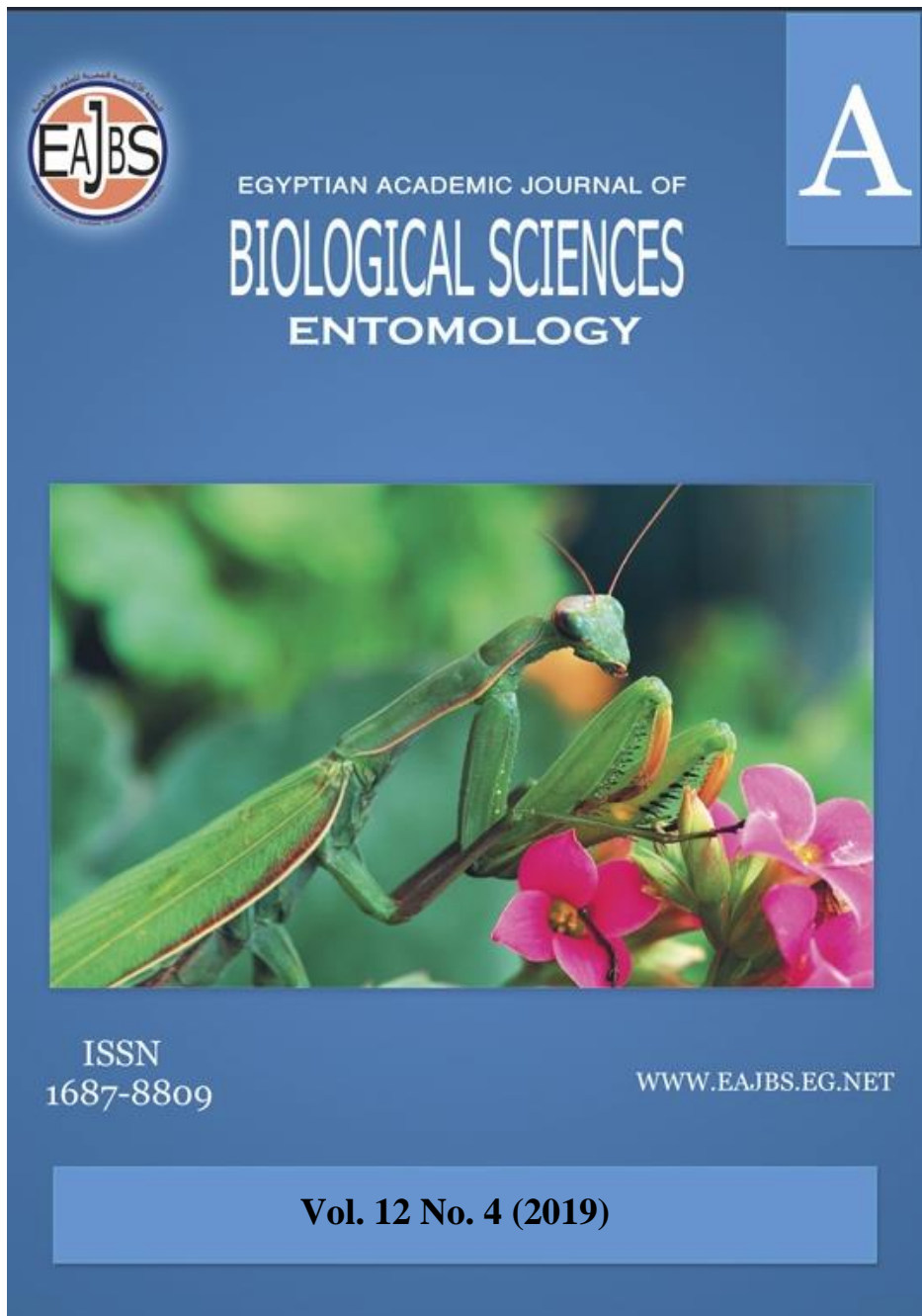


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**A morphotaxonomic album of phlebotomine sand flies  
(Diptera: Psychodidae) of Egypt**

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**ABSTRACT**

Leishmaniasis are endemic in Egypt. The sand fly vectors have been incriminated. An album for the sand fly fauna was based on slide-mounted specimens from the archive of the Research and Training Center on Vectors of Diseases, Ain Shams University, Cairo, Egypt. The sand fly specimens originated from several surveys conducted in different parts of Egypt over 20 years. The album presented twenty species of the genera *Phlebotomus* and *Sergentomyia*. These were presented in 68 photos in 18 plates. Nine species of the genus *Phlebotomus* were reported *P. papatasi*, *P. bergeroti*, *P. langeroni*, *P. orientalis*, *P. major*, *P. arabicus*, *P. kazeruni*, *P. sergenti* and *P. alexandri* and eleven of the genus *Sergentomyia*, *S. squamipleuris*, *S. palestinensis*, *S. fallax*, *S. cincta*, *S. schwetzi*, *S. taizi*, *S. theodori*, *S. tiberiadis*, *S. christophersi*, *S. clydei* and *S. adleri*.

**INTRODUCTION**

Phlebotomine sand flies are insects of significant medical importance with many species serving as vectors of protozoan parasites the etiological agents of cutaneous and visceral leishmaniasis. They are also vectors of sand fly viruses and *Bartonella bacilliformis*.

In Egypt, both cutaneous (CL) and infantile visceral leishmaniasis (IVL) are endemic. The vector of (CL) *Phlebotomus papatasi* was incriminated (Fryauff et al., 1993) and the vector of (IVL) was *Phlebotomus langeroni* (El Sawaf et al., 2012).

A comprehensive understanding of the sand fly species identification is crucial from the taxonomic and epidemiological point of view.

Entomological surveys were conducted in different parts of Egypt to document sand fly species composition. The collected sand fly species were identified and maintained in the Research and Training Center on Vectors of Diseases (RTC), Ain Shams University, Cairo, Egypt.

The present study was interested in revising the identification of the archived slide-mounted sand flies and providing photomicrographs of the most prominent characteristics that are used to determine taxa.

## MATERIALS AND METHODS

### Collection Areas:

The slide-mounted sand flies examined were collected during surveys conducted in North Sinai Nekhel, CL focus (El Hossary *et al.*, 2000), South Sinai, Abu Rudeis (on coast), Feiran Oasis and Saint Catherine (high altitude) (El Sawaf *et al.*, 1987), Ras Sider, Abu Zenima, Abu Rudeis, El Tor, Sharm El Sheikh, Saint Catherine, Wadi Feiran, Nuweibaa, Sheikh Atiya and Wadi Sa'l, (Kamal, 2004). Southern Eastern transect of Upper Egypt (Halayeb and Shalateen) (Soliman *et al.*, 2001). North Western coast (El Agamy, Alexandria) IVL focus and Matrouh (Beier *et al.*, 1986; Doha *et al.*, 1991).

### Collection of Sand Flies:

CDC light traps were used in different biotopes, urban, periurban, rural areas, human dwellings, animal and poultry sheds. Sticky paper traps and hand aspirators were also used for collection.

### Identification of Sand Flies:

Chloral hydrate cleared specimens were mounted and identified according to the key of Lane (1986). Photomicrographs using Xiaomi mobile camera, attached to a compound microscope (KARL KAPS Asslar/Wetzlar) were recorded. The morphological characteristics examined were: the external and internal genital features of males; the internal spermathecae and spermathecal duct for the females; cibarial teeth and pharyngeal armature for both males and females. Voucher specimens were preserved in the entomology department of the RTC.

## RESULTS AND DISCUSSION

The album comprised 18 plates: Plate 1-8 micrographs of *Phlebotomus* species. Plate 9-18 micrographs of *Sergentomyia* species.

The number of species within the genus *Phlebotomus* was low (9) compared to the fauna of the genus *Sergentomyia* (11) which exceeded *Phlebotomus* in diversity. This is in agreement with the findings of many investigators in different countries (Lane, 1986; Tateng *et al.*, 2019).

The goal of our study was to provide sand fly identification experts with photomicrographs of the characters mostly used to determine gender and species of the sand fly fauna of Egypt.

*Sergentomyia minuta* was not identified in the present study. However, Zein El Dine (1972) reported the collection of *S. minuta*, a common Mediterranean species, by Eflaton in 1922. It is possible that this species was misidentified as also suggested by Lane (1986). Moreover, *Sergentomyia cincta* was identified. This species is very closely related to and considered to be conspecific with *S. antennata*. Their differentiation in this paper relied on the shape and dentation of the pharynx in females. The absence of *S. antennata* from the listed *Sergentomyia* species in this paper does not preclude its presence in Egypt. Additional surveys are required to understand the sand fly species diversity and dynamics which are important knowledge for the successful control of leishmaniases.

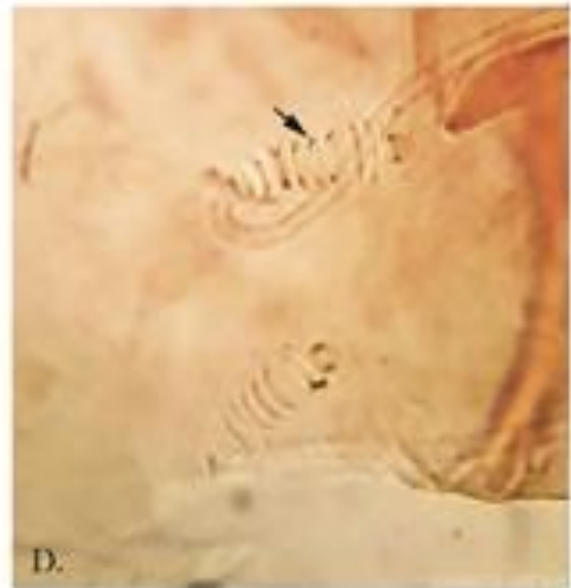


Plate. 1

**Phlebotomus (Phlebotomus) papatasi**

A. and B. male genitalia

C. female spermatheca D. enlarged spermatheca



Plate. 2

**Phlebotomus (Phlebotomus) bergeroti**

A. male genitalia B. and C. female spermatheca

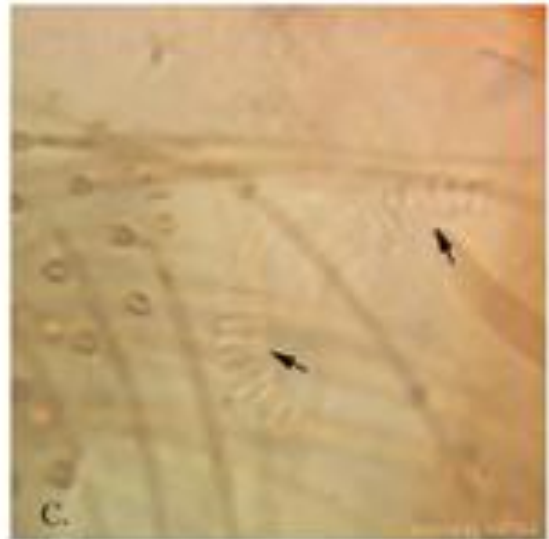
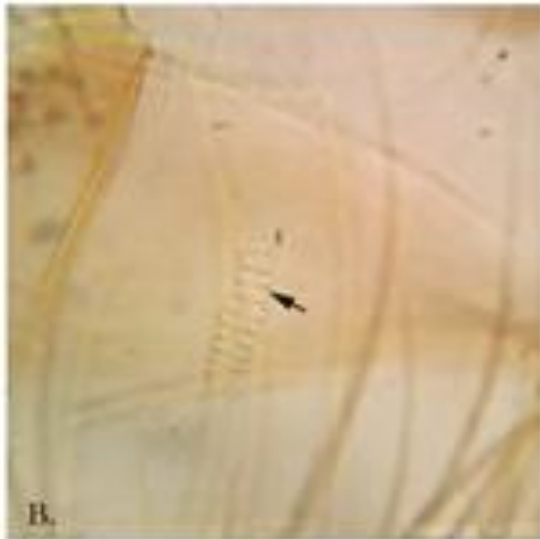


Plate. 3

**Phlebotomus (Larrousius) langeroni**

A. male genitalia B. and C. female spermatheca

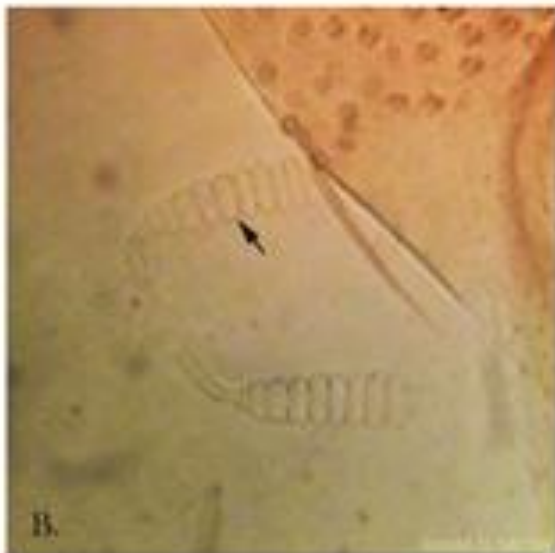
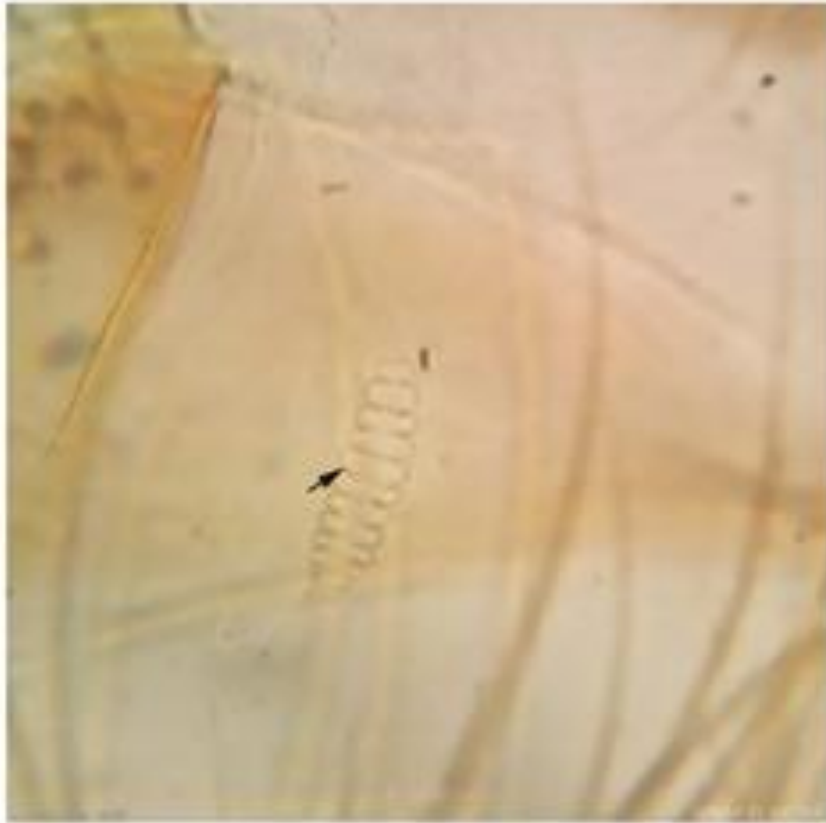


Plate. 4

- A. *Phlebotomus (larroussius) langeroni*  
B. *Phlebotomus (larroussius) orientalis*  
C. *Phlebotomus (larroussius) major*  
arrow: spermatheca

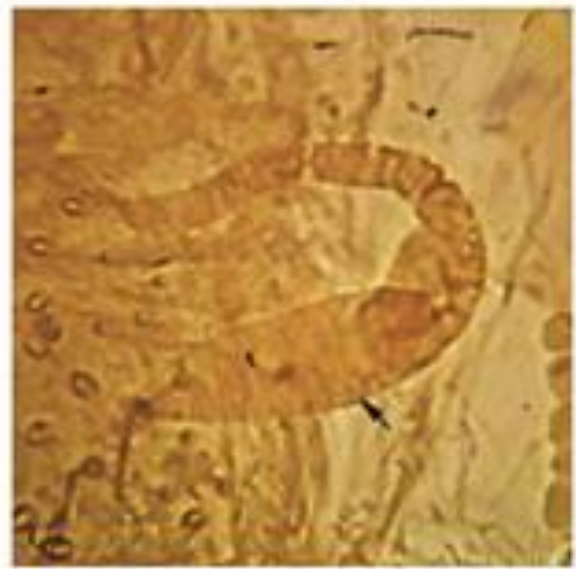


Plate. 5

**Phlebotomus (Adlerius) arabicus**

A. male genitalia B. female spermatheca

C. enlarged spermatheca



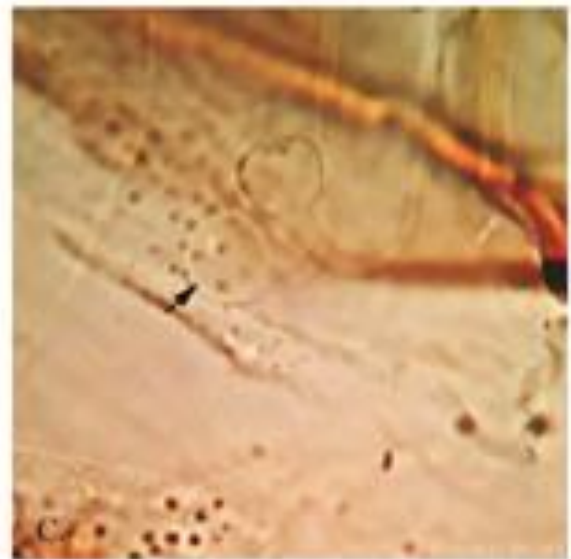
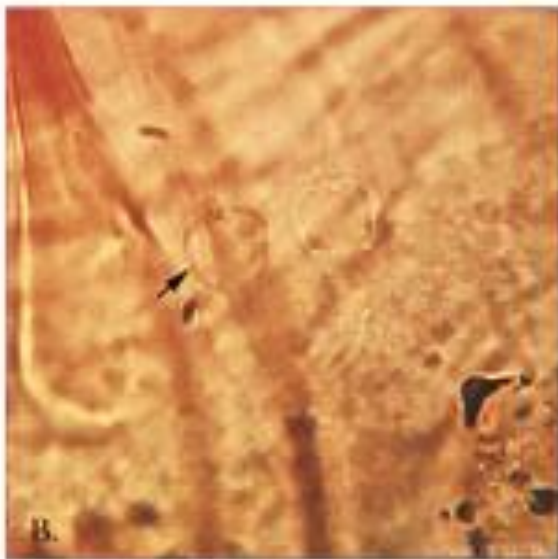


Plate. 6

***Phlebotomus (Paraphlebotomus) kazeruni***

A. male genitalia B. and C. female spermatheca

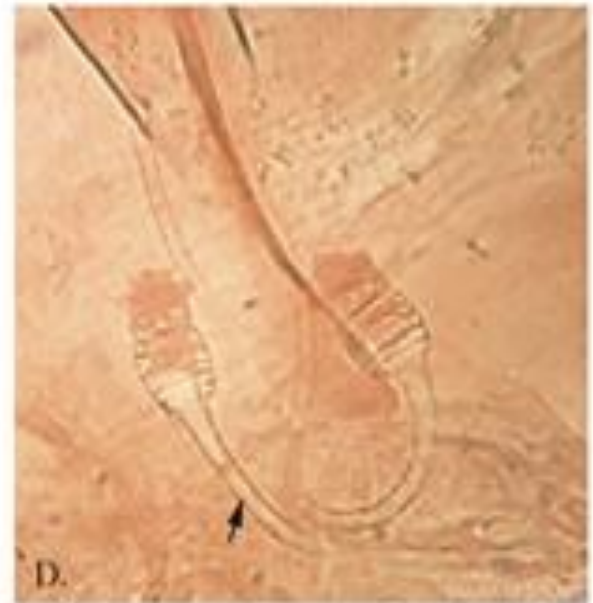


Plate. 7

***Phlebotomus (Paraphlebotomus) sergenti***

A. and B. male genitalia

C. female spermatheca D. enlarged spermatheca

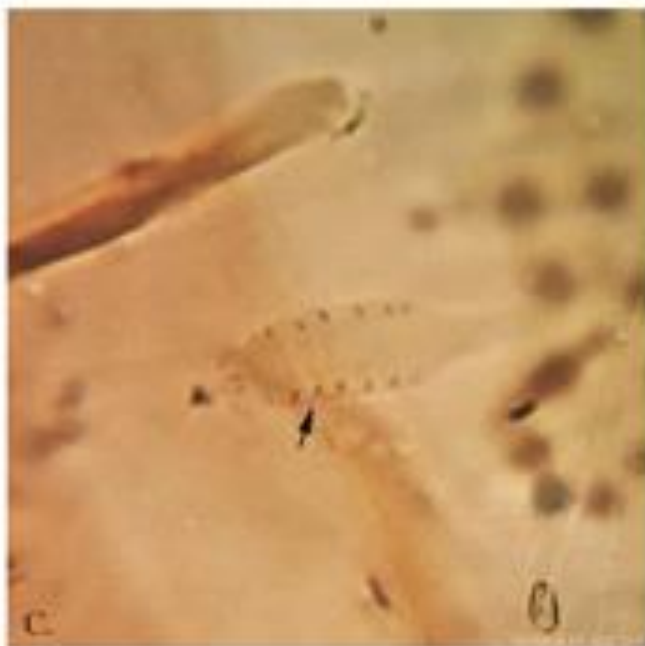


Plate. 8

## *Phlebotomus (Paraphlebotomus) alexandri*

A. male genitalia B. male head (pharynx & cibarium)  
C. female spermatheca D. female head (pharynx & cibarium)

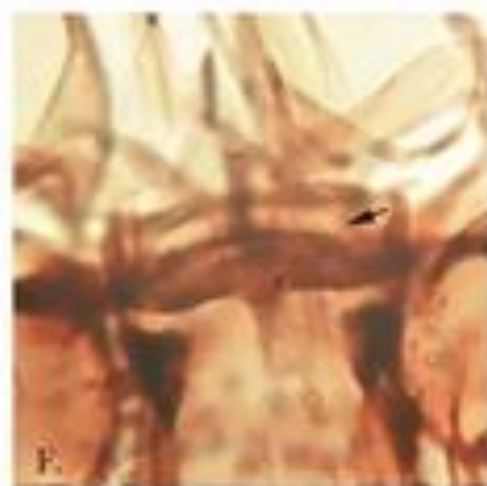
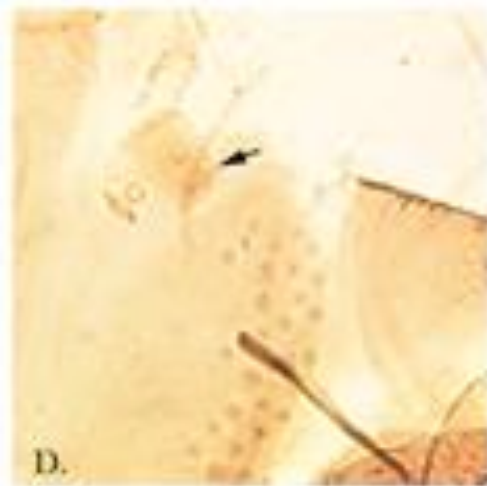
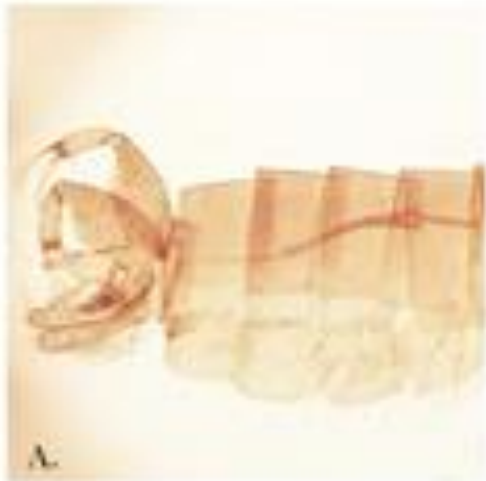


Plate. 9

**Sergentomyia (Grassomyia) squamipleuris**

- A. male genitalia B. male cibarium teeth C. female spermatheca  
D. enlarged spermatheca E. female head (pharynx & cibarium)  
F. female cibarium teeth

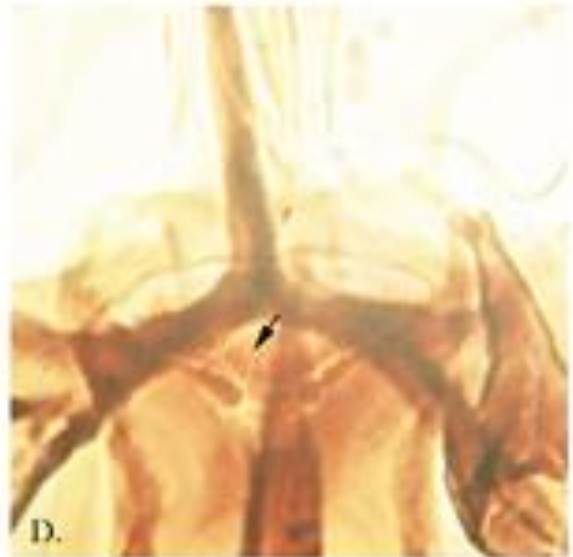
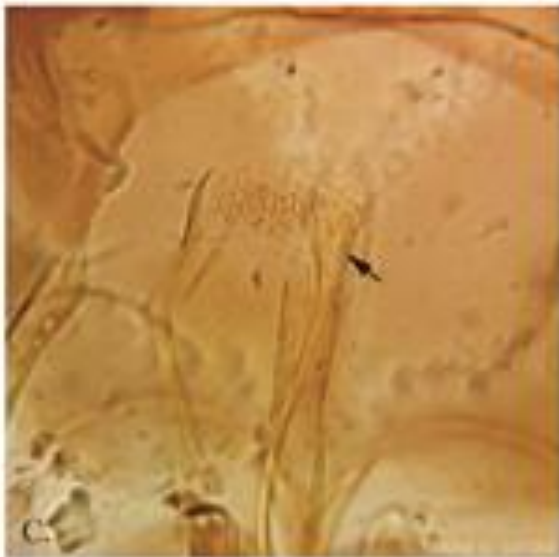
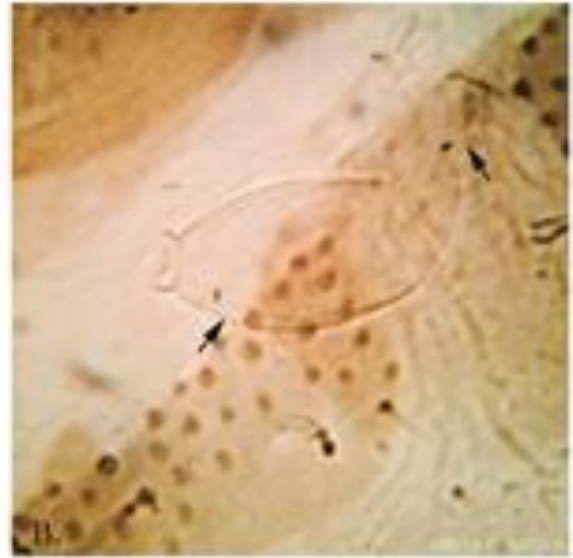
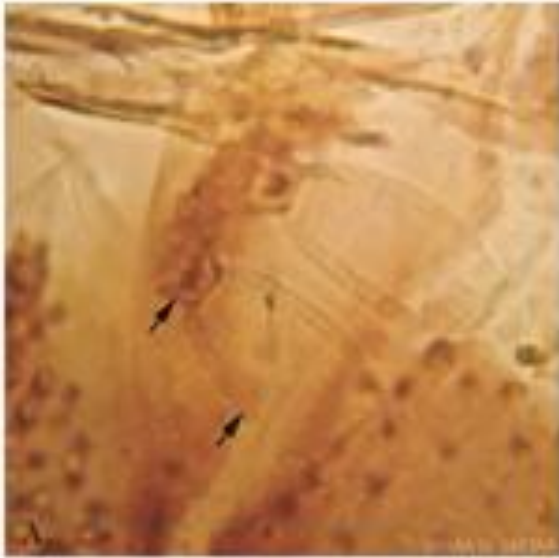


Plate. 10

### *Sergentomyia (Parrotomyia) palestinensis*

A. female spermatheca with double wall and collar head

B. female spermathecal duct C. female pharynx

D. female cibarium teeth

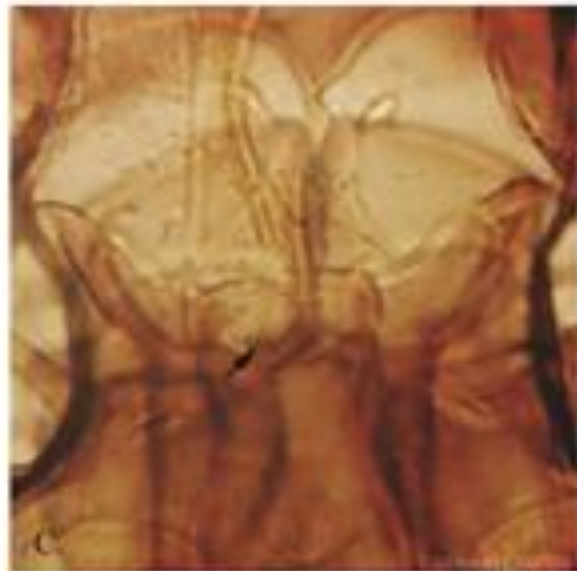
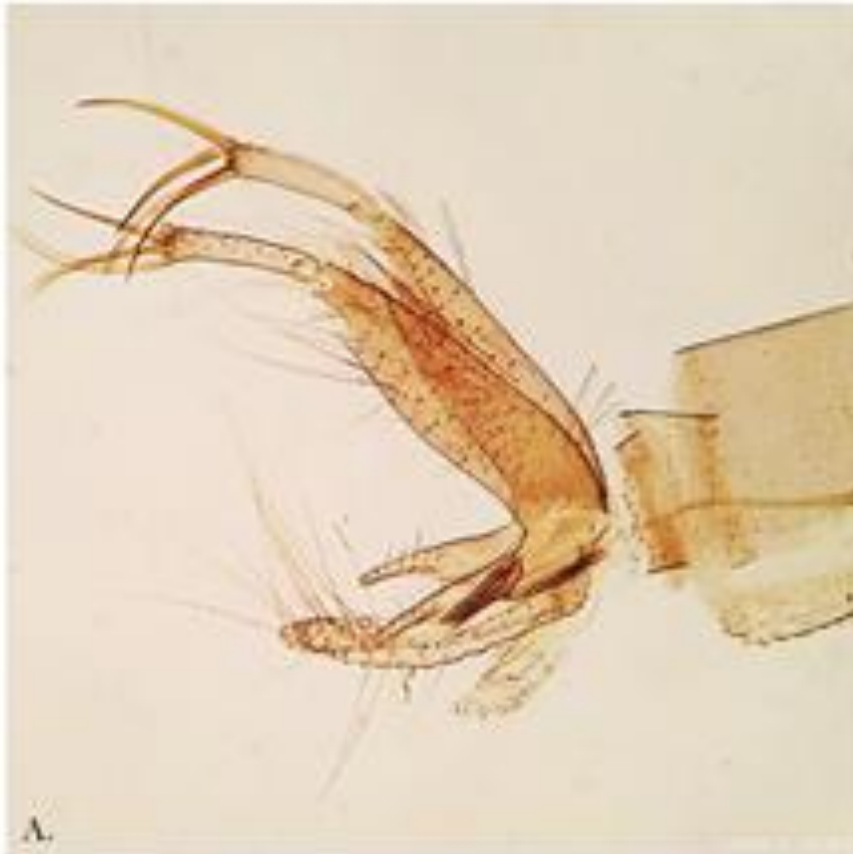


Plate. 11

***Sergentomyia (Sergentomyia) fallax***

A. male genitalia B. female head (pharynx & cibarium)

C. female cibarium teeth

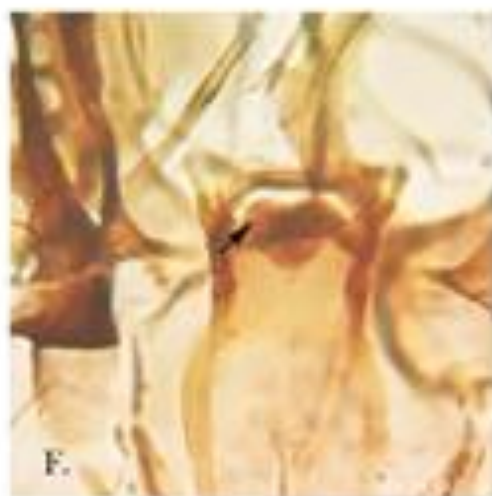
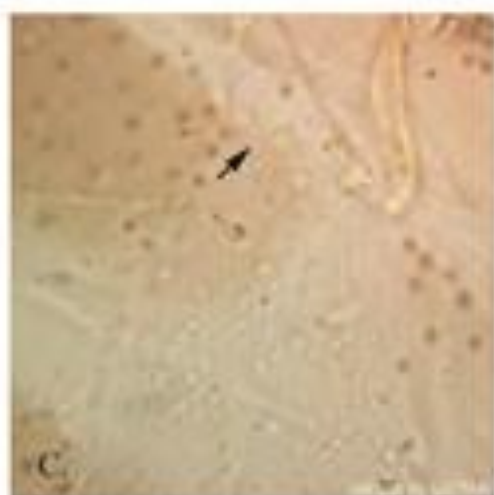
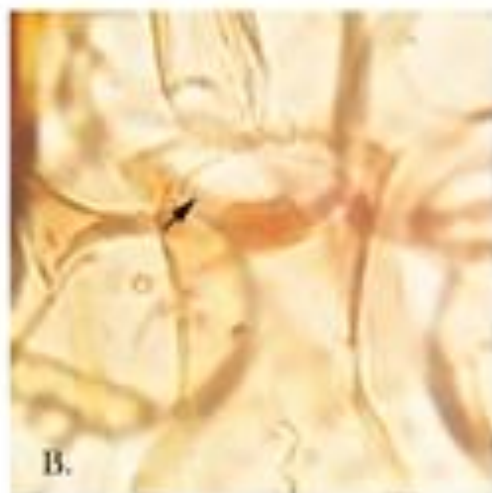


Plate. 12

### *Sergentomyia* (*Sergentomyia*) *cincta*

A. male genitalia B. male cibarium teeth C. female spermatheca  
D. and E. female pharynx and cibarium F. female cibarium teeth

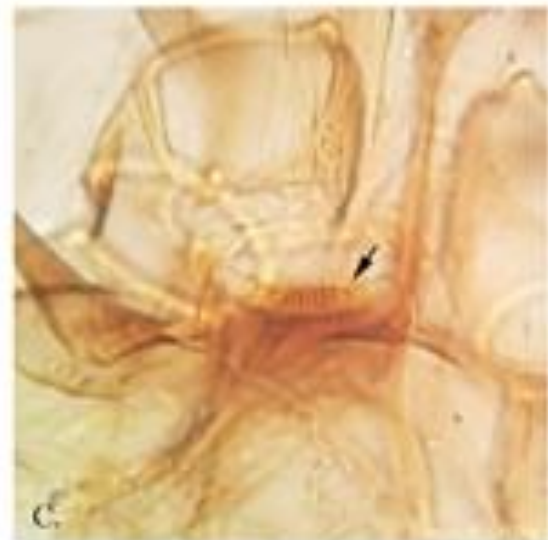
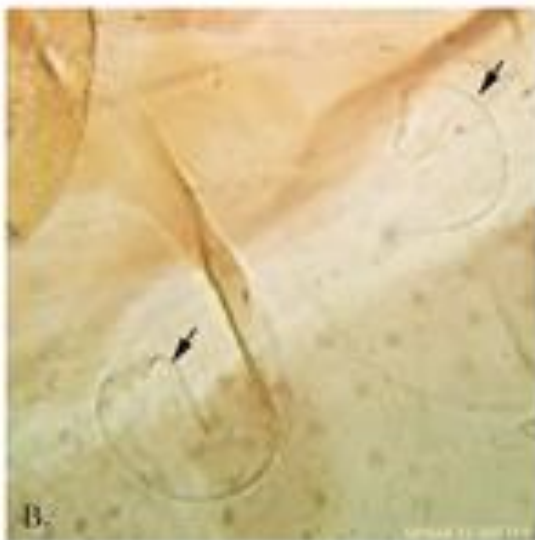


Plate. 13

***Sergentomyia (Sergentomyia) schwetzi***

A. male genitalia B. female spermatheca

C. female cibarium teeth



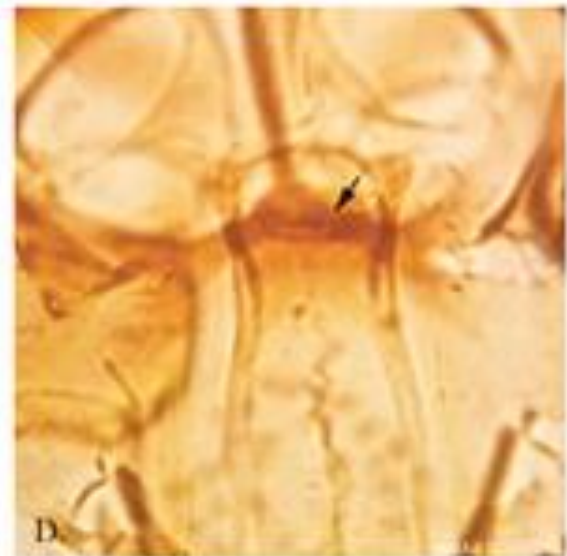
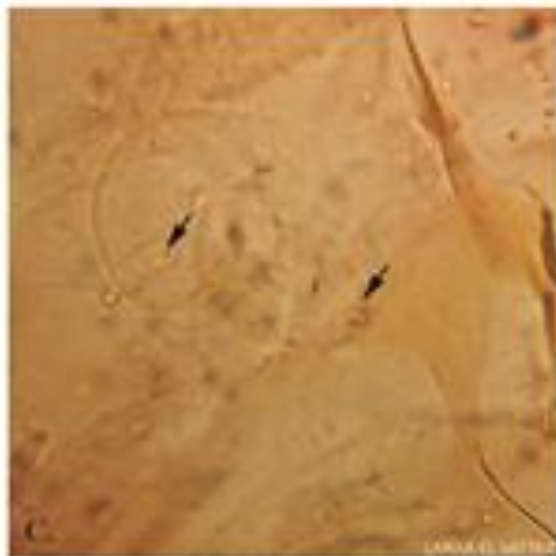


Plate. 14

## *Sergentomyia (Sergentomyia) taizi*

A. male genitalia B. male cibarium teeth  
C. female spermatheca D. female cibarium teeth

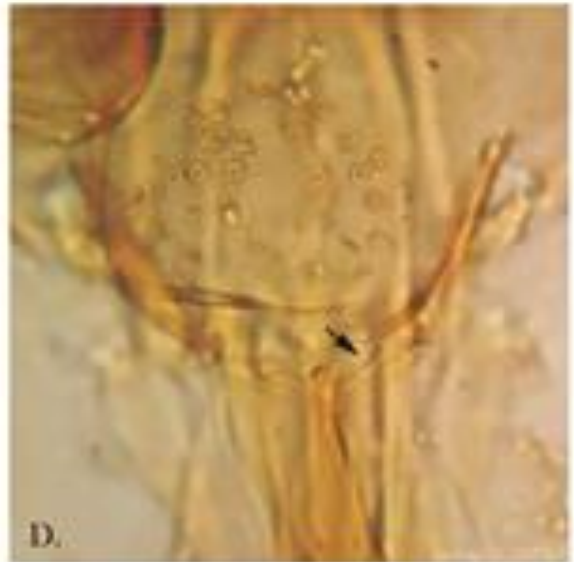
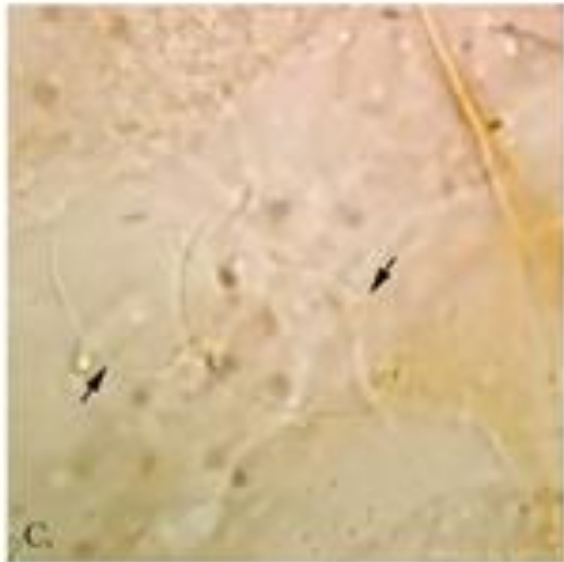
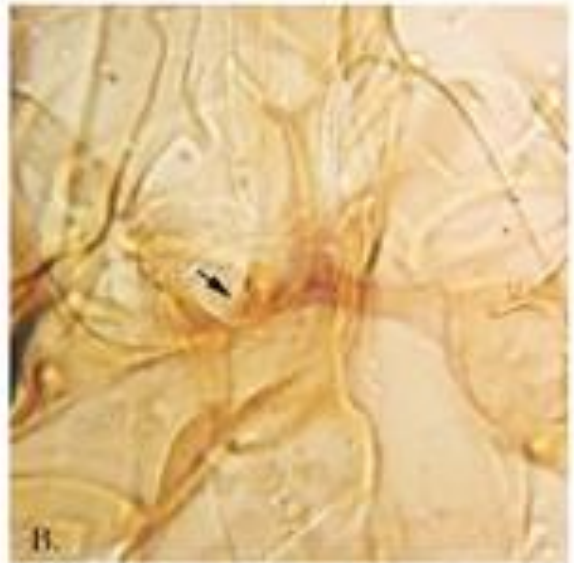


Plate. 15

***Sergentomyia (Sergentomyia) theodori***

A. male genitalia B. male cibarium teeth  
C. female spermatheca D. female cibarium teeth

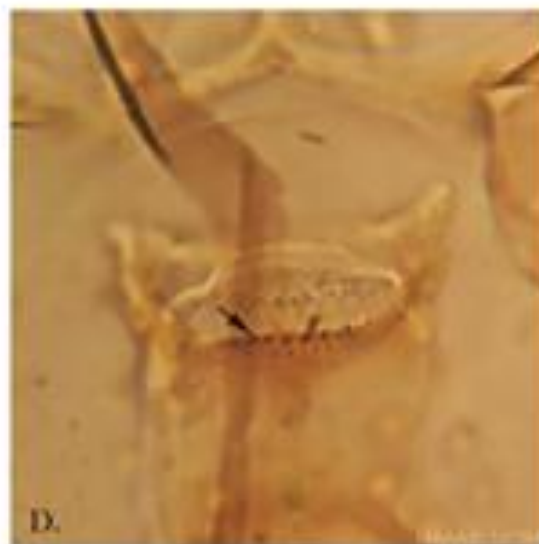
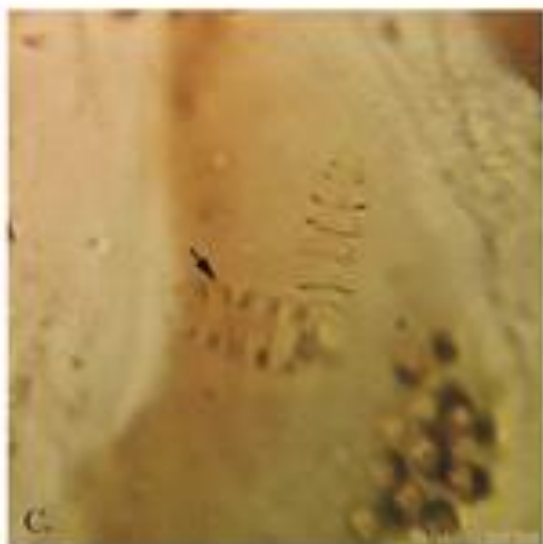
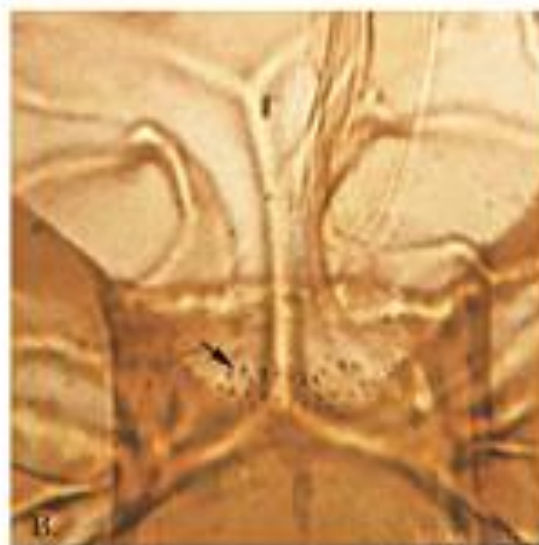


Plate. 16

## *Sergentomyia (Sintonius) tiberiadis*

A. male genitalia B. male cibarium teeth  
C. female spermatheca D. female cibarium teeth

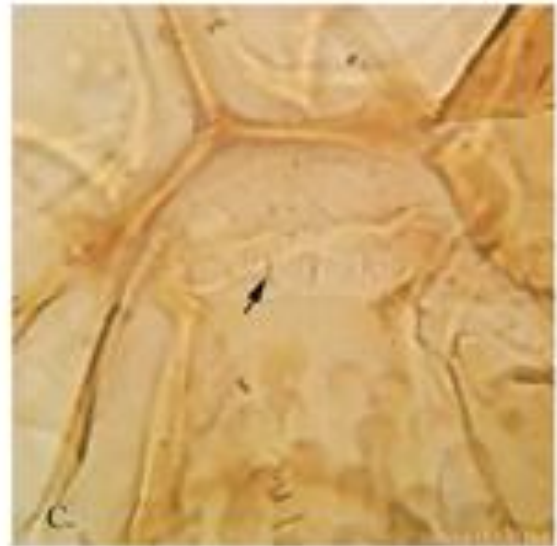
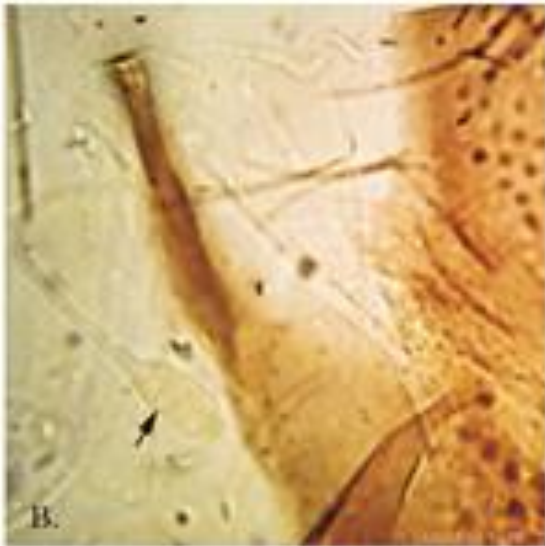


Plate. 17

*Sergentomyia (Sintonius) christophersi*

A. male genitalia B. female spermatheca

C. female ciliarium teeth

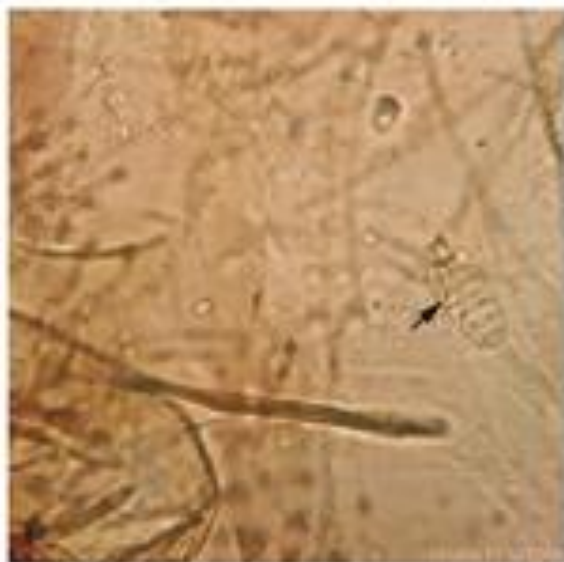
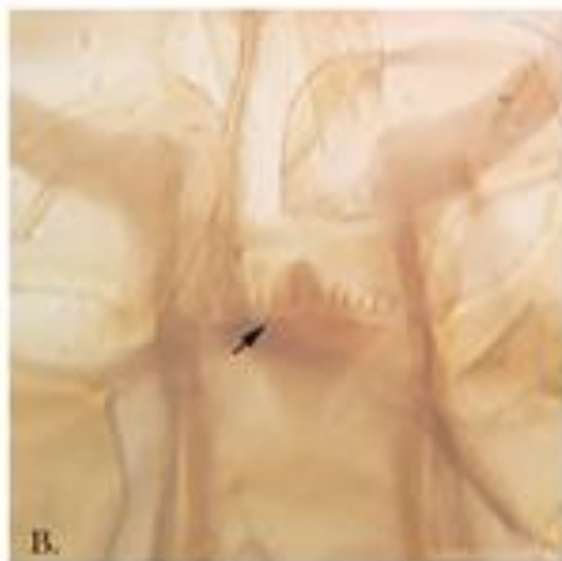
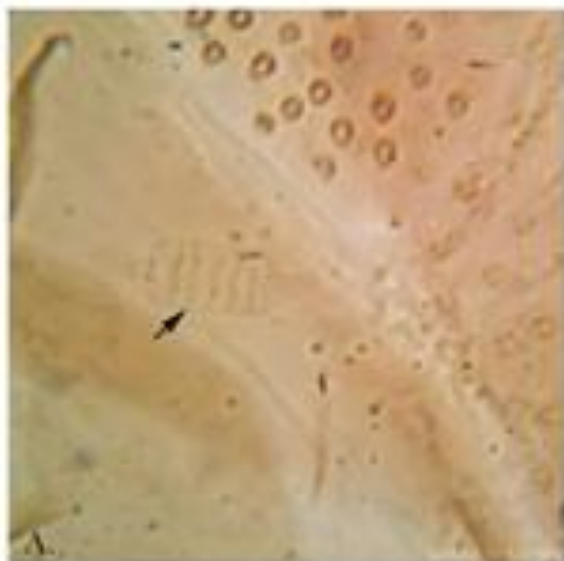


Plate. 18

### *Sergentomyia* (Sintonius) *clydei* & *adleri*

A. female *S. clydei* spermatheca B. female *S. clydei* cibarium teeth  
 C. female *S. adleri* spermatheca D. female *S. adleri* cibarium teeth

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