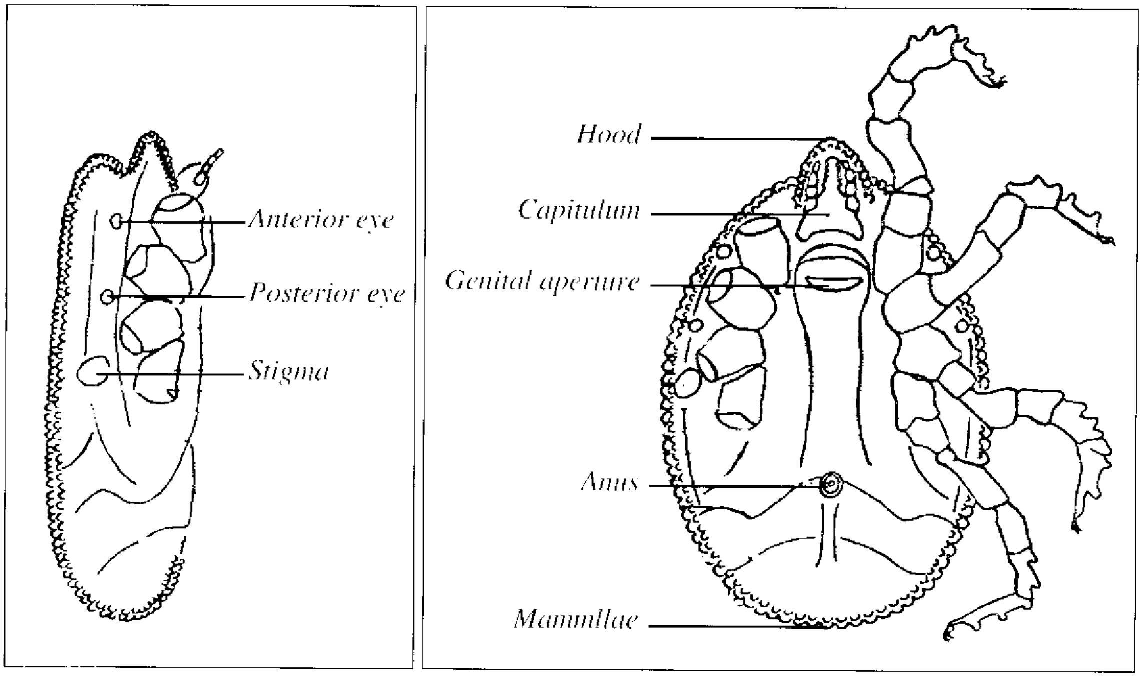



*Figure (11.5): Ventral view of an argasid tick, showing major structures*

*nithodoros*) with seven species.

Soft ticks (Argasidae), are known to transmit *Borrelia* spirochetes, the causative agent for relapsing fever. One important species, *Ornithodorus tholozani*, seems to be the important vector for this disease in Jordan. This species is associated with caves that are used to house animals (sheep, goats and cattle). Such caves are common in many parts of the country.

**Stages of Argasid Ticks**

1. Adult stage: Four pairs of legs are present and the genital opining is well developed.
2. Nymphal stage: Nymphs have four pairs of legs and the genital opening is not developed.
3. Larval stage: as in ixodid ticks, larvae of soft ticks have three pairs of legs. The captiulum is anterior **(Fig.11.6)**.

**Life Cycle of Soft Ticks**

Both males and females of soft ticks feed on their host at night. After fertilization, females seek shelter and deposit eggs. Eggs usually hatch within one to

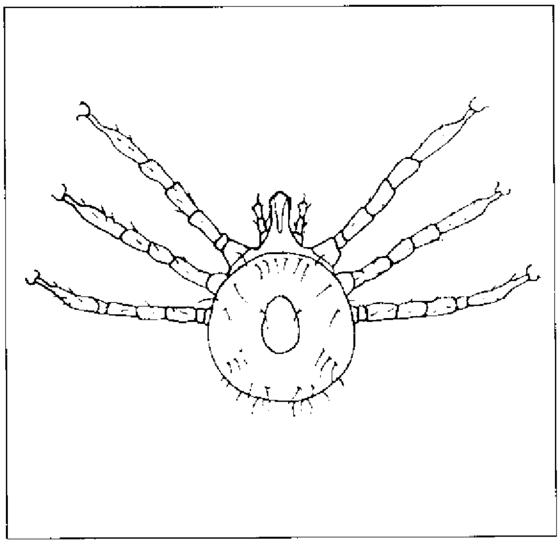


*Figure (11.6): Morphology of a larval stages of an argasid tick.*

two weeks, and sometimes longer, where as a six-legged larva emerges, similarly, larvae look for a host, feed until repletion and detach. Larvae molt into nymphs within few weeks. The nymphal stage is eight-legged, similar to the adult, feeds, and molts, giving a second nymphal stage. Two or up to six other nymphal stages takes place before reaching the adult stage. The entire life cycle can be completed in 6 weeks to three months. The adult may live for one year producing thousands of eggs produced in several clutches, contrary to female ixodid ticks.

**Genus *Argas***

Integument is leathery, with small rounded button-like structures. Dorsal and ventral surfaces are defined by the presence of a distinct sutural line. Eyes are absent. In Jordan, this genus is represented by two species; *Argas persicus* and *Argas vespertilionis*.

**Genus *Ornithodoros***

Integument is roughened and warty in appearance. Sutural line is absent. Apparently, the genus *Ornithodoros* is represented by many species, of which *Ornithodoros tholozani*, is of medical importance in transmitting relapsing fever.

**Ticks and Diseases in Jordan**

During the early fifties, the World Health Organization (WHO) sent Dr. B. Badudieri to investigate on the vector responsible for the transmission of relapsing fever in Jordan. His findings implicated *Ornithodoros tholozani* as a carrier for the spirochete. *Ornithodoros coniceps* was found naturally infected with the spirochete. Badudieri (1957) tried to experimentally infect mice with bed bugs, fleas and several tick species (*Argas persicus*, *Rhipicephalus sanguineus* and *Hyalomma*

*Table (11.2): Soft ticks in Jordan and their respective hosts*

| Species | Host (s) |
|---|---|
| *Argas persicus* | Domestic chicken |
| *Argas vespertilionis* | *Myotis nattereri* |
| *Ornithodoros coniceps* | Domestic sheep |
| *Ornithodoros erraticus* | *Meriones libycus* |
| *Ornithodoros salahi* | *Myotis* sp. and *Rousettus aegypticus* |
| *Ornithodoros tholozani* | Collected from caves |
| *Ornithodoros lahorensi* | Domestic sheep and Camel. |

***Key to Genera of Family Argasidae in Jordan***

1. Margin of the body is thin and acute, with a distinct sutural line separating the dorsal and ventral sides ........................ *Argas*
   Margin of the body is thick and rounded, without a distinct sutural line separating the dorsal and ventral sides........................ *Ornithodoros*

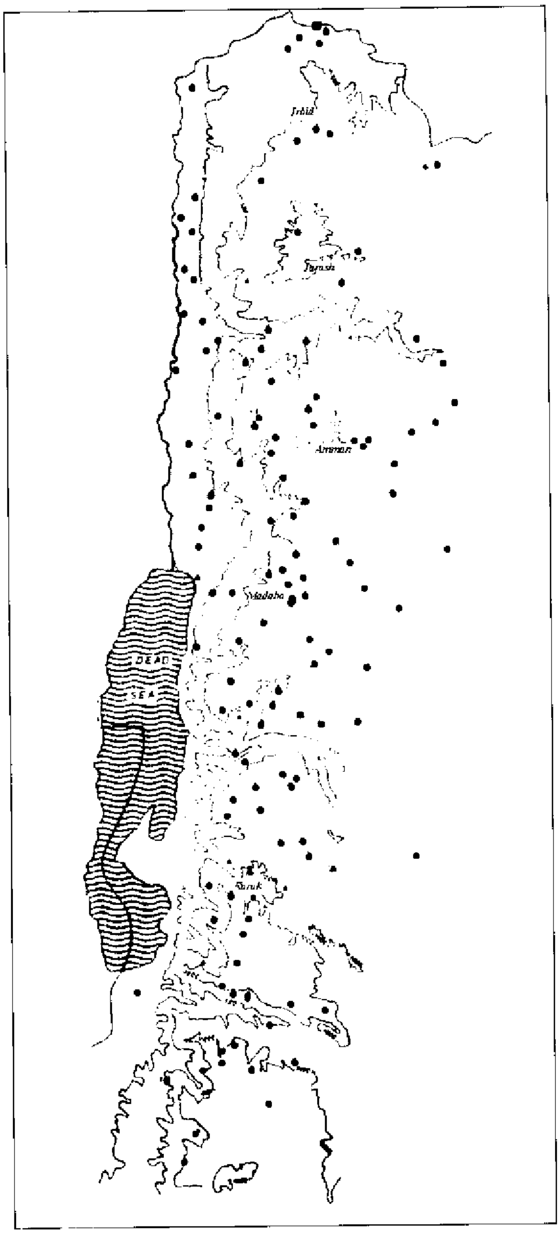


*Figure (11.7): Distrubition of relpasing fever cases in Jorda (1959-1969). Modified after De Zulueta et al.(1971).*

*excavatum*) collected from houses of relapsing fever patients, however, all mice were negative.

De Zulueta *et al.* (1971) reported on relapsing fever cases encountered by the Jordanian Malaria Services while examining blood smears for *Plasmodium* during 1959-1969. They concluded that tick-borne relapsing fever is common in rural regions of Jordan **(Fig.11.7)** and affects young adult males.

No further studies were undertaken to establish the role of tick-borne diseases in Jordan. However, with the presence of a representative of the genus *Ixodes*, it is possible that Lyme disease may be present in northern Jordan, since both the tick and the probable rodent reservoir host (*Apodemus mystacinus*) occur.

Other viral diseases are transmitted by hard ticks. Crimean-Congo haemorrhagic fever virus is known from the surrounding countries, where several outbreaks occurred in the Arabian Peninsula and Iraq (Tikriti *et al.*, 1981; Hassancin *et al.*, 1997; Khan *et al.*, 1997; El-Azazy & Scrimgeour, 1997). The virus was isolated from three tick species; *Hyalomma anatolicum anatolicum*, *Hyalomma excavatum* and *Hyalomma impeltatum* (Khan *et al.*, 1997).

Other tick-borne diseases occurring in Jordan and the surrounding countries affecting humans and domestic animals are summarized in **Table (11.3)**.

*Babesia ovis* is the most common tick-borne disease in Jordan (Abo-

*Table (11.3) Some Tick-borne Diseases Affecting Human and Domestic Animals in the Middle East*

| Disease | Etiologic Agent | Host | Country | Source |
|---|---|---|---|---|
| Tick-borne encephalitis | Flavivirus | Human | Saudi Arabia | Zaki, 1997 |
| Sheep babesiosis | *Babesia ovis* | Sheep | Israel | Yeruham *et al.*, 1995 |
| Spotted fever | *Rickettsia conori* | Human | Israel | Yagupsky & Wolach, 1993 |
| Equine babesiosis | *Babesia equi* | Horses | Jordan | Hilat *et al.*, 1997 |
| Dog hepatozoon | *Hepatozoon canis* | Dogs | Israel | Baneth *et al.*, 1996a |
| Canine Ehrlichiosis | *Ehrlichia canis* | Dogs | Israel | Baneth *et al.*, 1996b |
| Theileriosis | *Theileria annulata* | Cattle | Iraq | Hawa *et al.*, 1988 |
| Theileriosis | *Theileria* sp. | Sheep | Syria | Alyasino & Greiner, 1999 |

Shehada *et al.*, 1988). It is transmitted by several ixodid ticks, such as *Hyalomma excavatum, Rhipicephalus turanicus*, and *Rhipicephalus bursa*. Theileriosis caused by *Theileria hirci* and anaplasmosis due to *Anaplasma ovis* are known to affect sheep and goat in Jordan.

**Studies on the ticks of Jordan**

The first report on the ticks of Jordan was part of a treatment of the ticks of Arabia by Hoogstraal and Kaiser (1959). In this study they reported on the tick collection made by Dr. B. Babudieri, when he investigated the epidemiology of relapsing fever in Jordan during 1954. Later, Hoogstraal and Kaiser (1960) described *Boophilus kohlsi* from domestic animals from Jordan. In 1982, Dr. H. Hoogstraal gave the present author (Z. Amr) all the data that have been collected on the ticks of Jordan and the West Bank since the early fifties. This data in addition to other collections made by the author and others, culminated in the appearance of the most comprehensive paper on the ticks of Jordan (Saliba *et al.*, 1990). Furthermore, a study was published on the ticks collected from domestic animals (Sheep, goats, camel and cattle) by the Animal Health Department (Rabi *et al.*, 1990).

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# CHAPTER 12: SCORPIONS

Scorpions are easily recoginzed from other arachnids by their large, well developed pedipalps and distinct division of the abdomen (opisthosoma) into a broad pre-abdomen (mesosoma) and narrow, tail-like postabdomen (metasoma). All scorpions are equipped with a poisonous sting (telson) and a pair of peculiar, comb-like, sensory appendages called pectens. So far about 1100 species of scorpions are known worldwide. Scorpions are among the oldest arachnids and are referred to as "Living fossils". The earliest fossils dated over 400 million years ago.

Scorpions are generally large arachnids. Adults range in size from 1.5 cm to 21 cm in length. Their prey includes a variety of arthropods and other invertebrates, and the larger species are known to prey on small vertebrates.

The scorpion's most notorious feature is its poisonous sting. All scorpions are venomous, however, only about twenty species worldwide are known to inflict envenomziation and possess venom sufficient to kill humans.

### Morphology of Scorpions

Scorpions are members of class Arachnida of the phylum Arthropoda. They are characterized by large pedipalps equipped with strong claws, by a segmented body composed of the prosoma or cephalothorax, an abdomen consisting of pre-abdomen and post-abdomen and by four pairs of legs. The post-abdomen or tail ends with the telson or stinging apparatus in which there are two venom-producing glands. Scorpions also bear a unique paired sensory structure, the comb-like pecten on the ventral side of the pre-

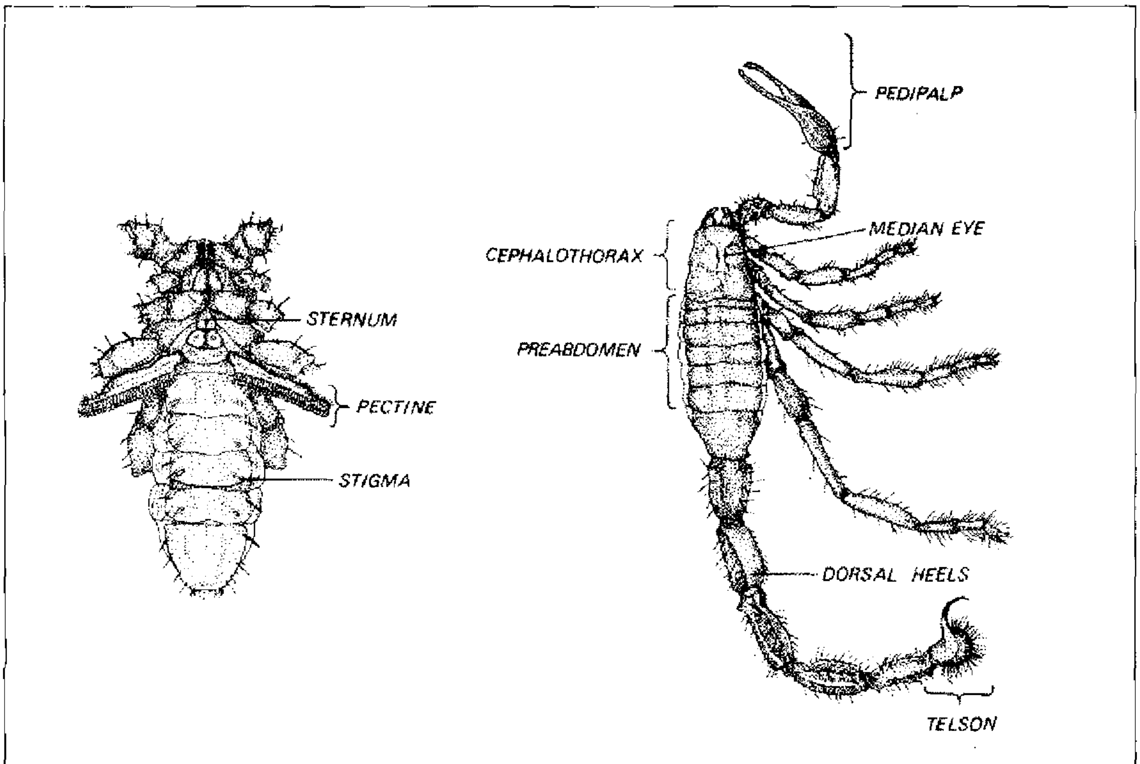


*Figure (12.1): General morphology of scorpion body part*

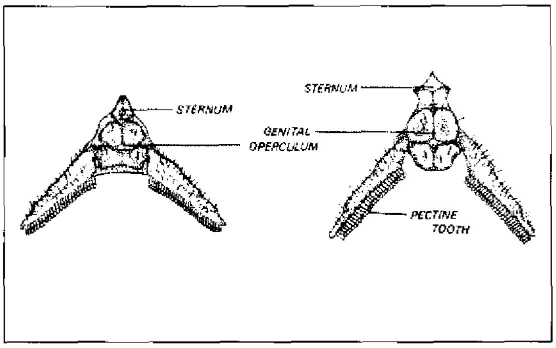


*Figure (12.2): Shape of sternum*

abdomen (**Fig. 12.1**). The body segments possess a variety of structures that are helpful in identifying the scorpion. For example, the shape of the sternum on the ventral side (Triangular or pentagonal) differentiate the different families. The presence or absence of tergal crests on the tergites (dorsal segments) on the prosoma or mesosoma are among the important features used in taxonomical studies. In some species, the shape of the pedipalps (Claws) is very distinctive. Below is a simple taxonomic key that identifies all the species known from Jordan.

**Jordan's Scorpions**

Although scorpions are abundant in Jordan and the surrounding countries, only a few studies have been published on the scorpions of the Middle East. Vachon (1966) gave a list of the scorpions from Egypt, Arabia, Palestine, Libya, Syria, Jordan, Turkey and Iraq based on previously published reports and from his own collection, in which he listed five species

### *Key for the Scorpions in Jordan*

1.Sternum triangular........................................ Family Buthidae 3
Sternum pentagonal........................................ 2

2.Telson lacks subaclear tubercle........................................ Family Scorpionidae 4
Telson equipped with a subaclear tubercle Family Diplocentridae ......... *Nebo hierichonticus*

3.Anterior tergal crests of mesosoma distinct ........................................ 6
Anterior tergal crests of mesosoma not distinct or absent ........................................ 5

4. Colour of the body yellow to light olive brown, legs yellow ............ *Scorpio maurus palmatus*
Colour of the body dark brown to greenish black, legs brown ............. *Scorpio maurus fuscus*

5. Metasoma with several rows of small depressions ........................ *Orthochirus scrobiculosus*
Metasoma without several rows of small depressions........................ *Buthacus leptochelys*

6. Tergal crests of mesosoma projecting beyond the posterior margins ............ *Compsobuthus* 7
Tergal crests of mesosoma not projecting beyond the posterior margins........................ 8

7. Intermediary crests of the second metasomal segment consists of several granules ........................................ *Compsobuthus werneri*
Intermediary crests of the second metasomal segment consists of 1-3 granules........................................ *Compsobuthus acutecarinatus*

8. Prosoma, mesosoma and metasoma are heavily granulated by rounded bead-like granules ........................................ *Birulatus haasi*
Prosoma, mesosoma and metasoma are not heavily granulated by rounded bead-like granules. 9

9. First two tergites of mesosoma with 5 tergal crest ........................ *Leiurus quinquestriatus*
Mesosoma without or with less than 5 tergal crests ........................................ 10

10. Latero-central crests united forming a harp-shape. ........................ *Buthus occitanus*
Latero-central crests not united and not forming a harp-shape ........................ 11

11. Sole of tarsi with spines ........................................ *Hottentotta judaicus*
Sole of tarsi with hairs and bristles ........................................ Androctonus 12

12. Third segment of metasoma longer than wide ........................ *Androctonus amoreuxi*
Third segment of tail longer than wide ........................................ 13

13. Pedipalps slender........................................ *Androctonus bicolor*
Pedipalps wide ........................................ *Androctonus crassicauda*

from Jordan. Levy *et al.* (1973) described a new species *Compsobuthus jordanensis*, from Wadi Deb'em southeast of Amman. In addition, Vachon & Kinzelbach (1987) listed all the scorpion genera in the Middle East. Fourteen species of scorpions belonging to three families have been reported from Jordan (Vachon, 1966 & 1974; Levey *et al.*, 1973; Wahbeh, 1976, Amr *et al.*, 1988; Amr & Al-Oran, 1994), of which four are remarkably venomous. **Figure (1 & 2)** shows their general morphology and the important features used for identification.

## Family Buthidae

Triangular sternum is the prominent feature of representatives in this family. Three to five eyes are usually present and the telson is usually equipped with accessory spines. This family includes most of the venomous scorpions.

### *Leiurus quinquestriatus*

Yellow in colour. The first two mesosomal tergites have 5 keels. Adult specimens may reach 9 cm in length. Total length 3-7.7 cm (average 5.8 cm), prosoma 3.8-9.6 mm, mesosoma 16.8-19.8 mm, metasoma 19.3-42.4 mm. Pectines 29-41.

This is the most common species in Jordan. Wahbeh (1976) reported that *L. quinquestriatus* constituted 85% of the scorpions collected from 13 different localities. Similar results were obtained by Amr *et al.* (1994).

This species is widely distributed over Sinai, Egypt, Palestine (Levy & Amitai, 1980), Arabia (Vachon, 1979) and extends northwards to southern Turkey

### *Hottentaptta judaicus*

Black in colour, prosoma granulated, pedipalps thin and long., terminating with brown Length may reach 10 cm. Sole of the tarsi with small spines. Number of pectines: 22-25 in females, 26-30 in males. Total length 5-7 cm (average 5.9 cm.), prosoma 6.4 mm, mesosoma 16.6-19.9 mm. metasoma 27.5-38 mm. Pectines 22-28.

This species was reported from Irbid and Salt (Wahbeh, 1976), Jarash (Kinzelbach, 1984) and Amman (El-Hennawy, 1988). It seems that this species may be confined to mountainous areas of Jordan. It is quite common in the Ajlune Mountains, and associated with the terra rosa soil, where it coexist with *Scorpio maurus palmatus* (Amr *et al.*, 1994). It constructs burrows that are usually located under stones and it was also found under rocks without burrows.

### *Androctonus crassicauda*

Black in colour. Tail segments thick and wide. Lateral keels of the second and third segments of the postabdomin are reduced to only a few granules. Adult specimen may reach over 8 cm. Total length 4-9 cm (average 8.5 cm), prosoma 10.3-11.5 mm, mesosoma 19.6-23.9 mm, metasoma 42.1-49.9 mm. Pectines 24-33.

Wahbeh (1976) showed that only 6% of scorpions collected belong to this species. It has been collected from Amman and Qaser Amra (Levy & Amitai, 1980) as well as from Aqaba (Amr *et al.*, 1988). This is a desert-adapted species as the localities suggest. *A. crassicauda* is one of the venomous species in the Middle East. It lives in horizontal burrows in dry soil in desertic regions or in rodent burrows.

### *Androctonus bicolor*

The colour of the terminal segments of the legs and pedipalps are light brown. Median lateral keels of the postabdominal segments two and three are developed and possess few granules. Adults may reach 9 cm. Total length 5.5 cm, prosoma 6.9 mm, mesosoma 15.6 mm, metasoma 33.2 mm. Pectines 28-26.

This is a rather rare species with few localities known from Jordan. It was reported this species from Ma'an, Aqaba and Petra (El-Hennawy, 1988; Amr *et al.*, 1994).

### *Androctonus amoreuxi*

Yellow to dark brown, prosoma densely granulated, the seventh segment with four crests. Adult specimens may reach 7 cm. Total length 4.5-7 cm (average 5.44 cm.), prosoma 5-8 mm, mesosoma 11.7-17.7 mm, metasoma 18.9-34.4 mm. Pectines 23-25 in females and 27-32 in males.

This is a desert-adapted species known from Wadi Araba (Amr *et al.*, 1994).

***Orthochirus scrobiculosus***

Small scorpion. Black in colour. Prosoma smooth. Metasoma covered with small depressions. Total length 2.6 cm, prosoma 3 mm, mesosoma 7.6 mm, metasoma 15.2 mm. Pectines 16-20.

This is a desert inhabitant; where it is usually found in small crevices under stones, on small shrubs and in burrows (Amr et al., 1994).

***Buthacus leptochelys***

Yellow to yellowish brown in colour, first segment with 10 keels, fifth segment lacks dorsal keels. cephalothorax entirely smooth. Total length 3.8-4.3 cm (average 4.1 cm), prosoma 4.4-4.6 mm mesosoma 9-10.3 mm, metasoma 22.7-25 mm. Pectines 20-26.

This species is known from Southwest Jordan and found mostly in rodent burrows in extreme desertic conditions (Amr et al., 1994).

***Compsobuthus werneri werneri***

Light yellow in colour, prosoma smooth except for small granules in front of the ocular crest and lateral eyes. Total length 2.5-3.8 cm (average 3.4 cm), prosoma 3.3-4.2 mm, mesosoma 7.1-8.9 mm, metasoma 14.6-15.5 mm. Pectines16-20.

It was collected from Petra and Wadi Al-Hasa, Shaumari, Wadi Sheib, several localities in the Eastern Desert and Amman (Kinzelbach, 1984; El-Hennawy, 1988; Amr et al., 1994).

***Compsobuthus acutecarinatus jordanensis***

Yellow to light-brown in colour, prosoma densely granulated. Total length of the adult approximately 3 cm.

Collected from Wadi Deb'em (Southeast of Amman) and Hissa towards Ma'an (Levy *et al.*, 1973).

***Buthus occitanus***

Colour yellow to dark brown, eight keels on the second and third segment, lateral ventral keels of the fifth segment equipped with distinct teeth. Adult specimens may reach 7 cm.

This species was reported from southern Jordan (Amr *et al.*, 1994).

**Family Diplocentridae**

The presence of accessory spine on the telson is the major distinctive character of this family. It is very similar to the family Scorpionidae in possessing a pentagonal sternum. Only one species belonging to this family occurs in Jordan.

***Nebo hierichontichus***

Dark-brown in colour, prosoma smooth, pedipalps thick and long. Adult may reach 14 cm. Total length 4.5-10.5 cm (average 7.3 cm), prosoma 7. -12.9 mm, mesosoma 17.4-35.2 mm, metasoma 20.2-47.4 mm. Pectines 13-22.

This species is endemic to Syria, Palestine, Lebanon, Jordan and Arabia (Vachon & Kinzelbach, 1988). It was collected from several habitats along the Mediterranean and Irano-Turanian biotopes (Amr *et al.*, 1994).

**Family Scorpionidae**

The pentagonal sternum is the prominent feature of this family. Species belonging to this family lack the accessory spine on the telson. In the Middle East, members of this family are not considered venomous.

***Scorpio maurus fuscus***

Dark brown in colour, pedipalpal claw similar to the lobster, prosoma smooth. Total length may reach 8 cm. Total length 4-5.5 cm (average 4.5 cm), prosoma 6.5-9.1 mm, mesosoma 18.6-20.3 mm, metasoma 19.1-25.7 mm. Pectines 9-10.

This species constructs its burrows either under stones or in the *terra rosa* soil. It was collected from areas characterized by high rainfall and cold winters. It is usually found in dense populations within the same area.

***Scorpio maurus palmatus***

Yellow to light olive brown in color,

pedipalpal claw similar to the lobster, prosoma smooth. Total length may reach 7 cm. Total length 5-5.5 cm (average 5.25 cm), prosoma 7.6-8.3 mm, mesosoma 14.9-18.6 mm, metasoma 18.9-22.9 mm. Pectines 11-13.

*Scorpio maurus palmatus* is of African origin, and is found in arid deserts of Jordan (Amr *et al.*, 1994)/

## Habits of Scorpions

Scorpions are nocturnal; they often slip into shoes, bedding or cracks, and under logs or stones. Stings are generally attributable to carelessness or negligence when, for instance, the victim puts his shoes on without first looking inside. Houses in most villages in Jordan have the toilets as a separate structure, located several meters away from the house. Toilets are usually inhabited by scorpions and during the night. When family members visit the toilet the scorpions may be provoked into stinging. Fissures and cracks around the doors of the house itself provide easy access for scorpions; once inside they slip into bedding and clothing of children while they are asleep. In fact, most of sting accidents occur among children at night, when scorpions get into their night-clothes.

The rocky terrain of northern Jordan offers an especially suitable habitat for scorpions. Here children, while flipping over stones and rocks receive scorpion stings. Field stone fences are also very common in Jordan, notably in the mountainous areas of Irbid, Jarash, Karak, Ajloun, and Tafilah where they offer a perfect habitat for *Leiurus quinquestriatus* and *Scorpio maurus*. In the desert terrain, scorpions were observed using desert rodent burrows; *Androctonus crassicauda* was seen in many rodent burrows around Azraq and the eastern desert.

## Venomous Scorpions of Jordan

Of the fourteen scorpion species known to occur in Jordan, only four are considered poisonous (*Leiurus quinquestriatus, Androctonus crassicauda, Androctonus bicolor,* and *Buthotus judaicus*). **Table (12.1)** summarizes the $LD_{50}$ for species known in the Middle East. *Leiurus quinquestriatus* and *Androctus crassicauda*, are the most toxic species (Ismail *et al.*, 1972),

All scorpions are venomous, since their venom glands produce a variety of toxins that have different effect on animals. Some scorpions are very poisonous to insects. The venom composition affects mammalian cells, reflecting a wide range of symptoms.

The scorpion's venom consists of a variety of fractions, it may include several neurotoxins, histamine, seratonin, enzymes, enzyme inhibitors, and other unidentified compounds. Also the venom con-

*Table (12.1): Reported toxicity of some scorpions known to occur in Jordan.*

| Species | $LD_{50}$ | Method | Family |
|---|---|---|---|
| *Androctonus amoreuxi* | 0.751 | SC | Buthidae |
| *Androctonus australis* | 5.691, 6-0.32 | SC, IV | Buthidae |
| *Androctonus bicolor* | 1.211 | IV | Buthidae |
| *Buthus occitanus* | 1.441, 6-0.90 | SC, IV | Buthidae |
| *Compsobuthus acuticarinatus* | 0.751 | IV | Buthidae |
| *Hottentptta judaicus* | 7.942 | IV | Buthidae |
| *Leiurus quinquestriatus* | 0.501, 6-0.8 | SC, IV | Buthidae |
| *Scorpio maurus* | 9.37 | IV | Scorpionidae |

$LD_{50}$ is the amount of toxin required to kill 50% of test animals and is expressed in mg of venom per Kg of mouse body weight.
Method: IV intravenous injection, SC subcutaneous injection.

tains mucous, various salts, peptides, nucleotides, and a variety of amino acids. Neurotoxins are often considered to be target specific, and target nerve cells of a certain animal. The venom is a strong stimulant of the autonomic nervous system. It's effect has been described as a "sympathetic storm" (Yarom, 1970).

**Epidemiology of Scorpion Stings in Jordan**

The epidemiology of scorpion stings in Jordan was investigated by Amr *et al.* (1988 and 1994) Since 1982-1986, a total of 547 cases were reported to the Ministry of Health clinics throughout Jordan during 1982-1985. Sixteen additional cases were treated at the Jordan University Hospital during 1985-1986. Two fatalities were reported from a total of 563 cases. Only 22 cases were referred to the Ministry of Health hospitals for further treatment. One hundred and thirty-eight patients received medical treatment at the local health centers, while the rest of the cases recovered within a few days (Amr *et al.*, 1988).

During 1989-1992, a total of 338 cases (209 males and 129 females) of scorpion stings were reported to Ma'an Government Hospital and outpatient clinics in the Irbid area (Amr *et al.*, 1994). Also, they recorded that most stings occurred between 21:00 and 1:00 hours. According to age groups **(Table 12.2)** children under 16 years were more vulnerable than other age groups and constituted 48.7%. Males showed a higher incident than females (61.8% and 38.2% respectively). Children under 16 years were more vulnerable than other age groups and constituted 48.7%. Eighty-three (24.7%) patients under six years old showed the highest rate of sting accidents.

Scorpion stings were reported from early February until November and peaked in August **(Table 12.3)** with most of the scorpion sting accidents occurring

*Table (12.2): Age groups ofscorpion stings cases recorded in Jordan from 1989 to 1992**

| Age Group | No. of Cases | Age Group | No. of Cases |
|---|---|---|---|
| 1-5 | 83 | 36-40 | 16 |
| 6-10 | 50 | 41-45 | 6 |
| 11-15 | 30 | 46-50 | 14 |
| 16-20 | 34 | 51-55 | 5 |
| 21-25 | 41 | 56-60 | 7 |
| 26-30 | 21 | 61-65 | 8 |
| 31-35 | 18 | Over 66 | 2 |
| Total | | 335 | |

*After Amr et al. (1994)*

*Table (12.3): Seasonality of scorpion stings recorded from Jordan from 1989 to 1992*

| Month | No. of Cases | Month | No. of Cases |
|---|---|---|---|
| January | 0 | July | 53 |
| February | 2 | August | 66 |
| March | 10 | September | 51 |
| April | 23 | October | 30 |
| May | 56 | November | 3 |
| June | 44 | December | 0 |
| Total | | | 338 |

*After Amr et al. (1994)*

during summer with peaks in July and August in most of the years (Amr *et. al.*, 1988 & 1994).

Most cases were reported from agricultural areas in the northern part of the country (Irbid and North Shounah), and the scattered towns bordering the Eastern Desert (Amr *et al.*, 1994).

**Symptoms Associated with Scorpion stings in Jordan.**

Amr *et al* (1988) presented some of the symptoms associated with scorpion stings in Jordan. A clinical study of 16 scorpion sting patients referred to the Jordan University Hospital revealed the following symptoms: tachycardia, abdominal pain, dizziness, leukocytosis ranging from 10450-20000 WBC/mm, parasthesia, dyspnea, proteinuria and electrocardiographic evidence of myocarditis. Two patients died (9 and 16 years old girls) due to acute heart failure secondary to toxic effects of scorpion venom on myocardial fibers. These two patients were autopsied and histological examination of the heart revealed evidence of focal myocarditis.

In the Middle East, and especially the neighboring countries, Dittrich *et al* (1995) gave an excellent analysis for symptoms associated with scorpion stings in Saudi Arabia, based on a ten-year study. **Table (12.4)** summarizes the symptoms and signs associated with the cardiovascular, gastrointestinal and the central nervous systems.

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*Table (12.4): Combinations of symptoms and signs occurred in several patients**

| Symptom and signs | No. of patients |
|---|---|
| ***Cardiovascular system*** | |
| Hypertension | 75 |
| Tachycardia | 19 |
| Hypertension + tachycardia | 13 |
| Bradycardia | 4 |
| Hypotension | 1 |
| ***Central Nervous System*** | |
| Anxiety | 18 |
| Dizzyness and/or drowsiness | 6 |
| Chills | 6 |
| Hyperventilation | 5 |
| Hysterical conversion reaction | 2 |
| Seizure | 1 |
| ***Gastrointestinal*** | |
| Nausea and/or vomiting | 14 |
| Abdominal pain | 4 |
| Diarrhea | 1 |
| Total exhibiting symptoms/signs | 111 |

* *After Dittrich et al., (1995)*

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# CHAPTER 13: SARCOPTID MITES

Mites are acarines that have much similarity to their relatives, the ticks. However, mites are quite different from ticks by their membranous or membranous with hard palate body texture, the hypostome is not toothed, the absence of Haller's organ (pore on the tarsas of the first pair of legs), and their small size. Mites are highly diversified, inhabiting almost all types of habitats. Many species are free living, feeding on decomposing matter, while others are parasites. They assume different shapes that are adapted to their feeding habits and habitats.

Parasitic mites feed on a wide range of hosts, ranging from invertebrates to the higher vertebrates. As human beings are concerned, scabies, caused by *Sarcoptes scabiei*, is the major infestation caused by mites in our region. Although other species, the follicle mite, *Demodex folliculorum*, and house dust mites (*Dermatophagoides farinae* and *Dermatophagoides pteronyssinus*) affects humans, but with minor ill effects.

## Morphology of the Itch Mite, *Sarcoptes scabiei*

The itch mite is a small parasitic mite

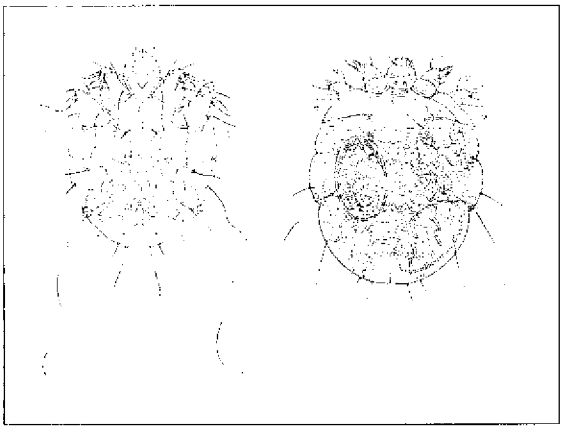

*Figure (13.1): The itch mite, Sarcoptes scabiei. Male (left), female (Right).*

infesting human skin. Females are about 0.2-0.4 mm in length, and males are usually smaller. They have an oval, sack-like shape with a finely wrinkled body surface. Appendages are short and the first two anterior pairs are distinctly separated from the last two pairs. The anal opening is located in the posterior end. Body has scattered spines and many backwardly pointed scales.

## Life Cycle of the Itch Mite

The female itch mite burrows under the epidermal layer of the skin and deposits its eggs in the tunnels that it forms while burrowing. Eggs hatch into the larval stage. Larvae molts into nymphs (eight-legged stage) and final the adult emerges after the nymph molts one or twice. The life cycle of the itch mite is completed within 11-17 days. The adult may live for a month and demise thereafter (Arlian, 1989).

## Scabies in Jordan

Scabies has been recognized through all over the world. In the old Arabic literature, scabies was known and described. In Jordan, scabies epidemiology and prevalence remains unknown. Many dermatologists consulted me on cases of scabies, and it seems as a common skin disease encountered in outpatient clinics all over the country. Our preliminary data shows that it affects both high and low socio-economic classes of the Jordanian community, but by far much common in poor and neglected neighborhoods.

## Specificity of *S. scabiei*

There are several strains of *S. scabiei*, although they do not differ morphologically, but differs physiologically. Collectively, all experimental studies to transfer the itch mite from one host to another failed. This fact suggests strain differences. Humans may occasionally acquire scabies while handling or living with infested animas. However, the frequency is still undetermined. When experimentally transferred, canine scabies affected human, however, it was self limiting and temporary (Arlian, 1989).

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