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A pictorial identification key for Mediterranean and Middle Eastern *Phlebotomus* sand flies

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Given the significance of leishmaniasis as a neglected parasitic disease—ranking second in mortality and fourth in morbidity among vector-borne diseases—and the prominence of the Mediterranean and Middle East regions as key areas for leishmaniasis incidence, the study and precise morphological identification of sand flies, the proven vectors of the disease, is crucial. Unfortunately, despite this importance, there are few reliable references or identification keys for the morphological identification of sand flies in the Middle East and Mediterranean regions. Some are outdated and no longer valid or remain local (restricted to a country). To date, no comprehensive study has been conducted on the sand fly fauna and their morphological characterization across these regions. In response to this gap, we present a comprehensive pictorial identification key for male and female *Phlebotomus* species of Middle East and Mediterranean areas. The key includes 720 selected photos and illustrations demonstrating discriminative morphological features out of 2,000 collected. Furthermore, a collection including descriptive morphological criteria of sand flies, first description of *Phlebotomus* species, a comprehensive checklist of *Phlebotomus* species accompanied by their distribution map across Middle Eastern and Mediterranean countries, as well as extensive information on their morphometry, ecology, medical relevance, synonymy, atypical forms and morphology of female *Adlerius* species are given. Finally, we provide an online pictorial dichotomous key to facilitate field application.

Keywords Leishmaniasis, Sand fly vectors, *Phlebotomus*, Morphological identification, Pictorial identification key, Online dichotomous key

Leishmaniasis, a neglected parasitic disease, poses significant public health concerns, ranking second in mortality and fourth in morbidity among vector-borne diseases. The Middle East and Mediterranean regions are the two uppermost important geographic areas in terms of leishmaniases incidence.

Sand flies belong to the Diptera order, Nematocera suborder, Psychodidae family, and Phlebotominae subfamily, which contains over 1,000 species across 40 genera[1]. The genus *Phlebotomus* holds significant medical importance in the Old World[2,3], encompassing suspected or proven vectors for parasites causing zoonotic cutaneous leishmaniasis (ZCL), anthroponotic cutaneous leishmaniasis (ACL), and zoonotic visceral

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leishmaniasis (ZVL) in the Palearctic, Afrotropical, Malagasy, Oriental, and Australian ecozones. The Middle East and Mediterranean regions exhibit a high abundance and diversity of these vectors. To date, 139 *Phlebotomus* species (excluding fossil species) across 11 subgenera have been described[1,4,5], with 59 species recorded in Middle East and Mediterranean countries.

The study of sand flies as a proven vector of disease and their accurate identification based on morphological characteristics is crucial.

Phlebotomine sand fly identification, particularly at the specific and subspecific levels, has always been challenging due to differences or variations in identification criteria and methods, morphological similarities between some species, uncertainty in species identification, inadequacy in some species descriptions, and the growing number of described sand fly species. Morphological identification of sand flies relies on two main criteria: external structures (e.g., the structure of the male genitalia, wing venation, and other external measurements, known as phlebotometry) and internal structures (e.g., spermathecae, cibarium, and pharynx)[6–8]. Despite this significance, there are limited valid references and identification keys for the morphological identification of sand flies in the Middle East and Mediterranean regions. Many are outdated, locally restricted, or no longer valid. No comprehensive study has been conducted on sand fly fauna and their morphological identification in the Mediterranean and Middle East regions. In this study, we thoroughly examine essential aspects of their morphological identification and provide data on species composition, epidemiology, and geographical distribution in the Middle Eastern and Mediterranean basin, covering 60 countries at an unprecedented geographical scale.

Materials and methods

Phlebotomus specimens from Middle Eastern and Mediterranean countries were collected using CDC light traps, sticky traps, or mouth aspirators. They were washed twice with pure ethanol and examined under a stereomicroscope (Zeiss, Germany). Each specimen was labeled with location, date, and sex information, then lysed in a 10% potassium hydroxide solution at ambient temperature for 2 hours, washed three times in distilled water, bleached in Marc-André solution, and dissected individually using entomological needles[9]. Slides were mounted in Berlese medium[10] for species identification, which was performed at the species/subspecies level based on extrinsic or intrinsic morphological criteria[6–8,11–13]. Microphotography and microscopic drawings of discriminative morphological features were performed using a Lucida camera (Leica Microsystems, Germany)[14]. Some previously published photos/drawings were obtained through copyright permission or by visiting natural history museums in Paris (Muséum national d'histoire naturelle) and London (Natural History Museum, London) for rare species.

Results and discussions

We present a comprehensive pictorial identification key for *Phlebotomus* species in the Middle East and Mediterranean areas (Table 1). We provide an illustrated overview of these species and the essential criteria for morphological identification of both male and female specimens. The essential morphological criteria and their application for sand fly species identification are provided and explained in the Supplementary Information I (SI.I). Given the reports of some atypical *Phlebotomus* specimens worldwide, addressing these atypical forms within the main text poses a challenge for accurate identification and taxonomy, as they require additional clarification and distinction from typical specimens. Due to the journal's word limit, we have chosen to focus exclusively on typical species and exclude atypical forms or geographical variations. However, a complete list of atypical specimens reported in the literature is provided as a supplementary file.

Based on conservation and clarification quality statuses, 720 authentic photomicrographs and drawings were selected from over the 2,000 gathered (Table 2). Discriminative morphological criteria were considered for the pictorial identification key. Alongside the pictorial and dichotomous keys, we compiled an extensive collection including a descriptive morphological criteria for sand flies identification (SI.I), first descriptions of *Phlebotomus* species (SI.II), an exhaustive list of *Phlebotomus* species (SI.III), a checklist of their presence in the Middle East and Mediterranean countries (SI.IV) with an accompanying distribution map (SI.V), information on their ecology, medical importance, synonymy (SI.VI) and morphometric data (SI.VII). We also provided a detailed morphology of female *Adlerius* species (SI.VIII) and a complete list of atypical *Phlebotomus* specimens reported in the literature (SI.IX). Finally, we proposed an online dichotomous identification key, freely available for field application (SI-X).

Pictorial identification key

Subgenus *Phlebotomus*

Male: Long terminalia; gonostyle with 5 short spines (3 spatulated terminal spines and 2 at the mid-gonostyle position). Inner side of gonocoxite with a group of long ventrally-directed hairs, close to the distal end. Gonocoxite has a basal process forming a small tubercle with short hairs close to the proximal end. Short and conical parameral sheath, with a short genital filament. Armed lateral lobes of the tergite 9.
Female: Pharyngeal armature with a scale-like tiny denticles network. Segmented spermatheca with small head without neck. Individualized spermathecal ducts. Ascoid formula: 2/III-XV.
Type: *Phlebotomus papatasi* Scopoli, 1786

Table 1. Table of contents.

1. *Phlebotomus bergeroti*
Male

- Median spines gonostyle close to the distal ones.
- Gonocoxite with < 10 distal hairs.
- Surgonostyle with 2 terminal spines.
- Slightly curved paramere, upper arms longer (Figures N°1a,b).

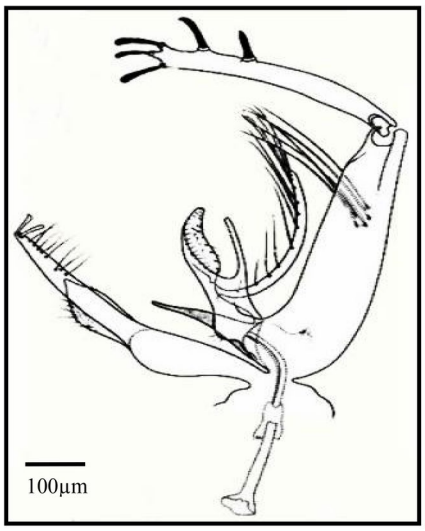
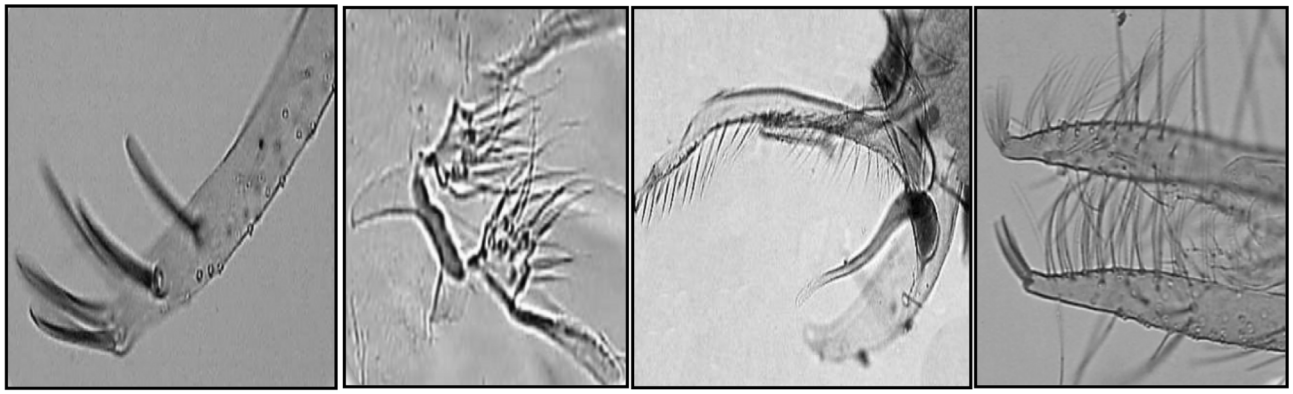


Figure N°1a

Figure N°1b



Gonostyle *Basal lobe* *Paramere* *Surgonostyle*

Female

- Characteristics anterior and lateral pharyngeal teeth (Figures N°1c,d).
- Long ascoids reaching or exceeding the subsequent junction antennal segment spaces.

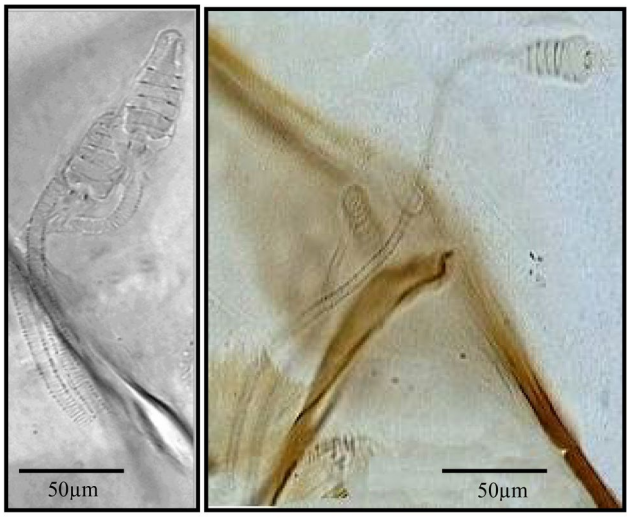
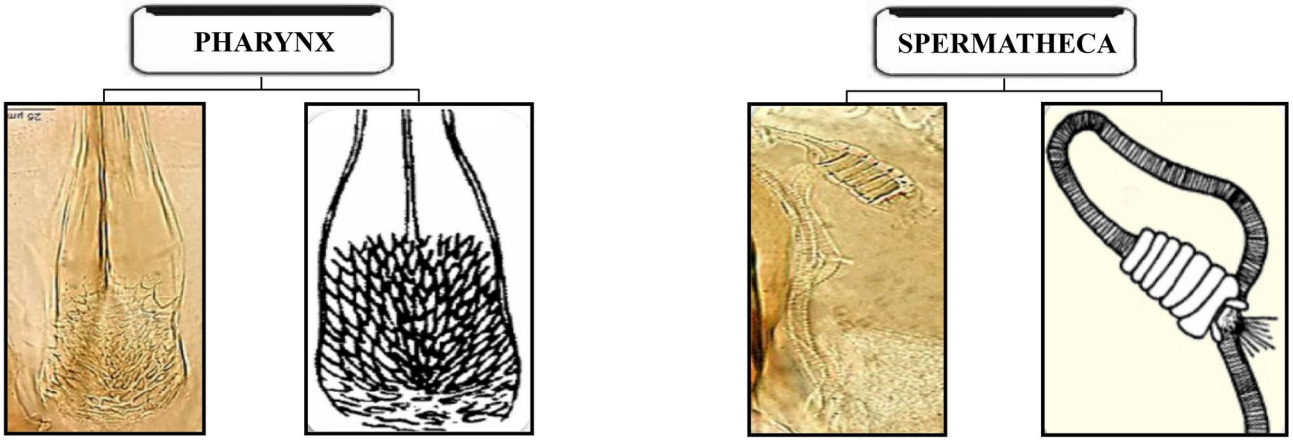


Figure N°1c **Figure N°1d**



2. *Phlebotomus duboscqi*
Male

- Gonostyle with median spines distant from distal ones.
- Surgonostyle with 5–7 terminal spines.
- Paramere slightly curved with smaller upper arm.

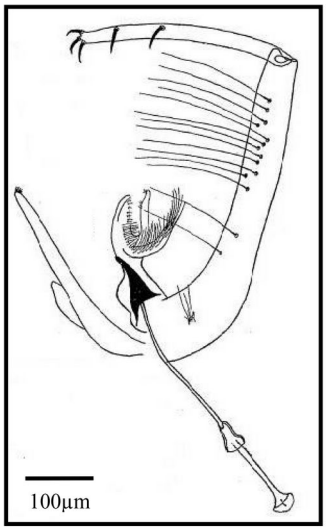


Figure N°2a

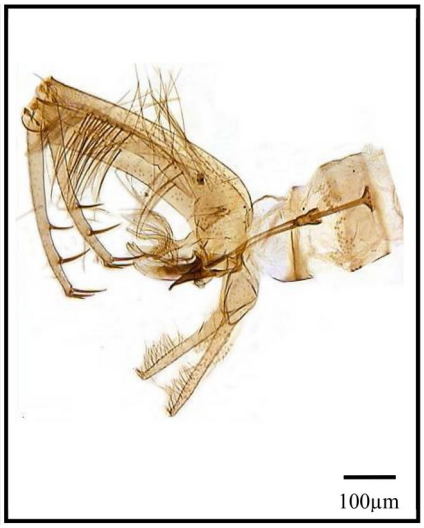
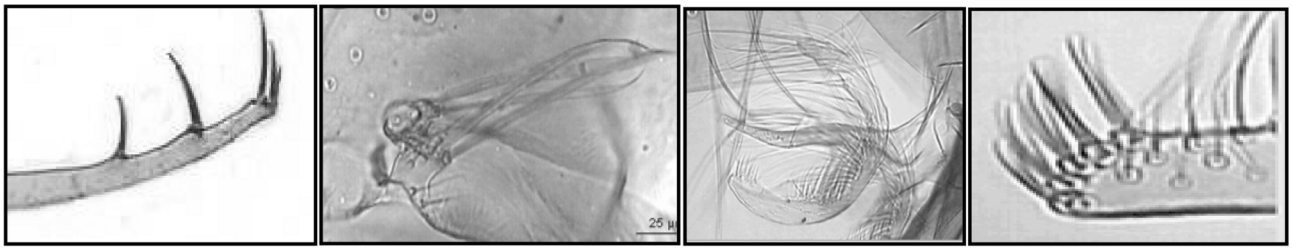


Figure N°2b



Gonostyle *Basal lobe* *Paramere* *Surgonostyle*

Female

- Absence of anterior and lateral pharyngeal teeth.
- Absence of characteristic teeth in the anterior part of the pharyngeal framework (Figures N°2c,d).

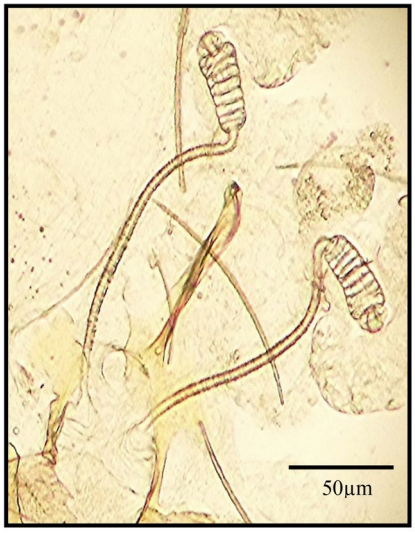
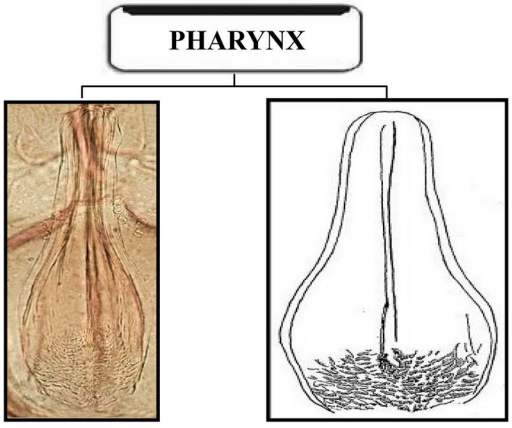
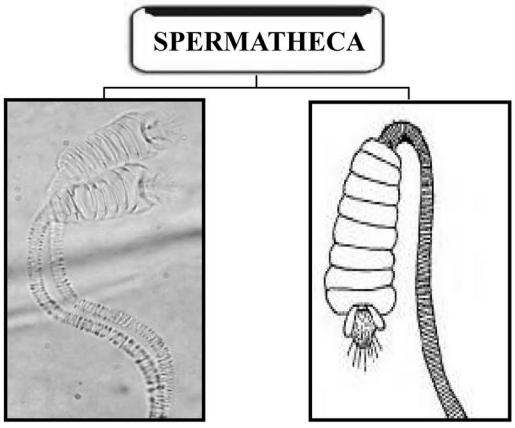


Figure N°2c

Figure N°2d





3. *Phlebotomus papatasi*
Male

- Short ascoid not reaching the junction space of the antennal segment.
- Gonostyle with median spines distant from distal ones.
- Gonocoxite with > 10 distal hairs.
- Surgonostyle with 2 terminal spines.
- Paramere slightly curved, upper arm longer (Figures N°3a,b).

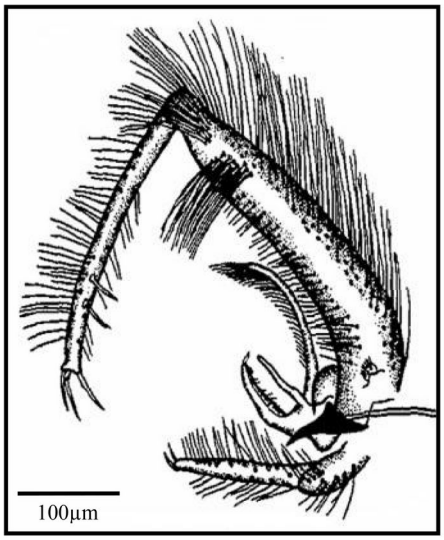
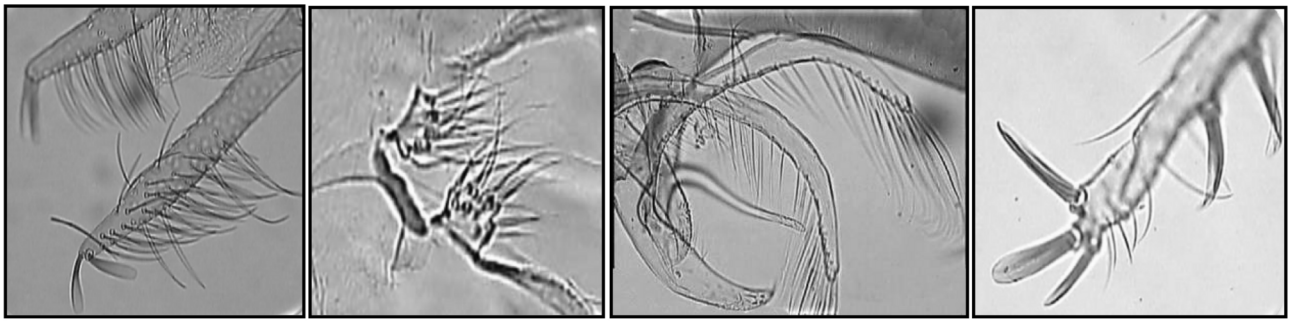


Figure N°3a

Figure N°3b



Surgonostyle *Basal lobe* *Paramere* *Gonostyle*

Female

- Short ascoid not reaching to the junction area with the antennal segment.
- Several rows of teeth at the anterior part of the pharyngeal armature (Figures N°3c,d).

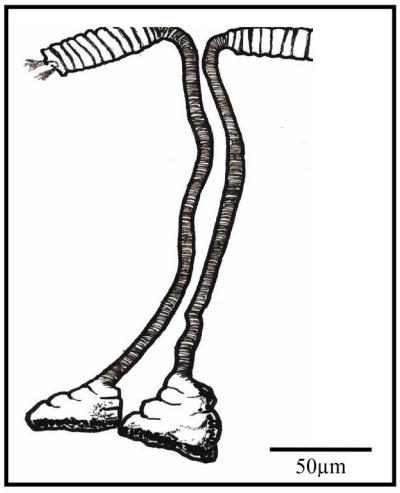


Figure N°3c

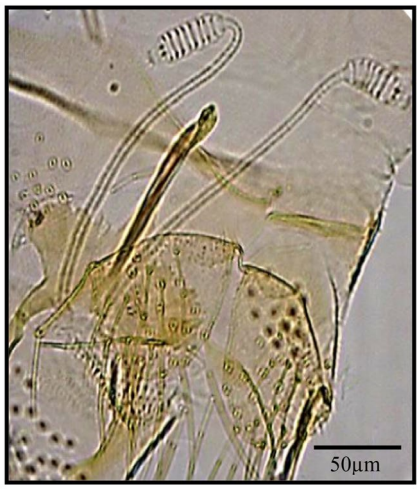
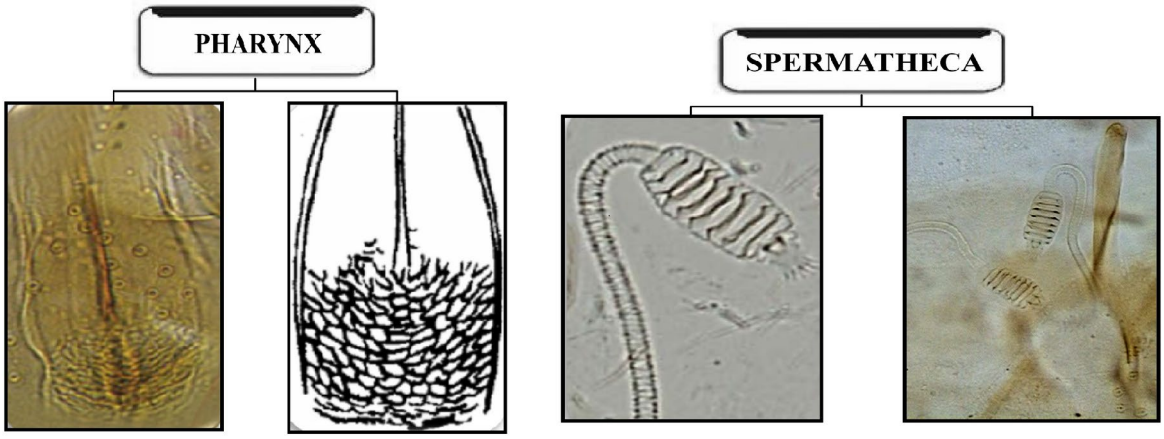


Figure N°3d

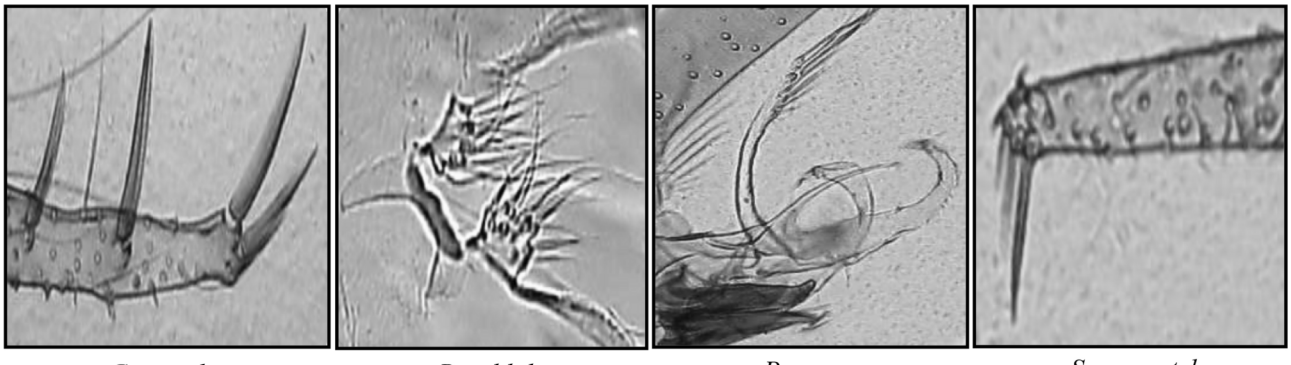


4. *Phlebotomus salehi*
Male

- Close to *Ph. papatasi* except for the gonostyle and the paramere.
- Gonostyle with equidistant median and terminal spines.
- Distal part of the paramere strongly curved up, 7–8 hairs at its end (Figures N°4a,b).

Figure N°4a

Figure N°4b



Gonostyle *Basal lobe* *Paramere* *Surgonostyle*

Female

- Pharyngeal armature with small coarse squamae, tougher and more pigmented at the center.
- Spermatheca with 8 segments, narrowing toward the duct (Figures N°4c,d).

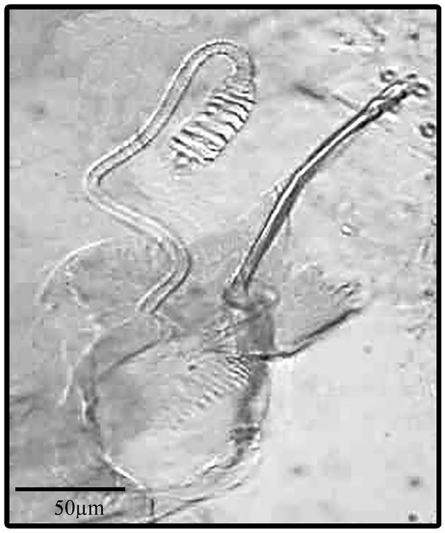
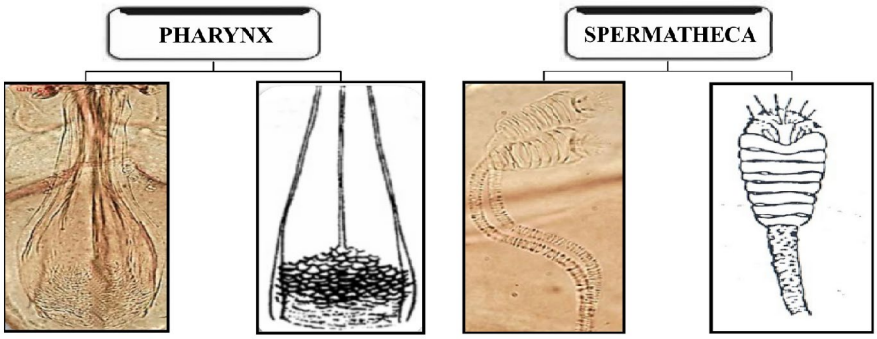


Figure N°4c

Figure N°4d



Subgenus *Paraphlebotomus*

Male: Short terminalia; oval or oblong gonostyle with 2 terminal and 2 long median spines. Basal lobe with a tuft of hairs at the base of the gonocoxite. Short conical parameral sheath with a slightly curved tip. Distal part of parameres covered by short and elliptical thin hairs. Unarmed 9th tergite lateral lobes.
Female: Pharyngeal armature well-marked with wedge-shaped teeth. Spermathecae capsule enlarged and rounded without neck opening separately to spermathecal ducts. Ascoids formula: 2/III-XV.
Type:*Phlebotomus sergenti* Parrot, 1917

5. *Phlebotomus andrejevi*
Male

- Gonocoxite basal lobe thick and long with symmetrical head.
- Gonostyle longer than *Ph. caucasicus*.
- Sub-terminal spine/gonostyle length = 0.81–0.97 (Figures N°5a,b).

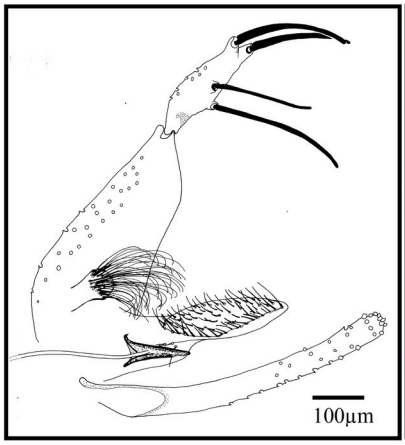


Figure N°5a

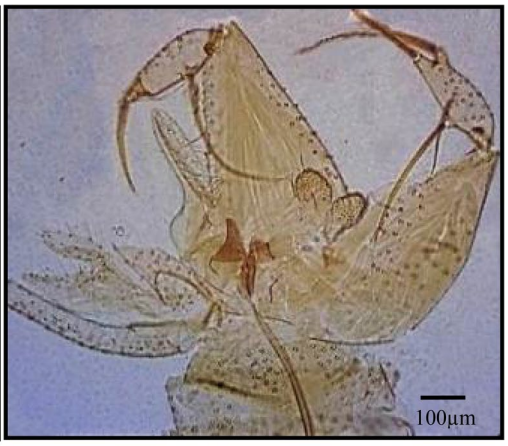
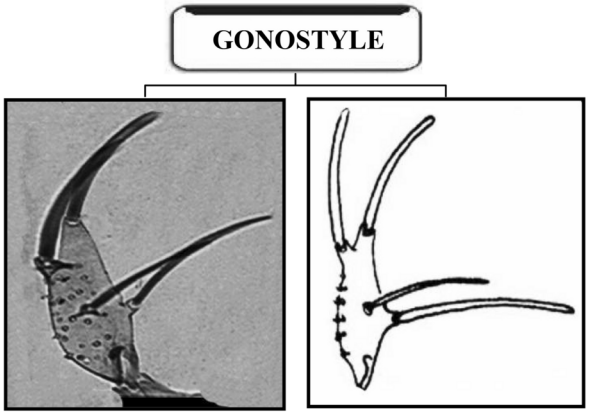
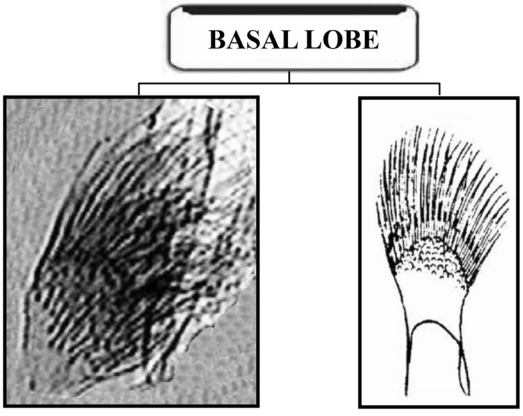


Figure N°5b





Female

- Spermatheca with 3–4 segments, apical ones larger and rounded.
- Pharynx with broad blunt teeth. Central group of teeth tougher and darker than lateral ones (Figure N°5c,d).

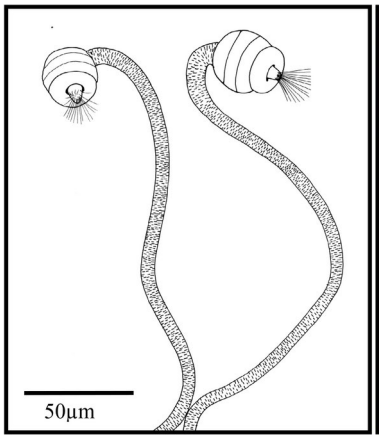
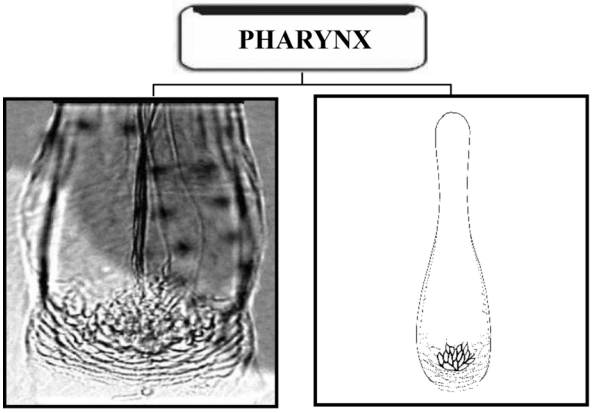
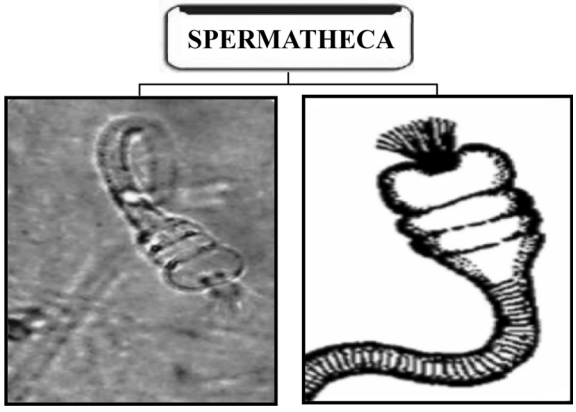


Figure N°5c

Figure N°5d





6. *Phlebotomus caucasicus*
Male

- Large, wide gonocoxite basal lobe, with an unrounded end and many lateral and ventral hairs (Figures N°6a,b).

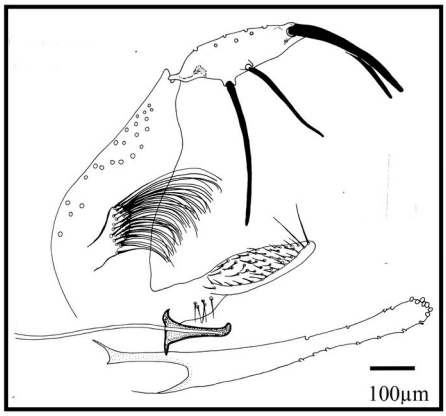


Figure N°6a

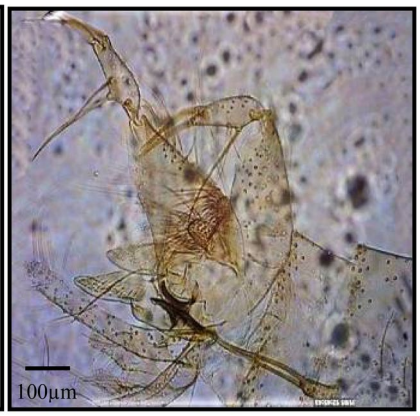
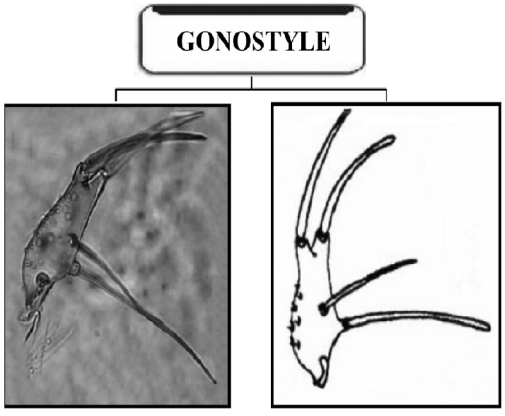
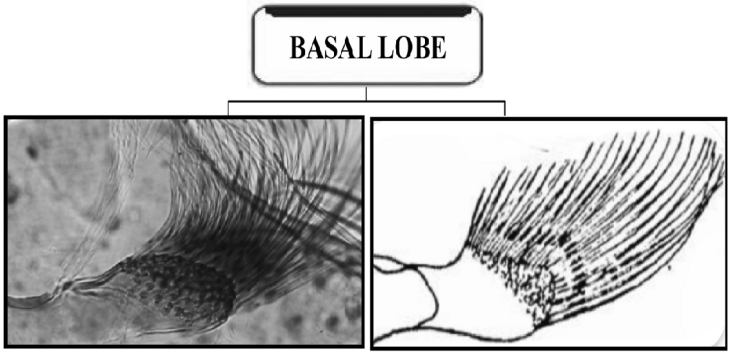


Figure N°6b



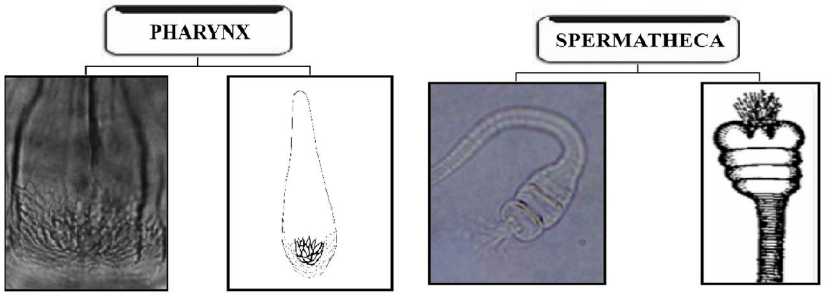


Female

- Pharynx with larger central teeth compared to lateral and posterior ones, with a characteristic rosette at the center.
- Spermatheca with 3–5 segments. Indistinguishable from *Ph. mongolensis* and *Ph. andrejevi* (Figures N°6c,d).

Figure N°6c

Figure N°6d



7. *Phlebotomus chabaudi*
Male

- Differs from *Ph. riouxi* by smaller size of gonocoxite basal lobe involving 7–15 hairs.
- Parameral sheath curved into "raptor's beak" at the apex.
- Basal lobe short, stocky and dilated at the extreme.
- Lateral lobe short or equal to gonocoxite (Figures N°7a,b).

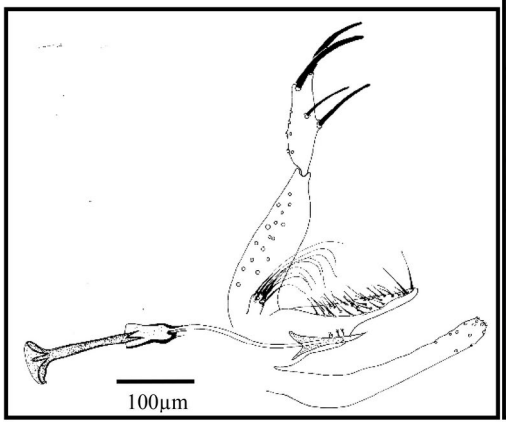


Figure N°7a

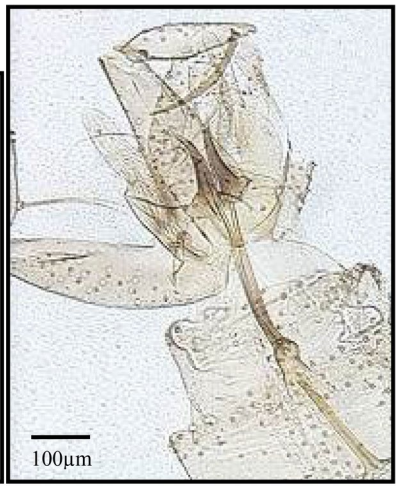
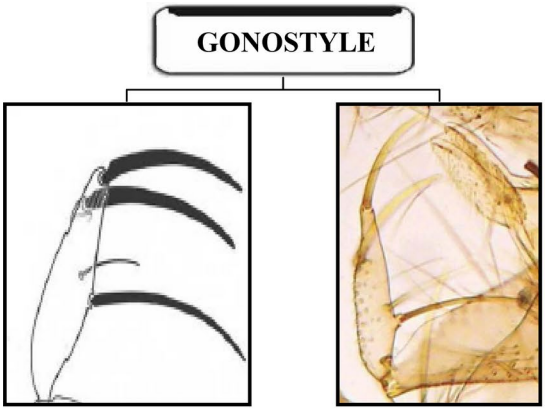
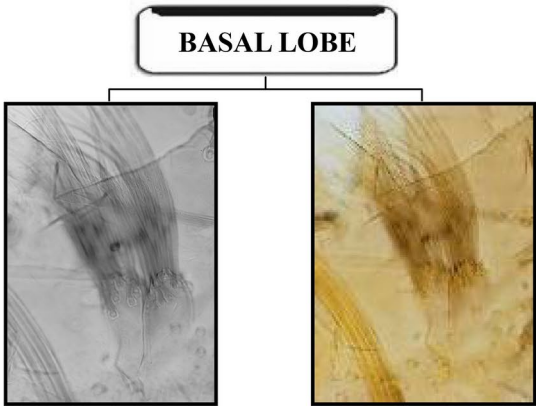


Figure N°7b





Female

- Spermatheca with 7–10 segments. The distal segment is campanulated and connected to the previous one by a long peduncle.
- Less-developed genital atrium frame (Figures N°8c,d).

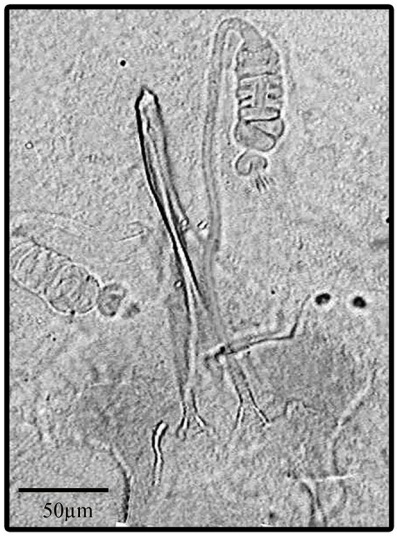
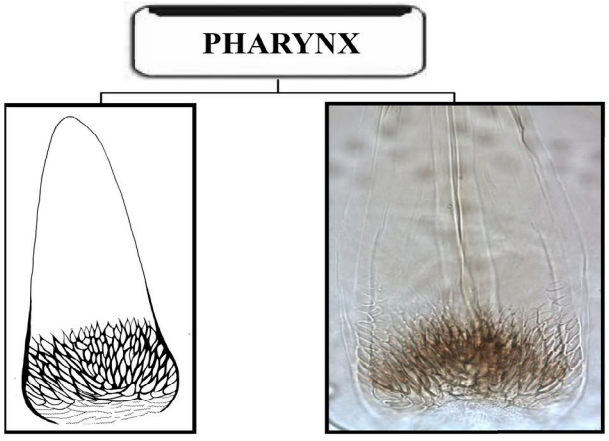
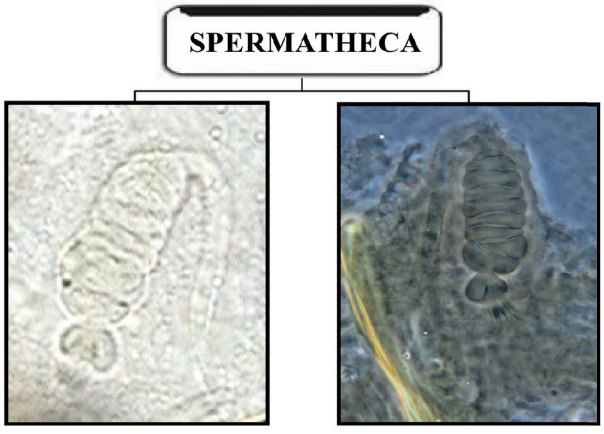


Figure N°7c

Figure N°7d



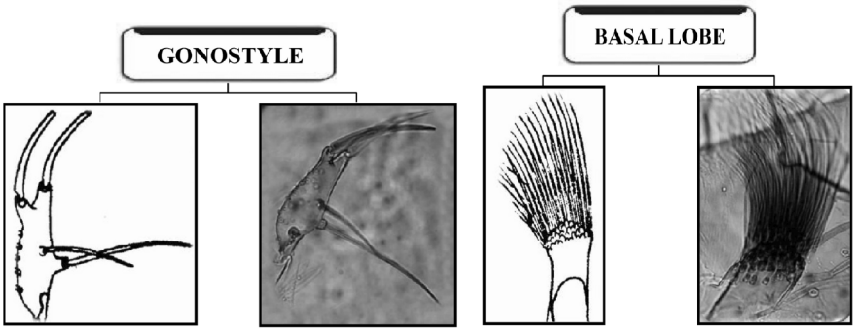


8. *Phlebotomus jacusieli*
Male

- Gonocoxite basal lobe has a uniform width, similar to *Ph. similis,* but differs in the orientation of the distal spines of the gonostyle, which are significantly shifted. Gonostyle four times as long as thick.
- Differential diagnosis with *Ph. alexandri* by AIII > 200 µm for *Ph. jacusieli*.
- Differs from *Ph. mongolensis* by the gonocoxite basal lobe shape and the position of spines on the gonostyle (Figures N°8a,b).

Figure N°8a

Figure N°8b



Female

- Spermatheca with 8–9 segments. Distal segment significantly expanded.
- Several concentric rows of tiny teeth make up the posterior and lateral portions of the pharynx. Large and dark prominent teeth in the middle of the frame. The center is more developed in *Ph. andrejevi*, *Ph. caucasicus,* and *Ph. mongolensis,* but is absent in *Ph. sergenti* and *Ph. similis* (Figures N°8c,d).

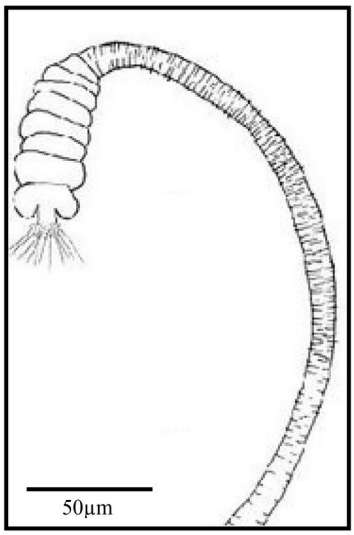
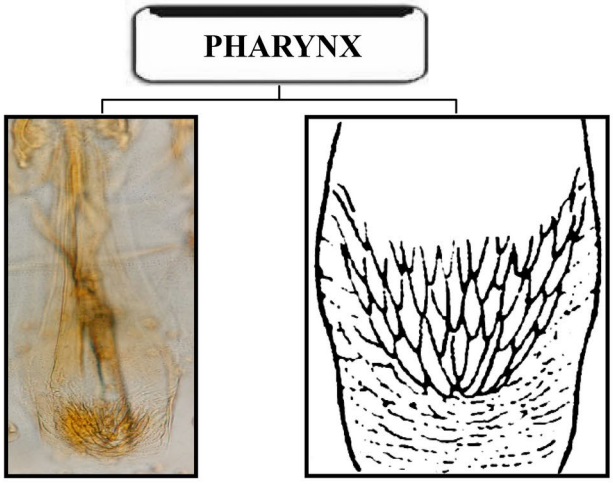
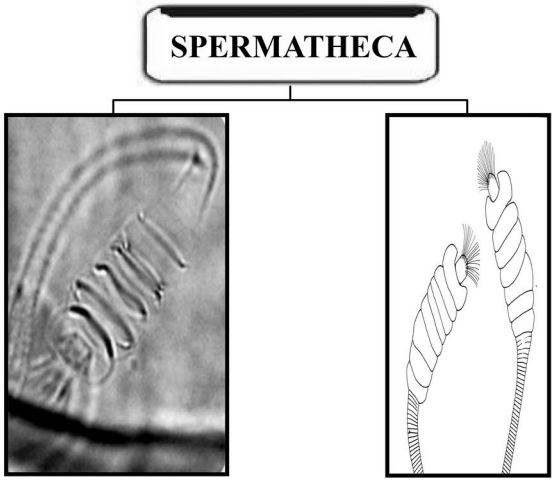


Figure N°8c

Figure N°8d





9. *Phlebotomus kazeruni*
Male

- Gonostyle more elongated and less globose than *Ph. sergenti*.
- Gonocoxite basal lobe slightly smaller, straight, symmetric, and rounded.
- Dark tergites and sternites (Figures N°9a,b).

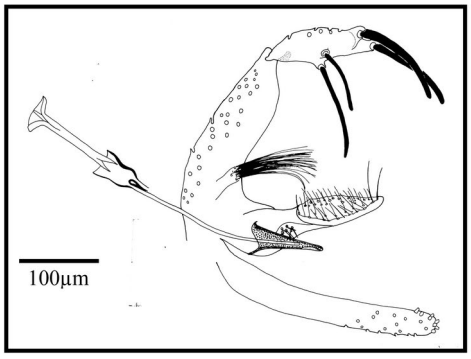


Figure N°9a

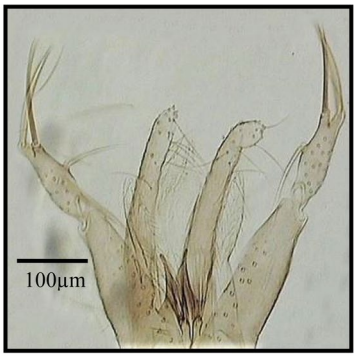
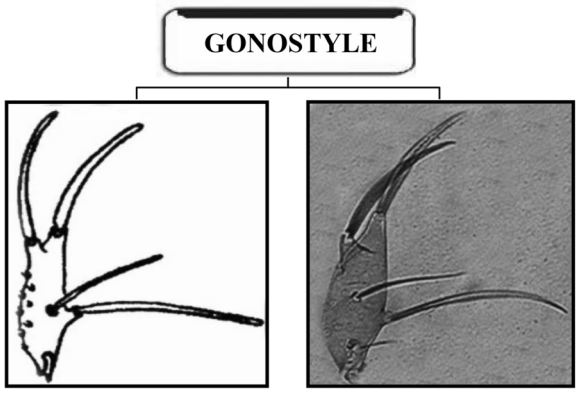
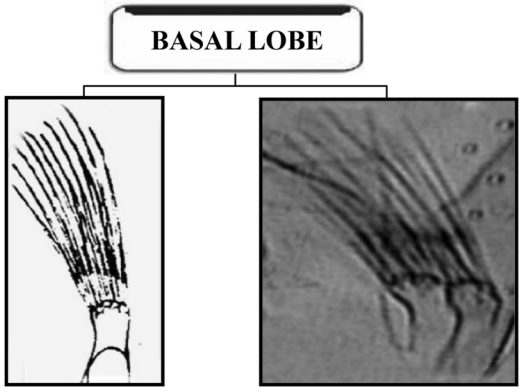


Figure N°9b





Female

- Spermatheca with 1–2 segments (Figures N°9c,d).

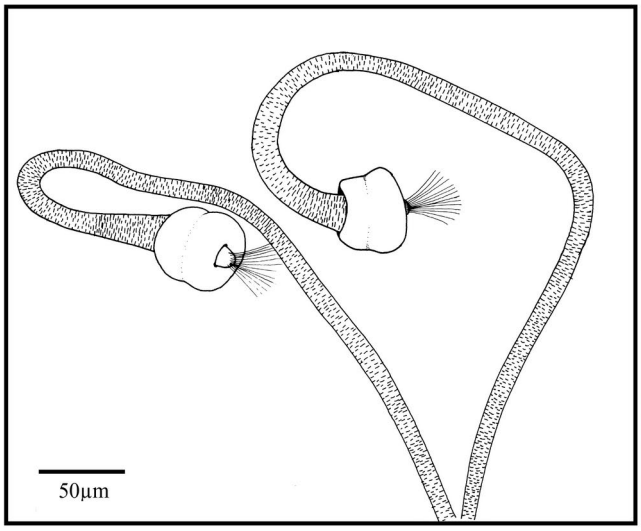
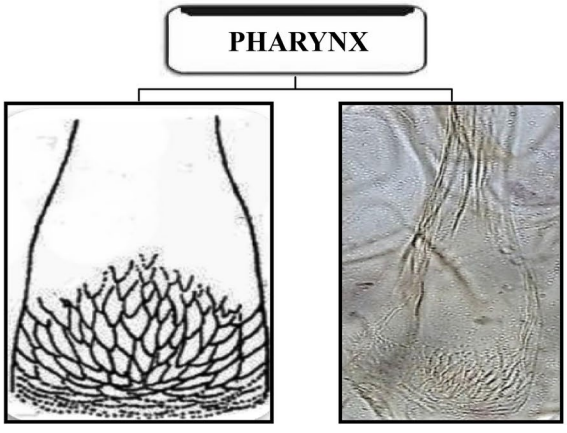
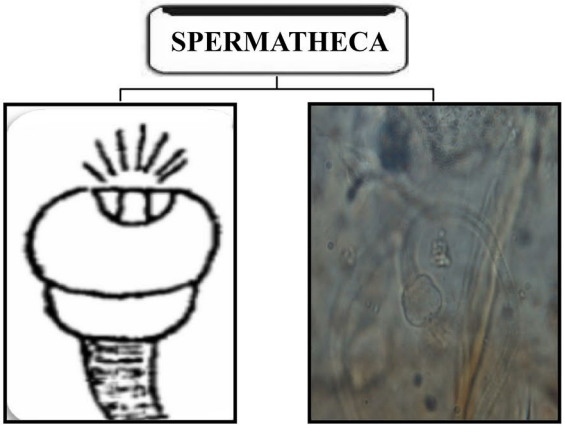


Figure N°9c

Figure N°9d





10. *Phlebotomus mongolensis*
Male

- Middle-sized gonocoxite basal lobe with symmetrical head and terminal hairs.
- Long gonostyle with a sub-terminal spine at 0.6–0.8 of its length (Figures N°10a,b).

Figure N°10a

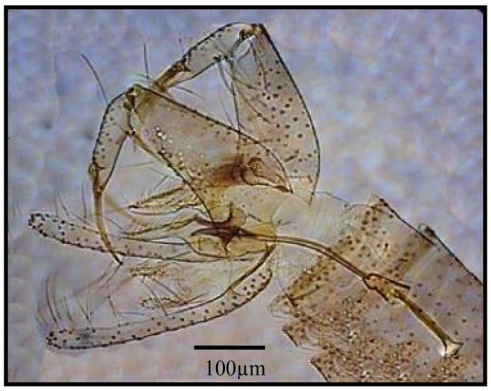
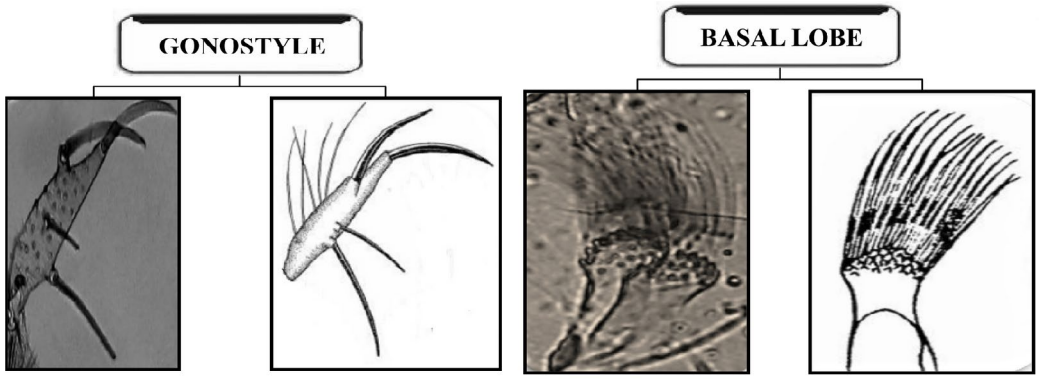


Figure N°10b



Female

- Spermatheca with 3–4 segments.
- Pharynx with broad blunt teeth; with harder and darker teeths in the central part (Figures N°10c,d).

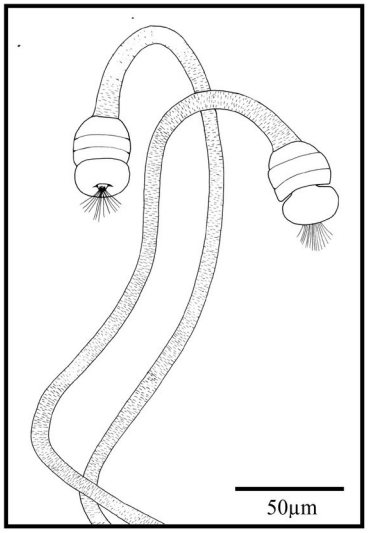
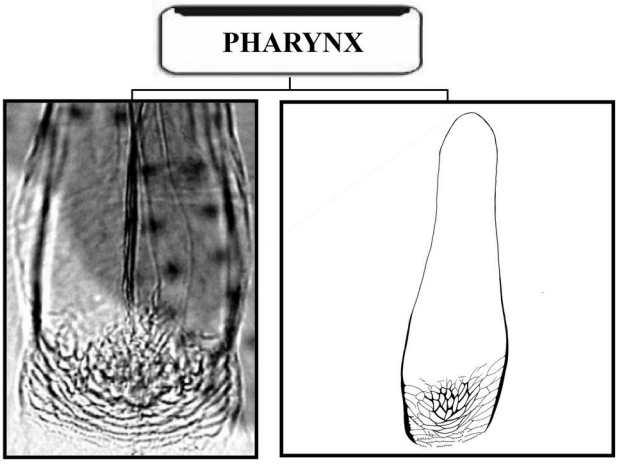
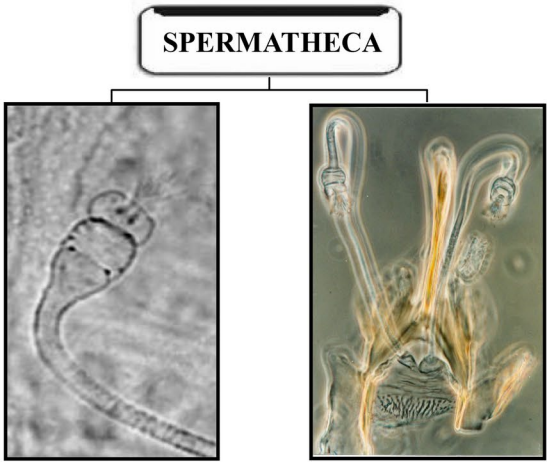


Figure N°10c

Figure N°10d





11. ***Phlebotomus nuri***
Male

- Differs from *Paraphlebotomus* species by its long terminalia, a long and thick basal lobe with long curved hairs, long gonostyle (longer than that of *Ph. caucasicus*), and a conical, straight parameral sheath (Figures N°11a,b).

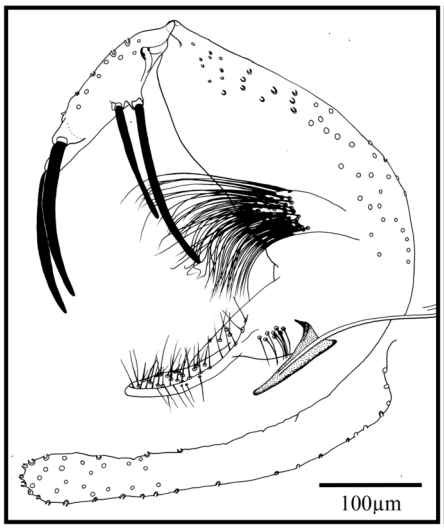


Figure N°11a

Figure N°11b

Female

- Spermatheca with 7–8 segments, a narrow apical segment and deep furrows between the segments (Figures N°11c,d).

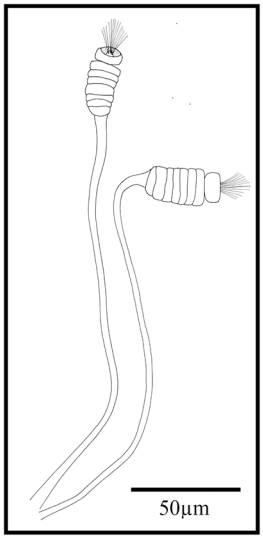


Figure N°11c

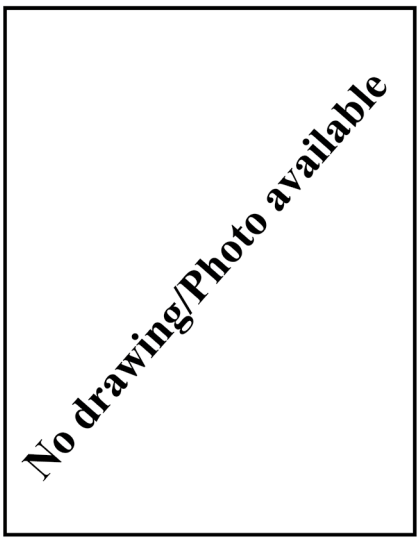
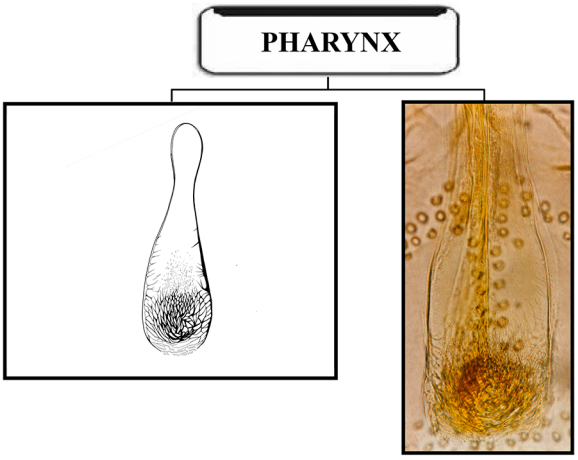
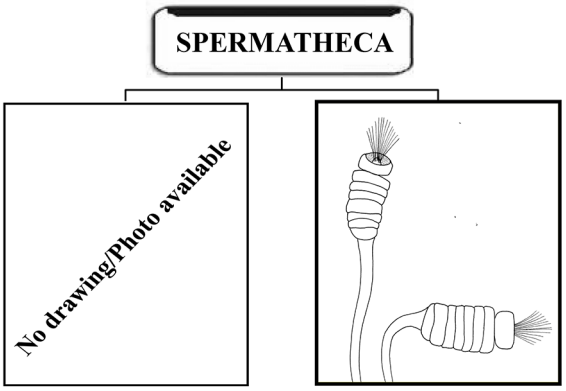


Figure N°11d





12. *Phlebotomus riouxi*
Male

- Narrow and elongated gonocoxite, elongated basal lobe, isodiametric, symmetrical, conical distal end, with 23–40 hairs.
- Gonostyle with a terminal, a sub-terminal (80% of its length), and 2 median spines of unequal diameters.
- Differs from *Ph. chabaudi* by a larger basal gonocoxite and more hairs (Figures N°12a,b).

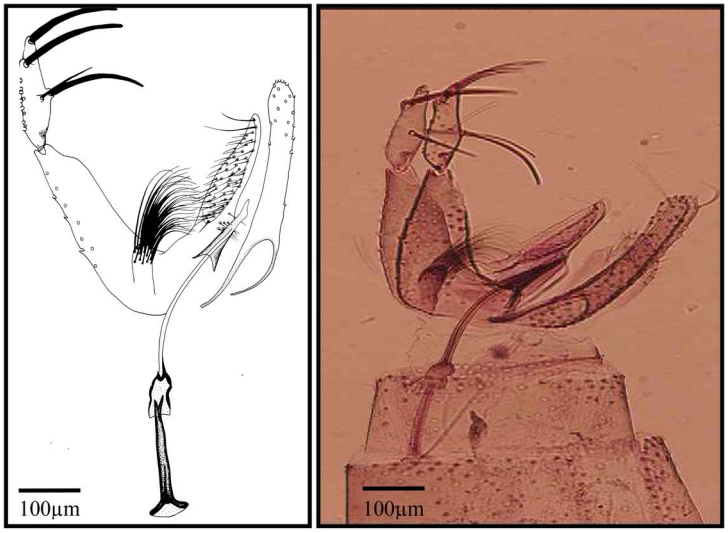
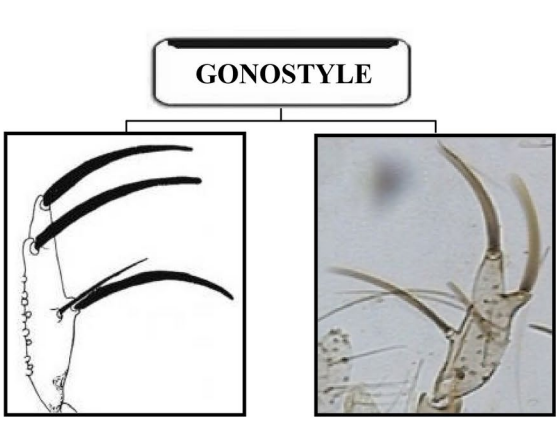
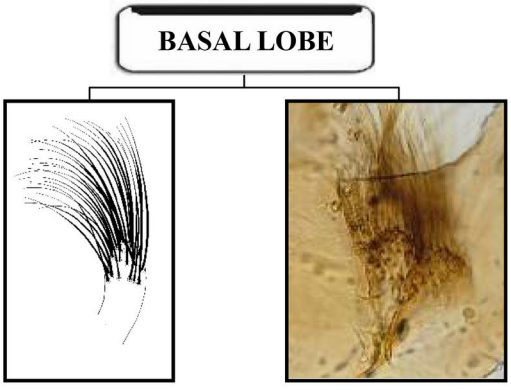


Figure N°12a **Figure N°12b**





Female

- Similar to *Ph. chabaudi*, with a developed pharyngeal framework consisting of flame-like teeth arranged in a lengthwise-stretched network.
- Spermatheca with 7–9 segments and a campanulated last segment.
- Absence of pharyngeal anterior lateral teeth (Figures N°12c,d).

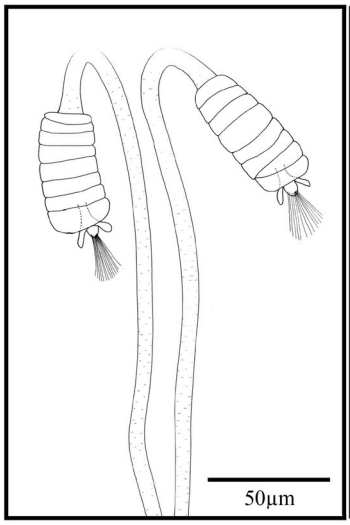
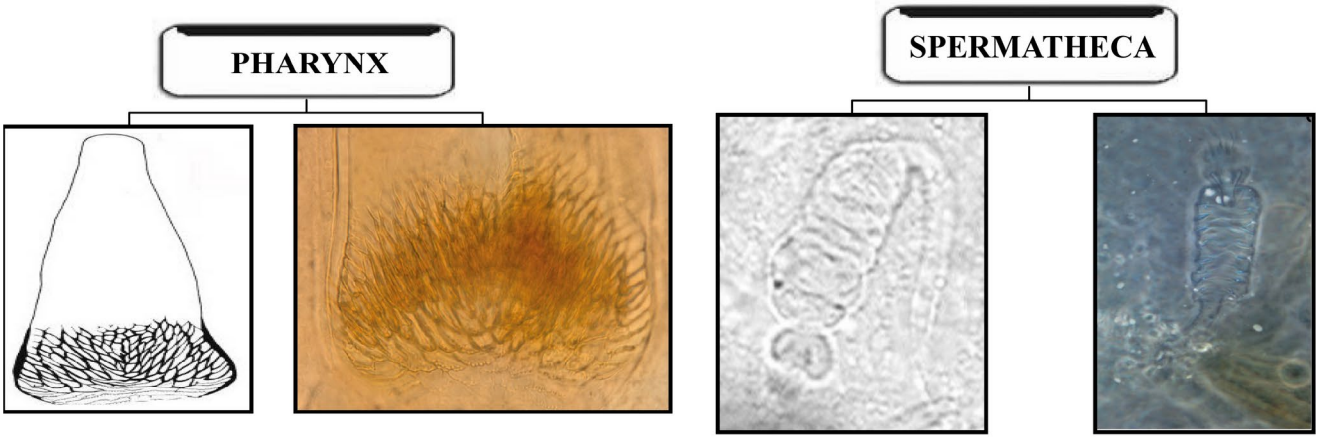


Figure N°12c

Figure N°12d



13. *Phlebotomus saevus*
Male

- Differs from *Ph. alexandri* and *Ph. sergenti* by longer gonocoxite basal lobe with > 30 hairs (Figures N°13a,b).

Figure N°13a

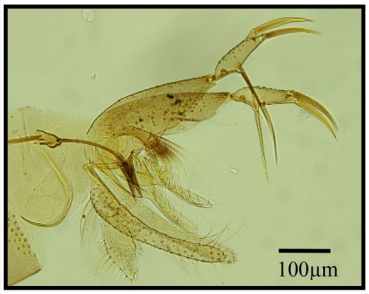
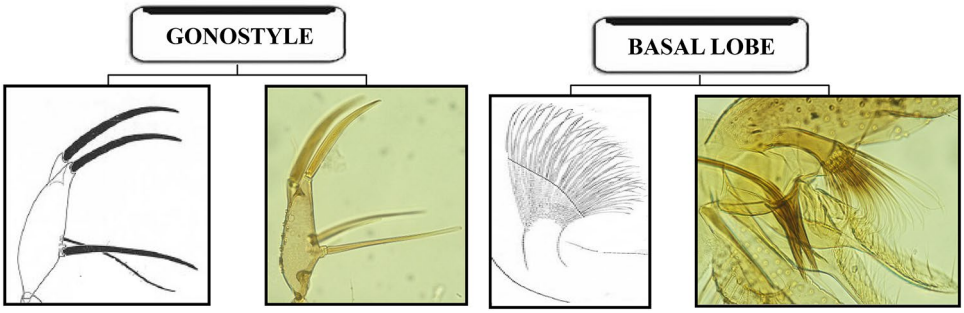


Figure N°13b



Female

- Absence of spines on the distal third of the spermathecae ducts.
- Pharyngeal armature well developed with more teeth than in *Ph. sergenti* (Figures N°13c,d).

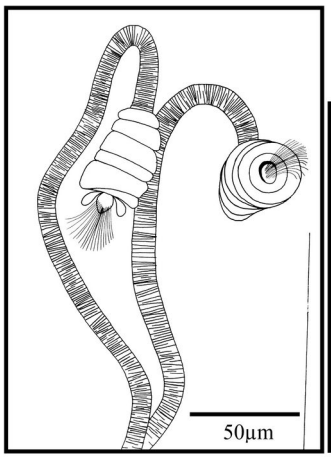


Figure N°13c

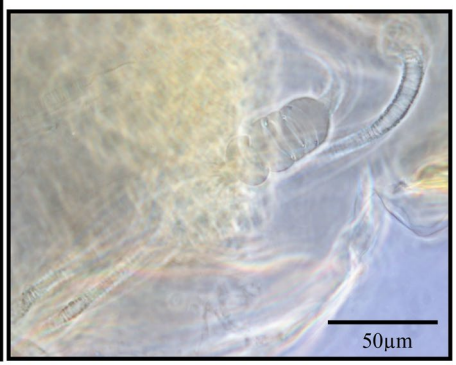
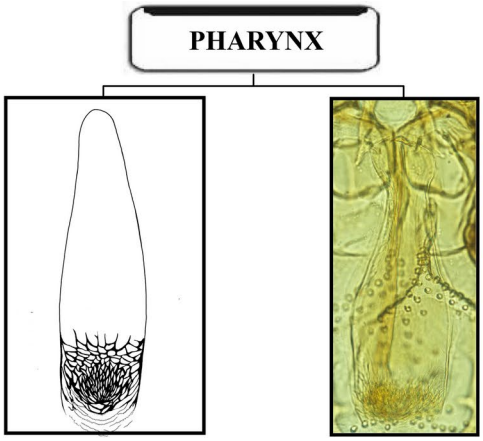
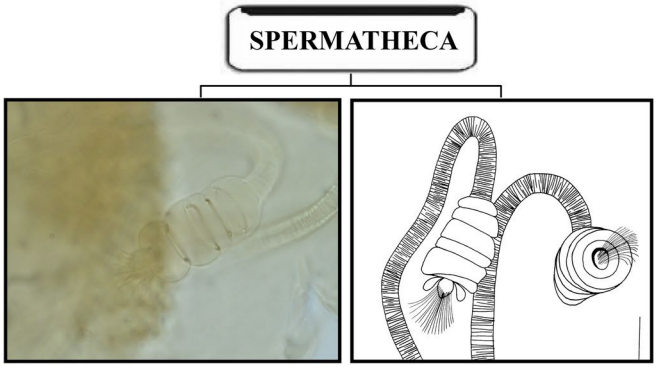


Figure N°13d





14. *Phlebotomus sergenti*
Male

- Gonocoxite with a narrow, angled basal lobe (distinguishing *Ph. sergenti* from *Ph. kazeruni* and *Ph. similis*) bearing 12–24 hairs.
- Gonostyle distal spines at the same level (Figures 14a,b).

Figure N°14a

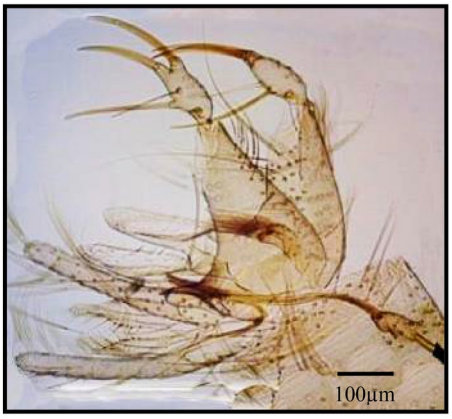
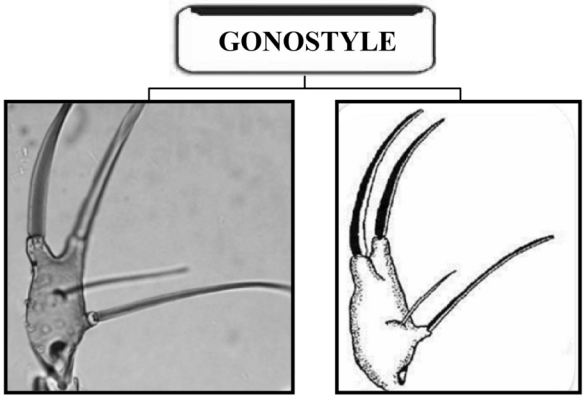
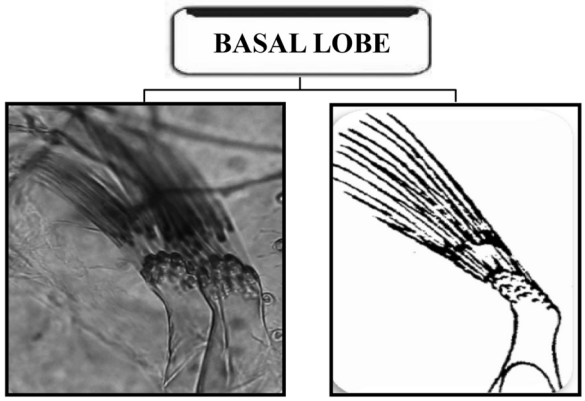


Figure N°14b





Female

- Spermatheca with 3–6 segments.
- Pharynx less armed than *Ph. similis* (absence of lateral teeth) (Figures 14c,d).

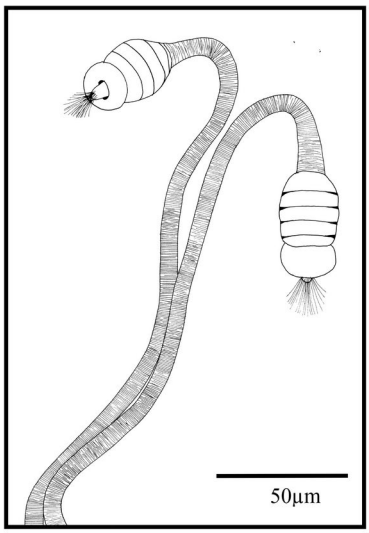
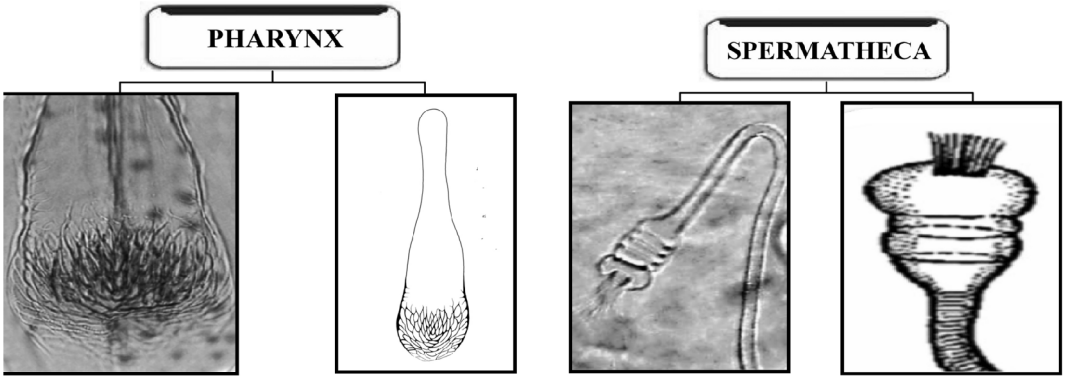


Figure N°14c

Figure N°14d



15. *Phlebotomus similis*
Male

- Straight and thick gonocoxite basal lobe with 24–37 hairs.
- Longer gonostyle than *Ph. sergenti*.
- Gonostyle distal spines at the same level (Figures N°15a,b).

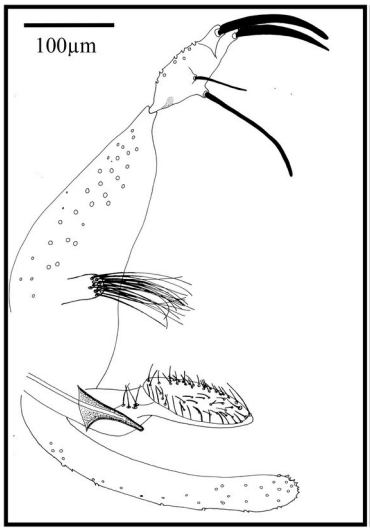
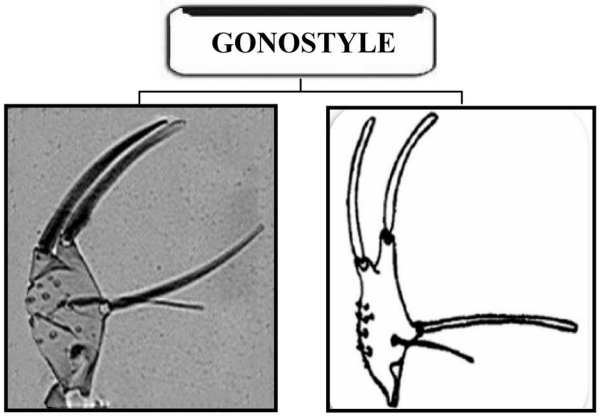
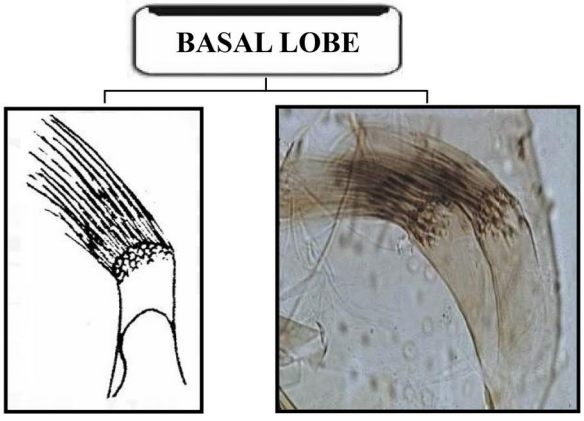


Figure N°15a

Figure N°15b





Female

- Spermatheca with 4–8 segments.
- More developed pharyngeal framework than *Ph. sergenti,* presence of lateral teeth (Figures N°15c,d).

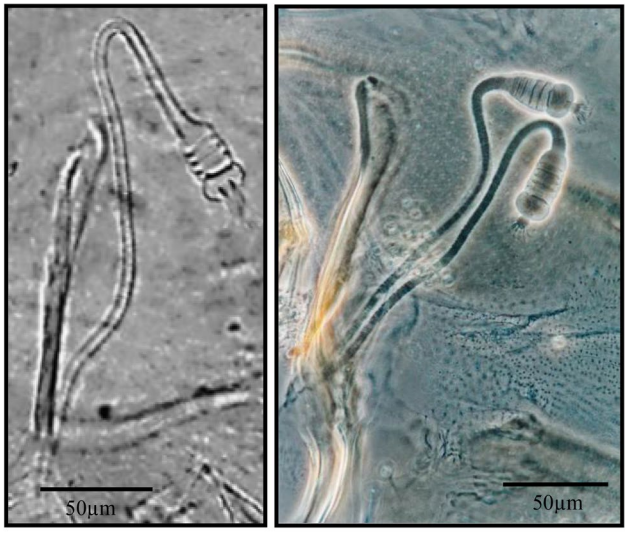
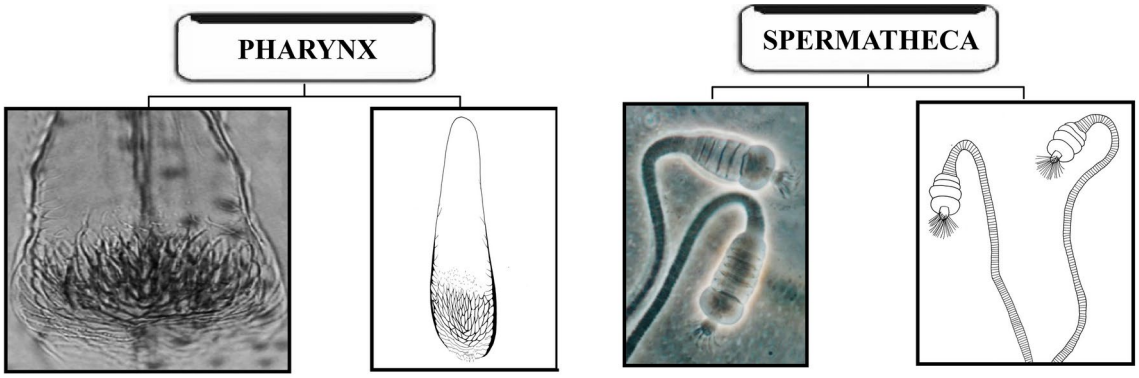


Figure N°15c **Figure N°15d**



Subgenus Artemievus

Male: Short terminalia; oval gonostyle with 2 terminal and 2 long median spines. Basal lobe with a tuft of hairs at the base of the gonocoxite. Short conical parameral sheath with a slightly curved tip. Distal part of paramere covered by short and elliptical thin hairs. Unarmed 9th tergite lateral lobes.
Female: Pharyngeal armature well-marked with wedge-shaped teeth. Spermathecae capsule enlarged and rounded, without neck, opening in separate spermathecal ducts. Ascoids formula in both sexes: 2/III-XIV.
Type: *Phlebotomus alexandri* Sinton, 1928

16. *Phlebotomus alexandri*
Male

- Short third antennal segment < 170 µm.
- Gonocoxite basal lobe, narrow but expanding apically, with 20–40 hairs.
- Distal spines of the gonostyle with a significant shift.
- Surgonostyle shorter than the gonocoxite (Figures N°16a,b).

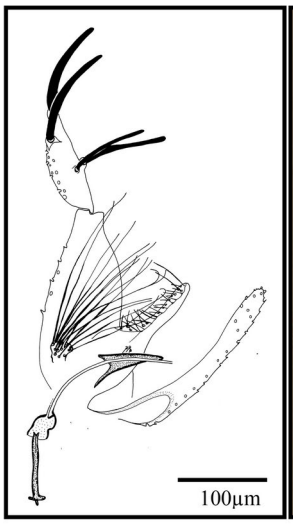
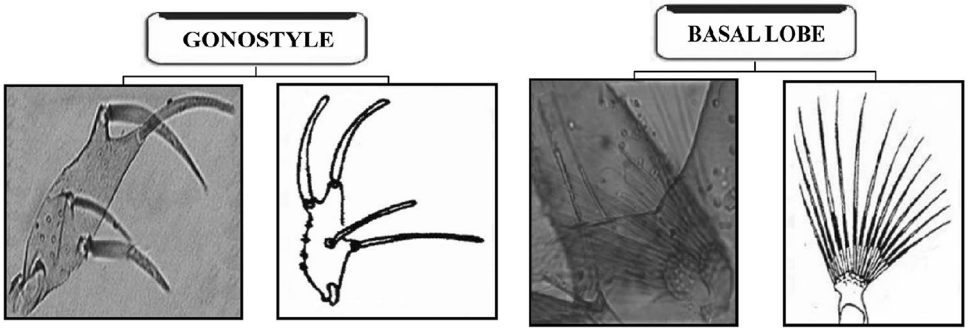


Figure N°16a

Figure N°16b

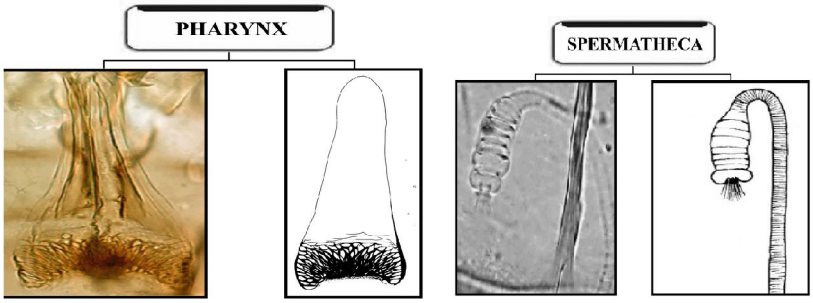


Female

- Short third antennal segment < 170 µm.
- The spermatheca has 7–10 segments, with the most distal segment thicker and standing out slightly from the preceding one.
- Small pharynx, with dark thick teeth, rectangular shape (Figures N°16c,d).

Figure N°16c

Figure N°16d



Subgenus *Larroussius*

Male: Gonocoxite without lobes and with a group of ventrally-directed hairs in the middle of the inner surface, usually < 25, rarely up to 40. Gonostyle with 5 long spines, 2 apical and 3 medians. Long, rod-like, or lamellate parameral sheath with variable terminal forms but without sub-terminal tubercle. The oblong parameres are club-shaped, with a variable ventral tubercle development, sometimes forming a slight ventral thickening. Genital filaments of no more than 5 times longer than the genital pump. Unarmed lateral lobes.
Female: Pharyngeal armature usually punctated, it rarely consists of different elements or scale-like structures. Spermatheca with 12–35 segments with a rounded head and a narrowed long tubular neck. Antennal formula: 2/III-XV.
Type: *Phlebotomus major* Annandale, 1910

17. *Phlebotomus ariasi*
Male

- Narrow gonocoxite with 20–32 scattered hairs.
- Thick parameral sheath enlarged at the apex.
- Antenna Formula: 2/III-VIII, 1/IX-XV (Figures N°17a,b).

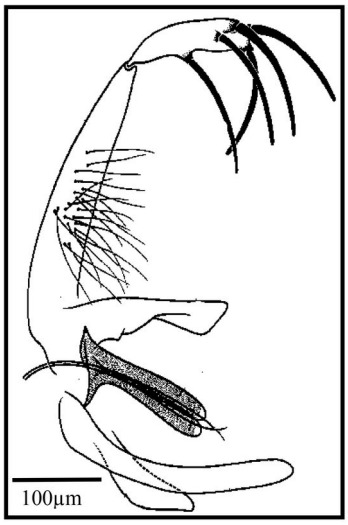
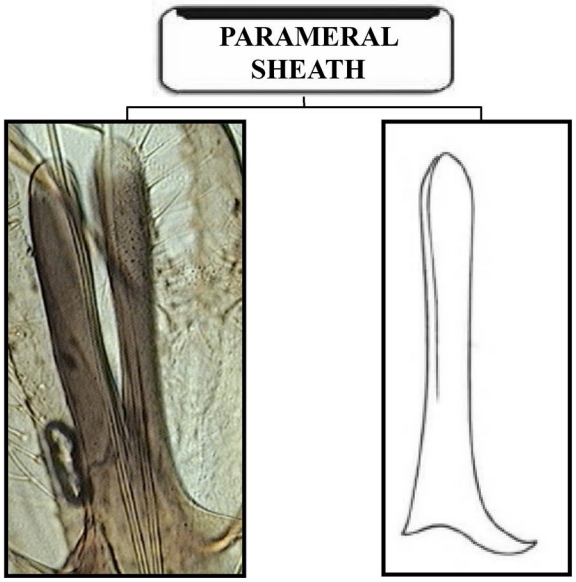
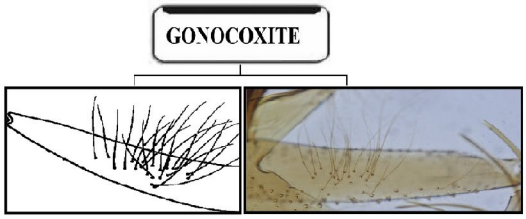


Figure N°17a

Figure N°17b

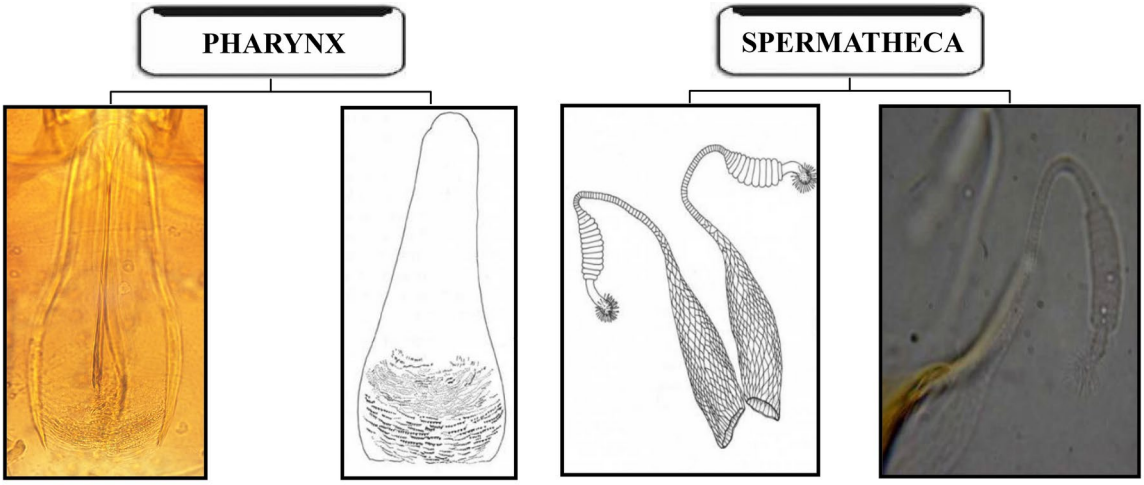




Female

- Individual spermathecal ducts striated and dilated in the form of a spindle. Narrow distal ducts, as long as the body.
- Armed pharynx with large teeth, separated by transverse folds, concave in front. Puncture-shaped denticles arranged irregularly.

Figure N°17c **Figure N°17d**



18. *Phlebotomus chadlii*
Male

- Antenna formula: 2/III-VIII, 1/IX-XV.
- Gonocoxite broad, carrying 70 grouped hairs.
- Parameral sheath enlarged at the apex, differing from sword-shaped parameral sheath of *Ph. ariasi* (Figures N°18a,b).

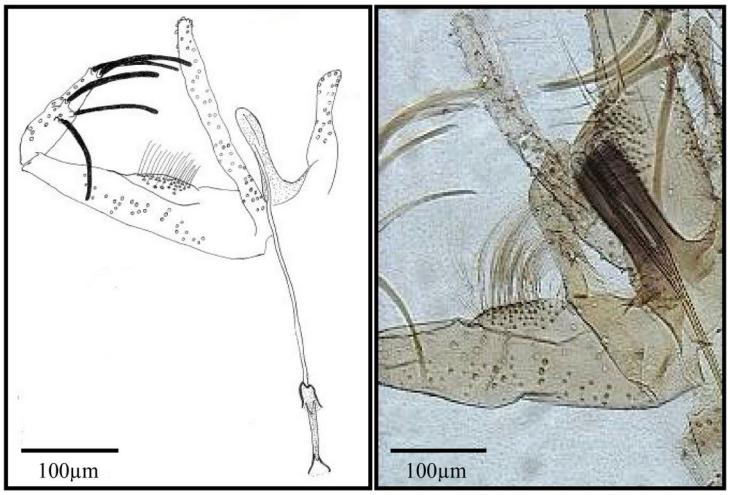
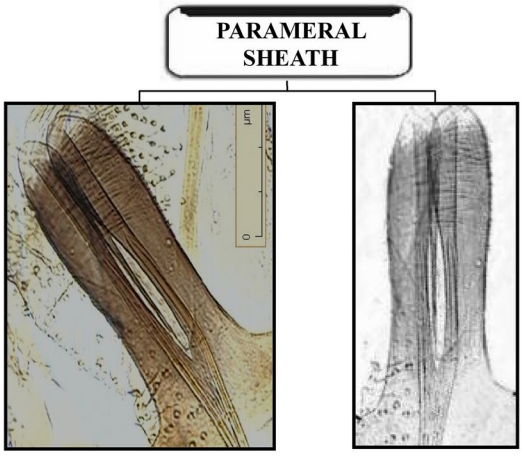
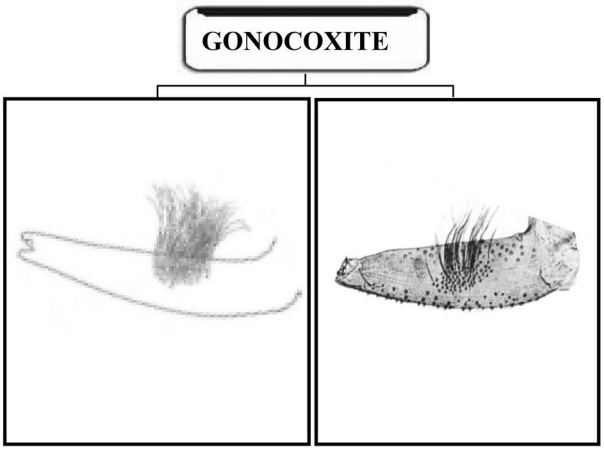


Figure N°18a **Figure N°18b**





Female

- Individualized spermathecal ducts smooth, devoid of reticles, with a dilatation on the 3/4 of their length. Very short narrow distal duct.
- Pharengeal armature occupying 1/3 of the pharynx (Figures N°18c,d).

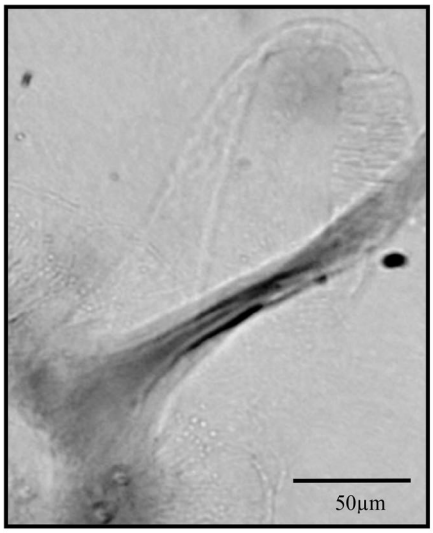
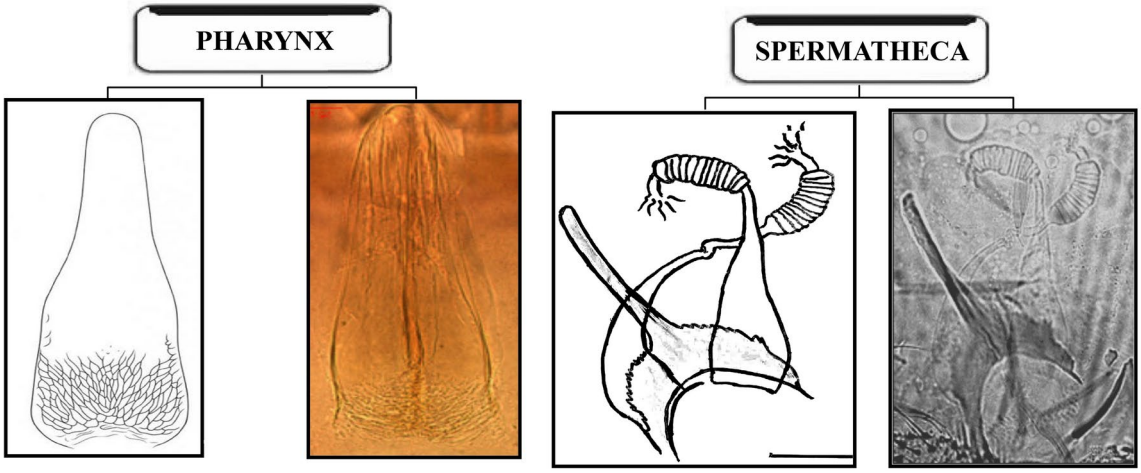


Figure N°18c

Figure N°18d



19. *Phlebotomus ilami*
Male
Undescribed.
Female

- A3 = A4 + A5.
- Pharyngeal armature occupying 1/3 of the pharynx. Armature's scales condensed in the center, with a network along the margins (20 rows of scales).
- Spermatheca with a very short common ducts, 18–23 segments wider in the middle and a long and thin neck (0/4 of the capsule) (Figures N°19a,b).

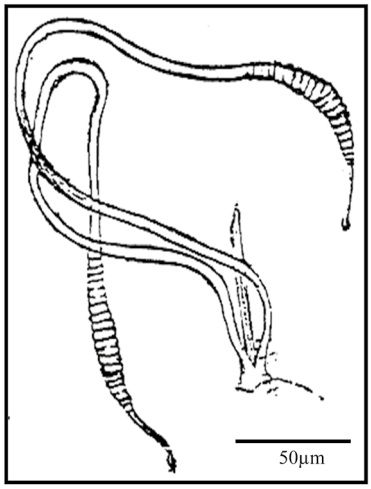


Figure N°19a

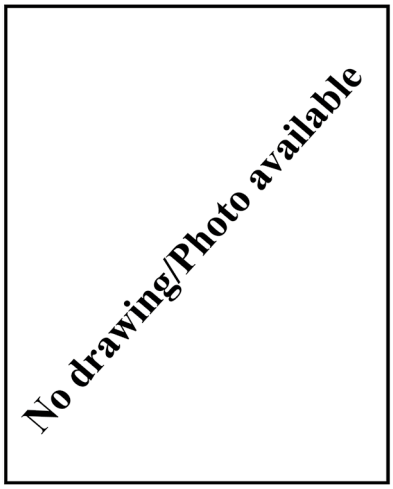
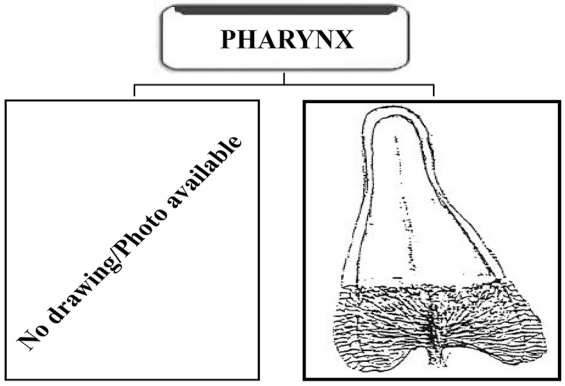
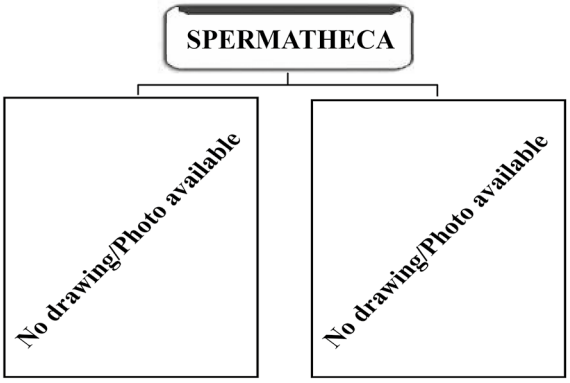


Figure N°19b





20. *Phlebotomus kandelakii*
Male

- Narrow gonocoxite with 10–20 medial hairs.
- Parameral sheath with fine denticles arranged in longitudinal lines.
- Paramere with short hairy process on the ventral side.
- Antennal formula: 2/III-V, 1/VI-XV or 2/III-VII, 1/VIII-XV (Figures N°20a,b).

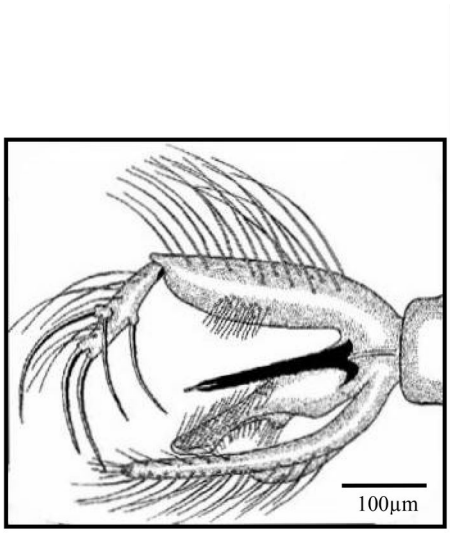
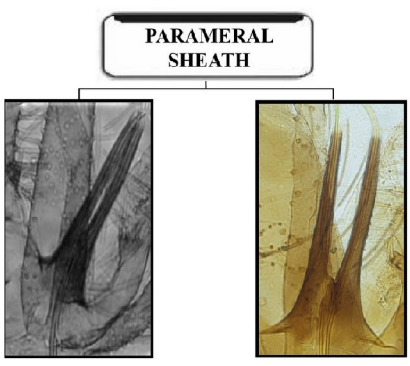
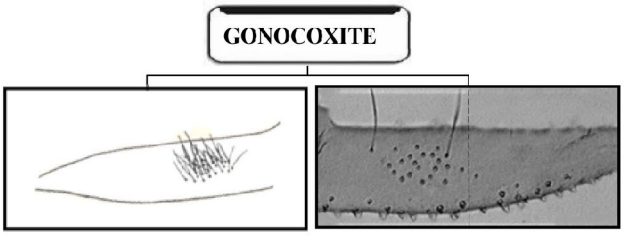


Figure N°20a

Figure N°20b





Female

- Individual spermathecal ducts gradually widen in the distal portion. Difficult to delineate duct and body limits.
- Armed pharynx with large puncture-shaped denticles on its 1/4 posterior surface (Figures N°20c,d).

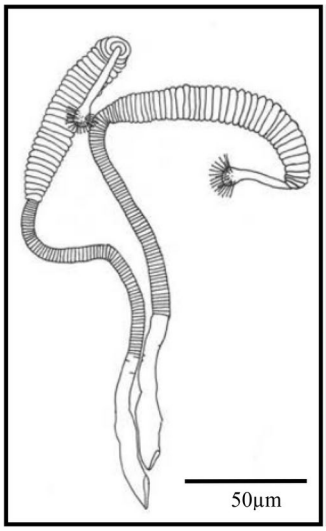
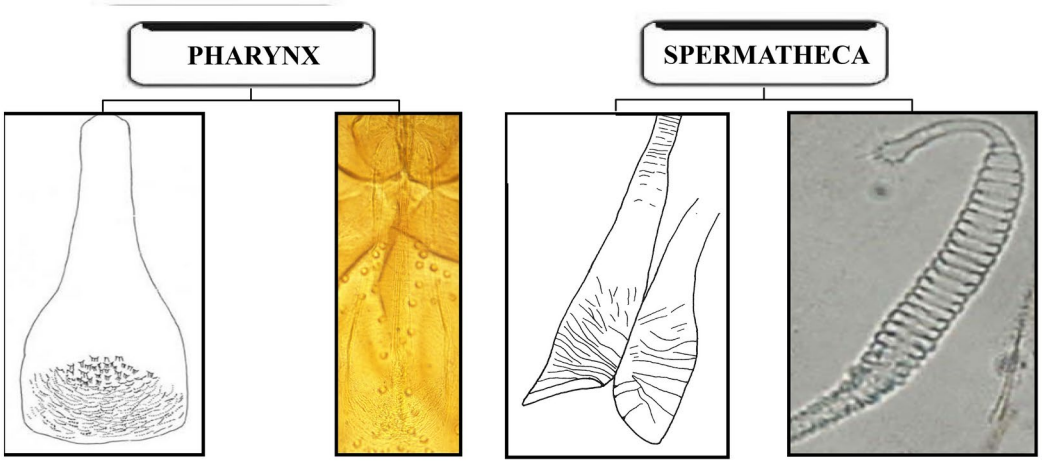


Figure N°20c

Figure N°20d



21. *Phlebotomus keshishiani*
Male

- Long narrow gonocoxite with 18–30 hairs on inner surface.
- Short parameral sheath narrowing gradually towards the apex with a symmetrical rounded shape.
- Long genital filaments, Filament/Pump = 5–6 (Figures N°21a,b).

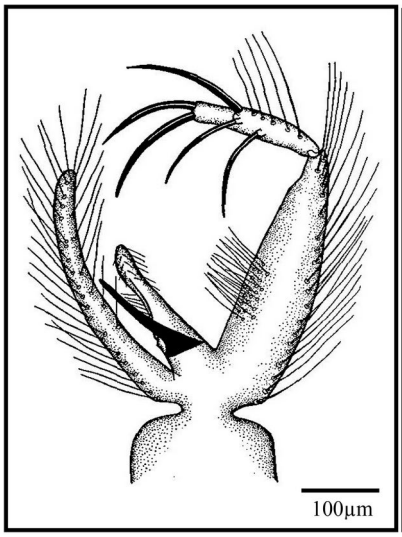
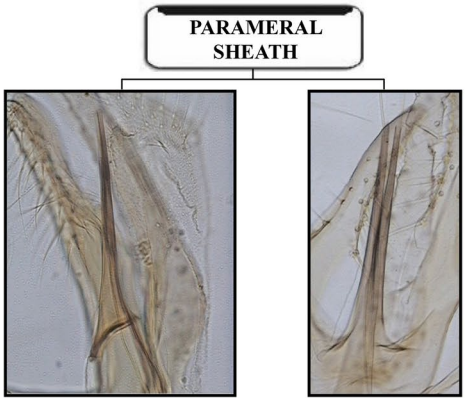
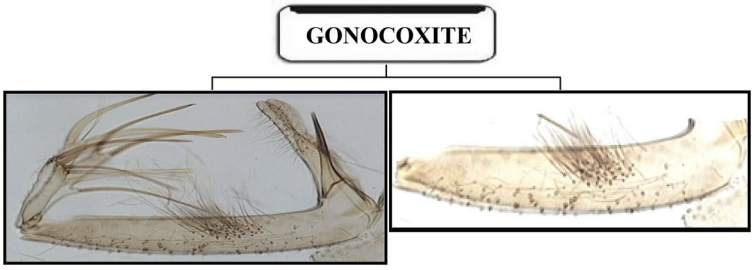


Figure N°21a

Figure N°21b





Female

- Pharyngeal armature occupying nearly the entire pharynx with convex rows of short, basal toothed lines and distal longitudinal lines.
- Spermatheca with 13–18 segments, relatively short neck. Individualized spermathecal bases (Figures N°21c,d).

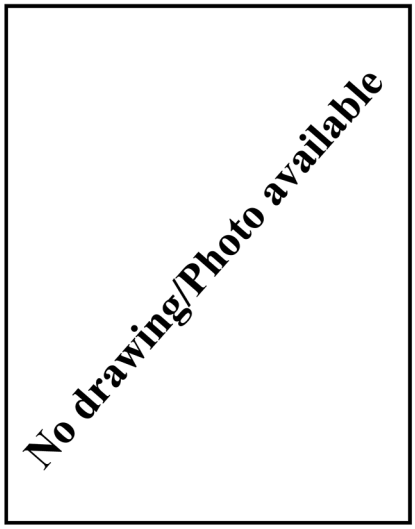


Figure N°21c

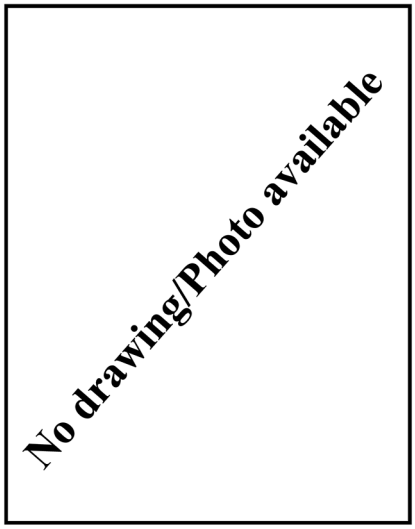
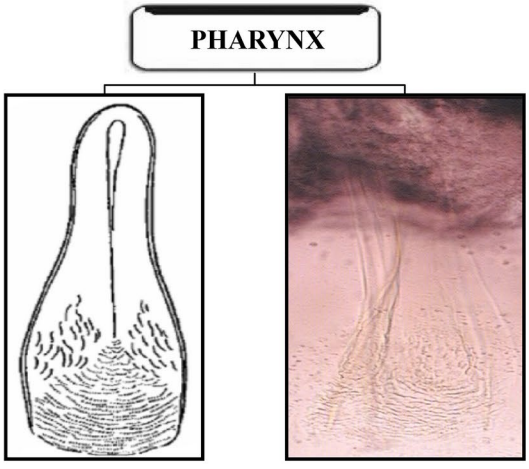
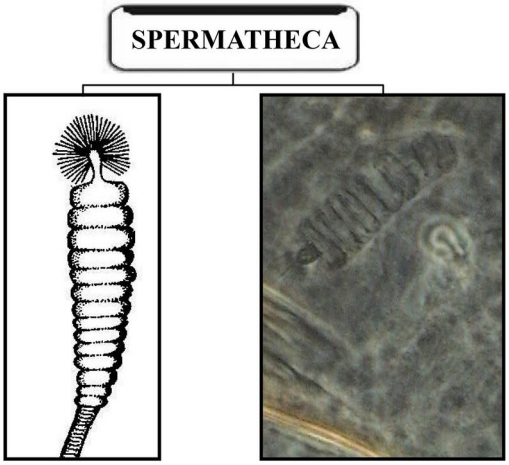


Figure N°21d





22. *Phlebotomus langeroni*
Male

- Antennal formula: 2/III-VII, 1/VIII-XV.
- Gonocoxite with a small bundle of hairs.
- Short parameral sheath with asymmetrical tip (Figures N°22a,b).

Figure N°22a

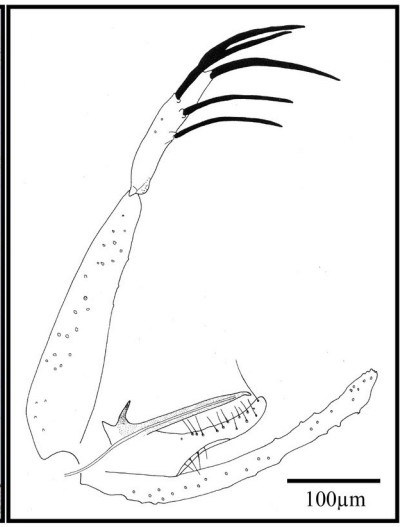
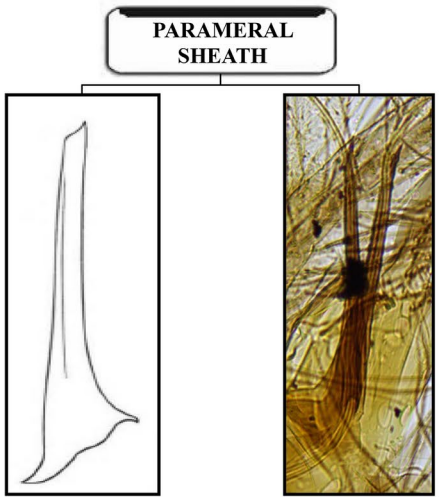
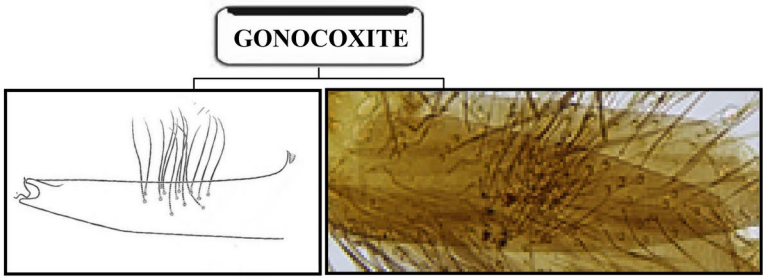


Figure N°22b





Female

- Antennal formula: 2/III- XV.
- The individual duct has transverse striations and lacks structures at the base, maintaining an uniform diameter until the final third, then widening progressively (Figures N°22c,d).

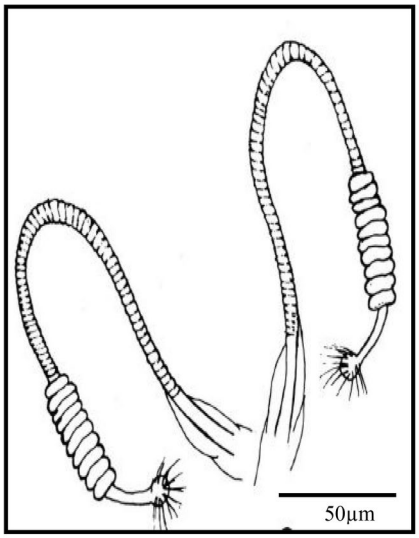
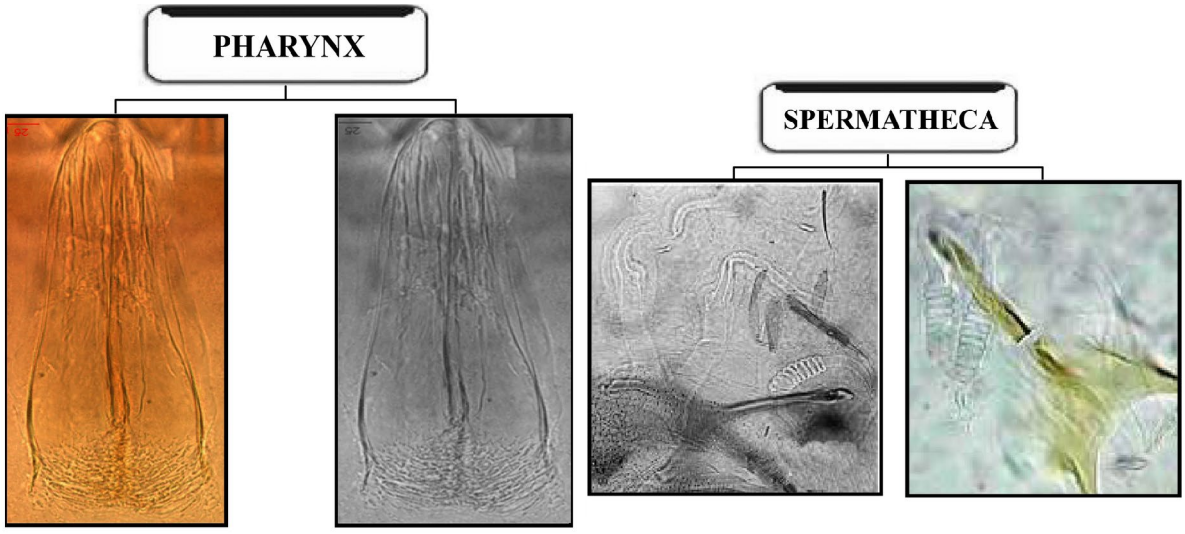


Figure N°22c

Figure N°22d



23. *Phlebotomus longicuspis*
Male

- Gonocoxite carrying a tuft of 18–32 hairs.
- Long parameral sheath, gradually narrowing and ending with a curved tip.
- Antenna formula: 2/III-VII, 1/VIII-XV (Figures N°23a,b).

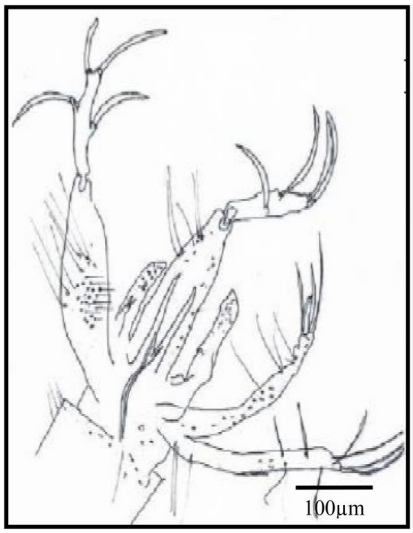
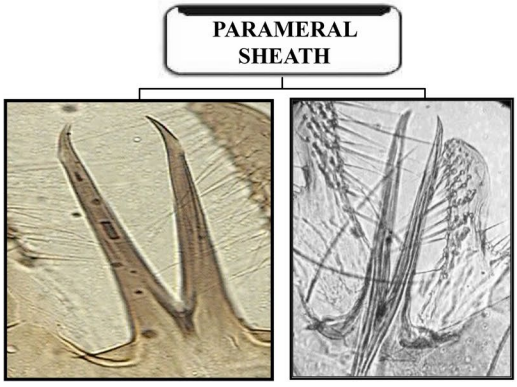
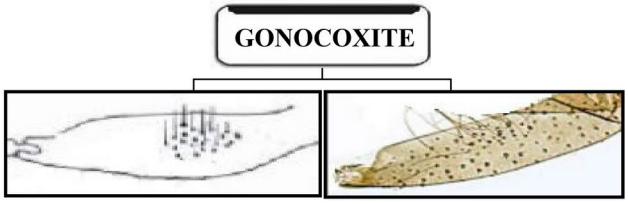


Figure N°23a

Figure N°23b





Female

- Over a 1/4 of the pharynx length with transverse rows of small denticles, more pronounced teeth in the anterior part.
- Individual striated spermathecal ducts with a slightly bilobed sub-terminal bulb (Figures N°23c,d).

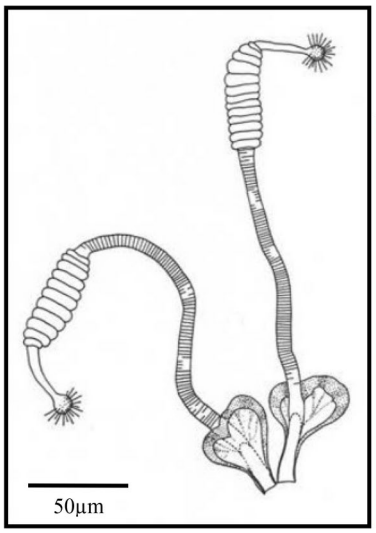
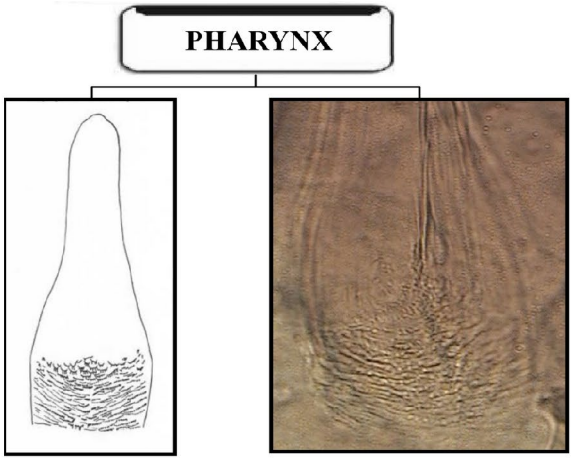
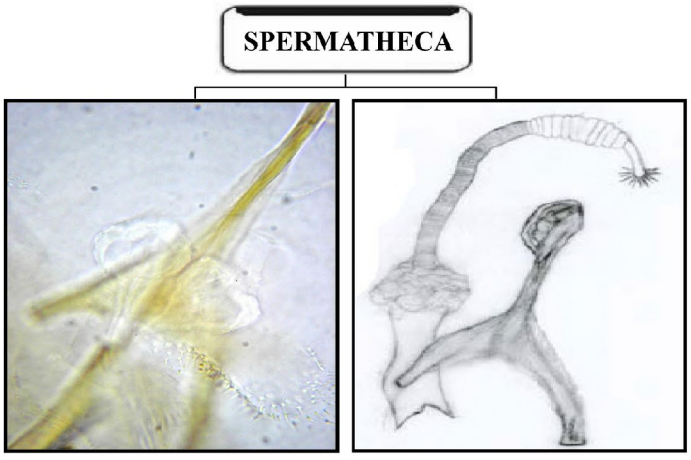


Figure N°23c

Figure N°23d





24. *Phlebotomus major s. st.*
Male

- Antennal formula: 2/III-VIII, 1/IX-XV
- Pharyngeal armature occupying 1/3 of the pharynx, with fine and punctiform teeth.
- Gonocoxite with 20–30 long hairs.
- Long parameral sheath with rounded tip (Figures N°24a,b).

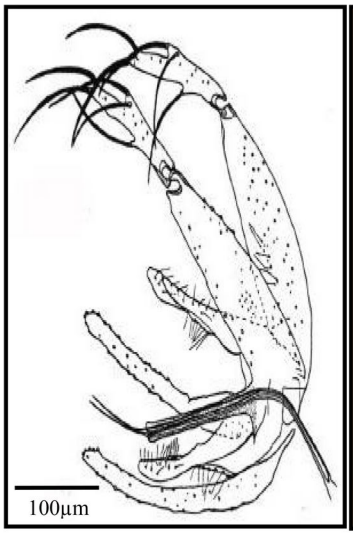
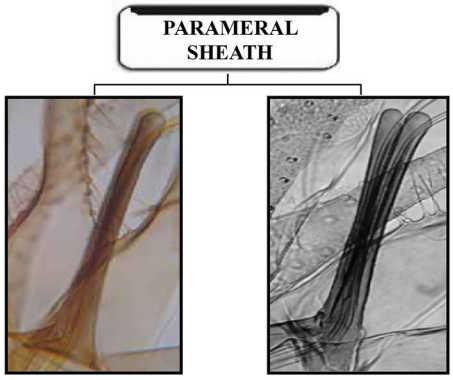
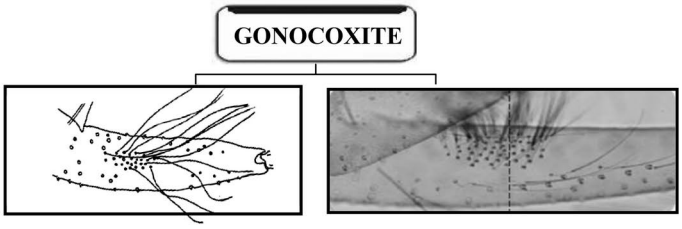


Figure N°24a

Figure N°25b





Female

- Pharynx extensively armed.
- Striated spermathecal ducts, slightly pleated, forming a common duct at 1/3 of the of ducts (Figures N°24c,d).

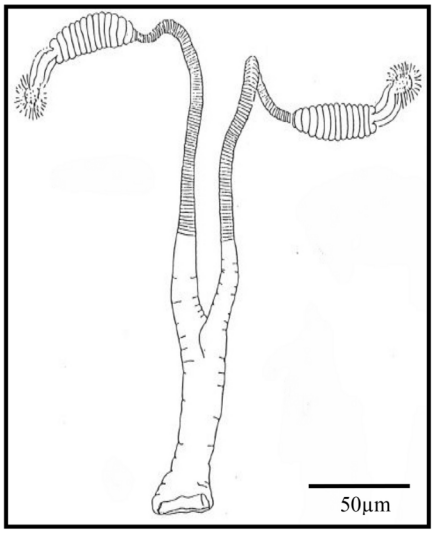


Figure N°24c

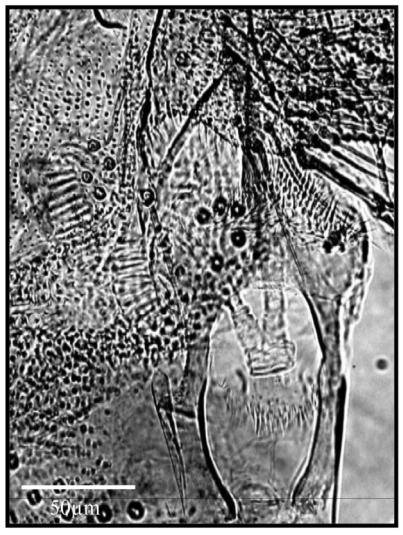
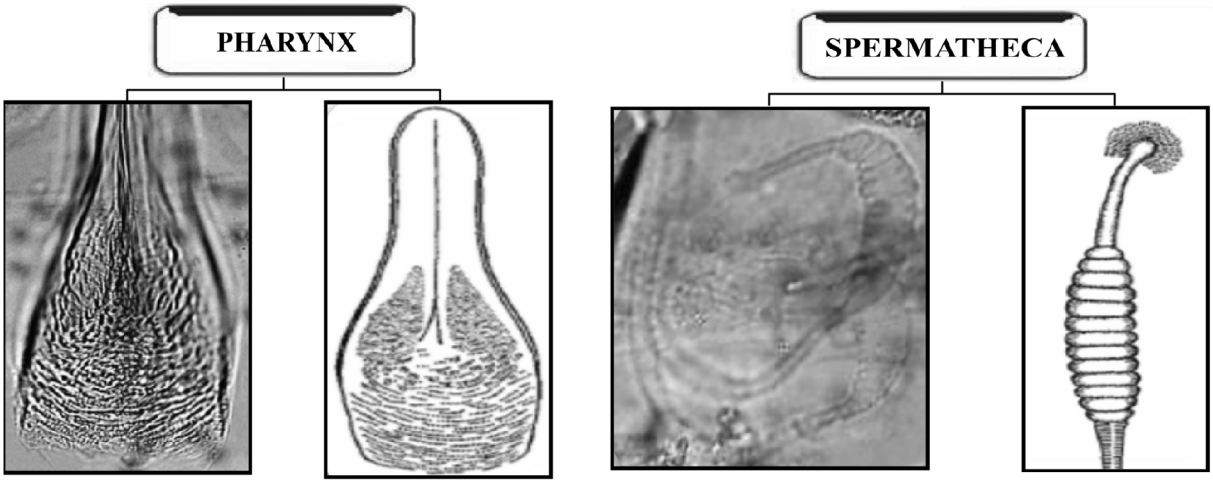


Figure N°24d



25. *Phlebotomus neglectus*
Male

- Antennal formula: 2/III-VIII, 1/IX-XV.
- Gonocoxite with 20 long hairs.
- Pharyngeal armature occupying 1/3 of the pharynx, with fine and punctiform teeth.
- Long isodiametric parameral sheath, rounded at its end, "drum stick" (Figures N°25a,b).

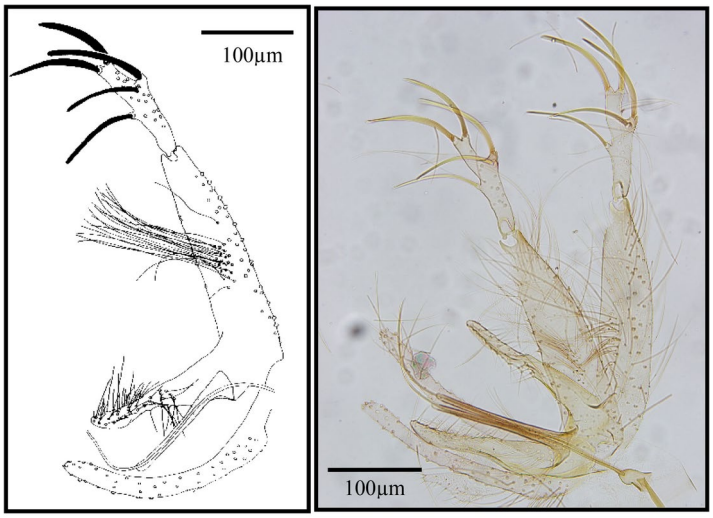
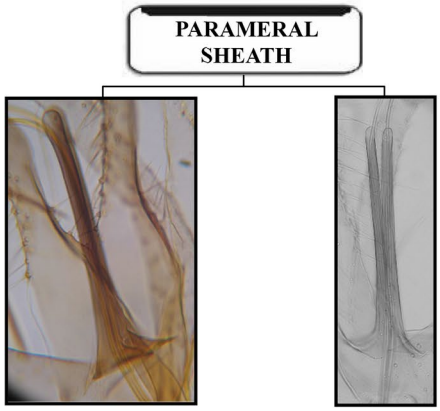
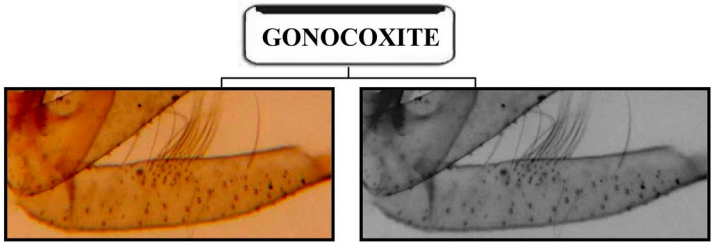


Figure N°25a **Figure N°25b**





Female

- Spermatheca with a long common duct.
- Pharengeal armature occupying 1/2 of the pharynx (Figures N°25c,d).

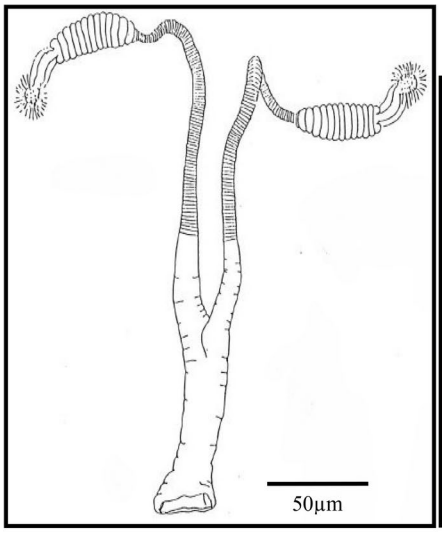


Figure N°25c

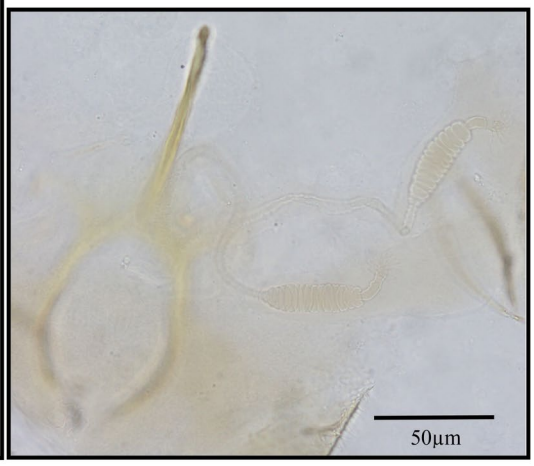
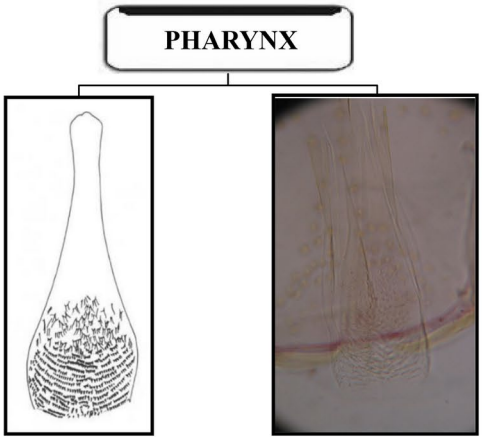
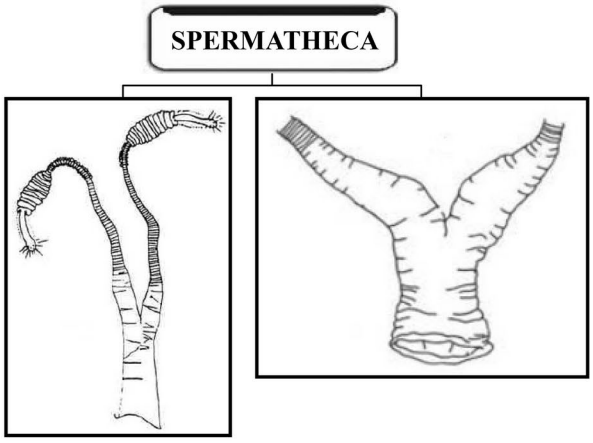


Figure N°25d





26. *Phlebotomus syriacus*
Male

- Antennal formula: 2/III-VIII, 1/IX-XV.
- Pharyngeal armature occupying 1/3 of the pharynx, with fine and punctiform teeth.
- Gonocoxite carrying 30–50 long hairs (more than *Ph. neglectus*).
- Long isodiametric parameral sheath rounded at its distal end (Figures N°26a,b).

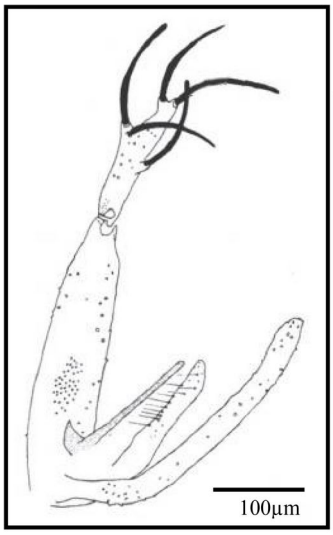
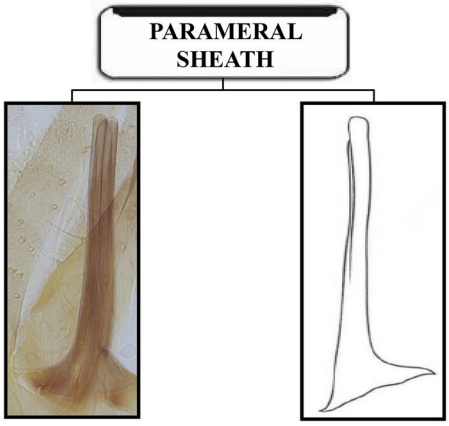
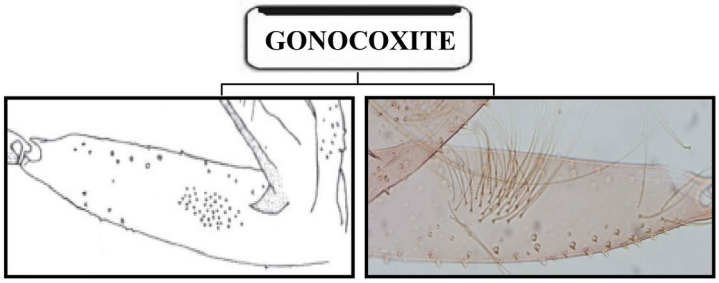


Figure N°26a

Figure N°26b





Female

- Spermathecae with a shared short duct.
- Pharengeal armature occupying 1/3 of the pharynx, a distinguishing feature compared to *Ph. neglectus* (Figures N°26c,d).

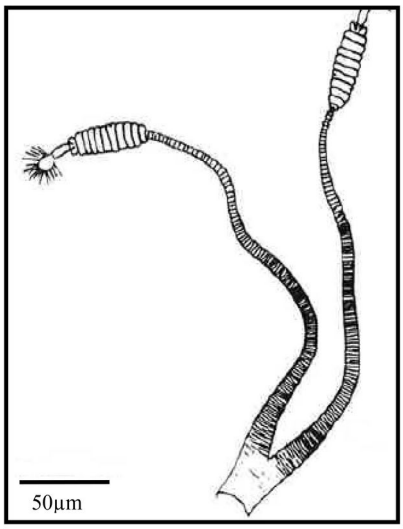


Figure N°26c

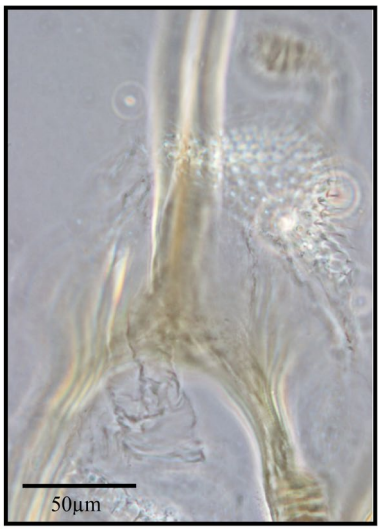
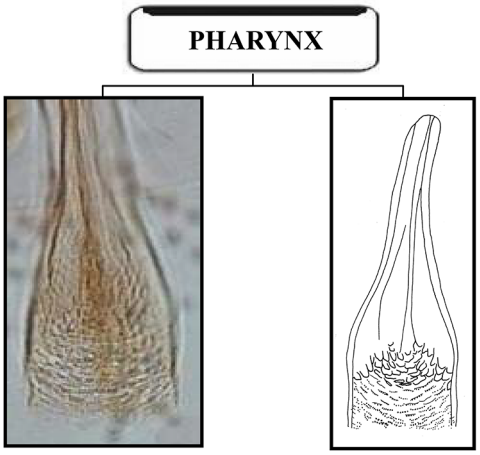
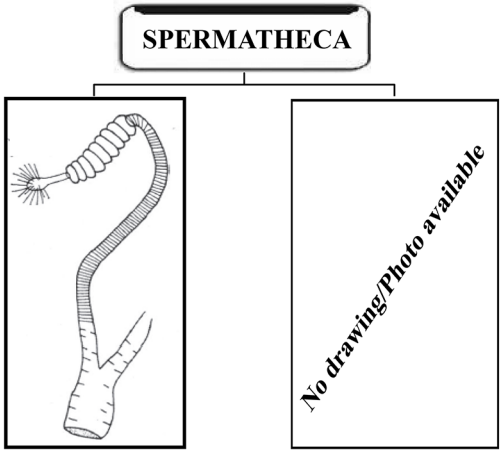


Figure N°26d





27. *Phlebotomus mariae*
Male

- Gonocoxite with 25–30 hairs.
- Long, slender, and symmetric parameral sheath with a faintly flared apex.
- Slender and longer lateral lobe than the gonocoxite (Figures N°27a,b).

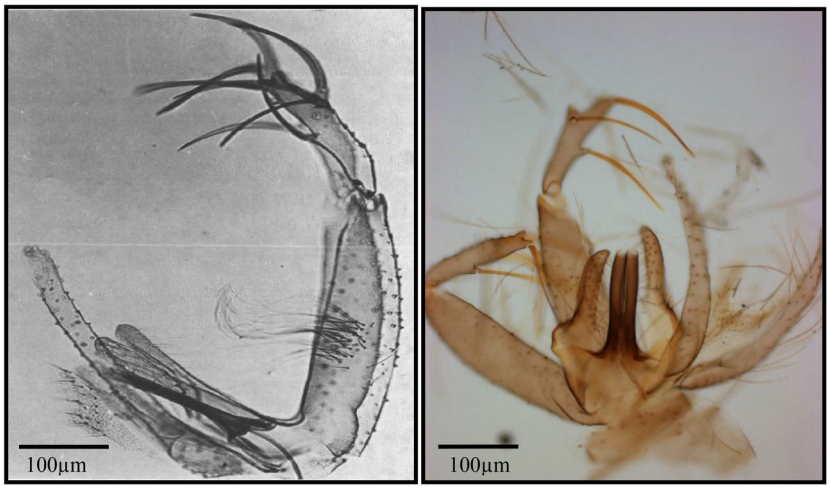
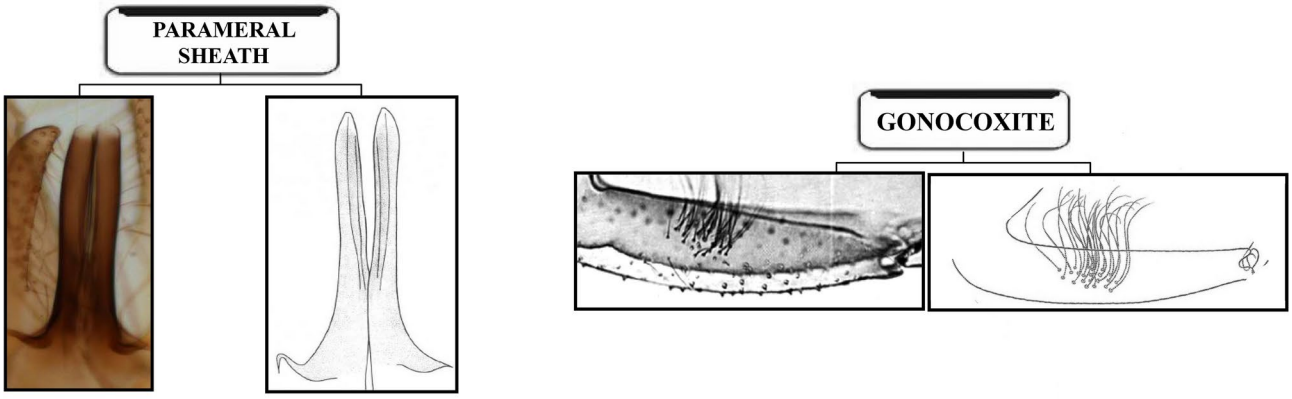


Figure N°27a **Figure N°27b**



Female

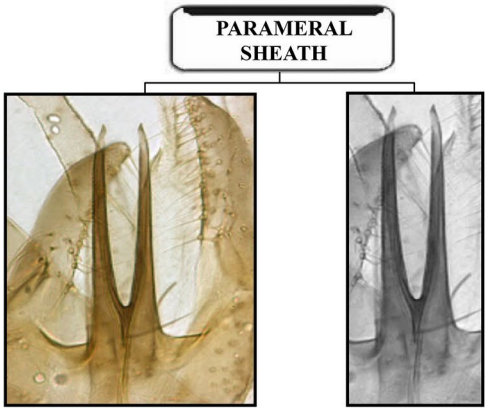
- Undescribed.

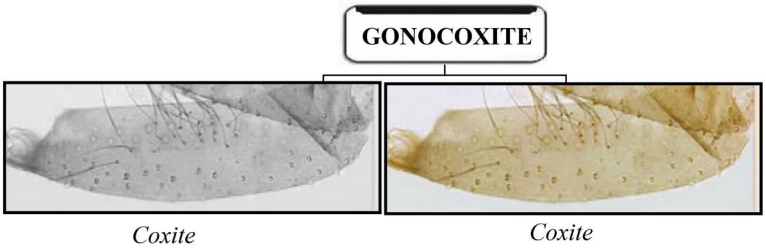
28. *Phlebotomus orientalis*
Male

- Long parameral sheath narrowing gradually with a bent tip.
- Gonocoxite with 15 scattered hairs (Figures N°28a,b).

Figure N°28a

Figure N°28b





Female

- Spermathecal ducts separated by a long-dilated cornet thickened at its base without lateral structure (Figures N°28c,d).

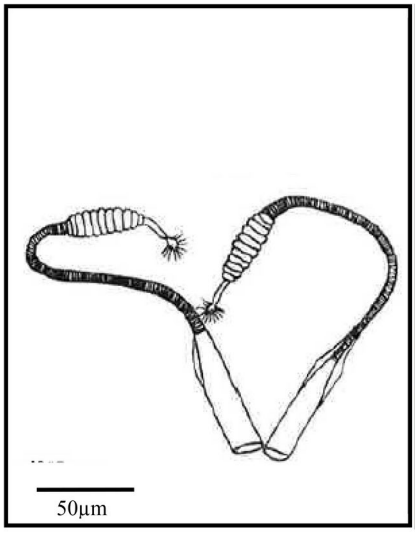
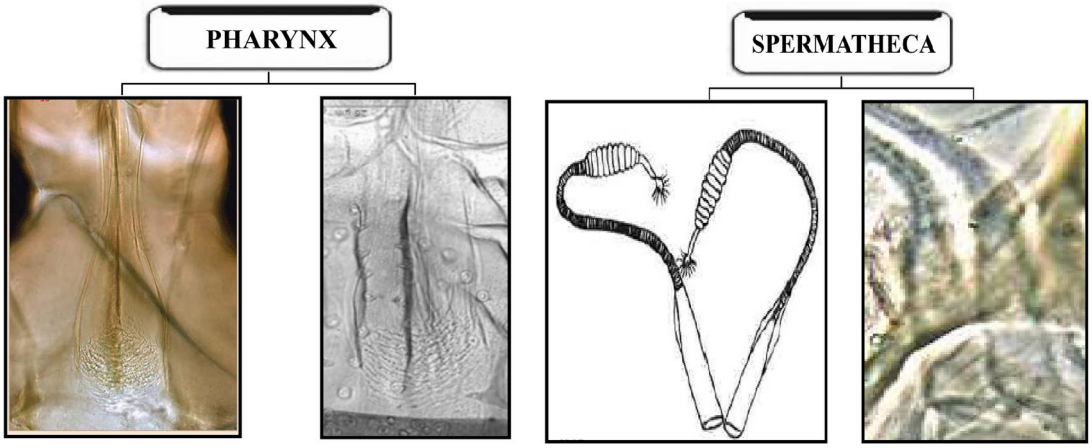


Figure N°28c

Figure N°28d



29. *Phlebotomus perfiliewi* s.st.
Male

- Antennal formula: 2/III-XV.
- Parameral sheath with transparent tip longer than *Ph. p. galilaeus*.
- Gonocoxite with 20 hairs on the ventral side (Figures N°29a,b).

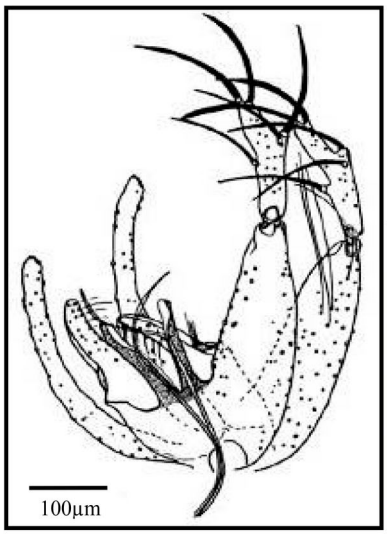


Figure N°29a

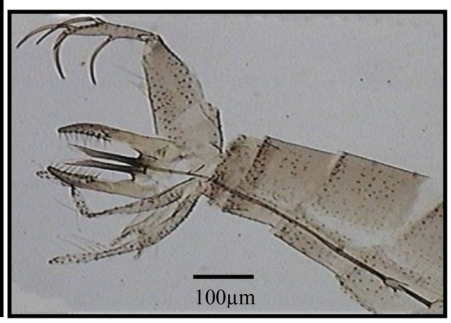
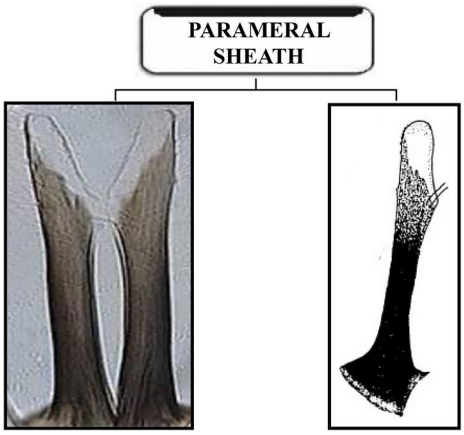
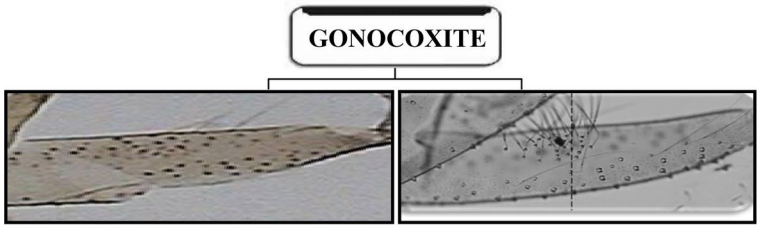


Figure N°29b





Female

- Asymmetric large lateral pocket near the spermathecal duct opening. The blunt tip of the pocket is rounded with chitin lines encircling it (Figures N°29c,d).

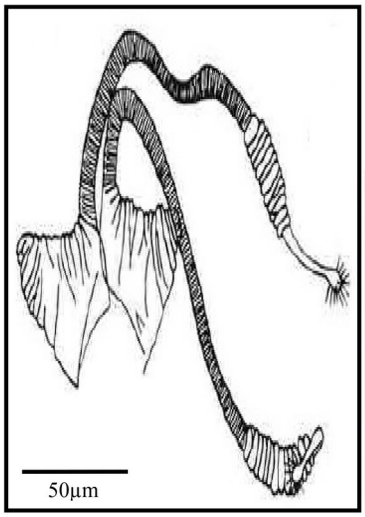


Figure N°29c

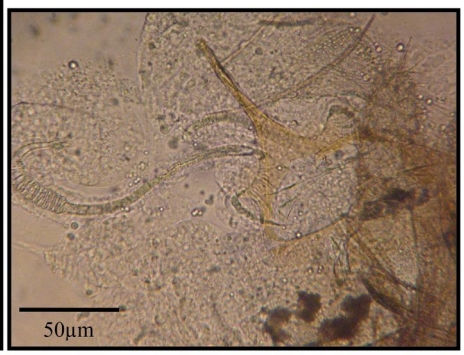
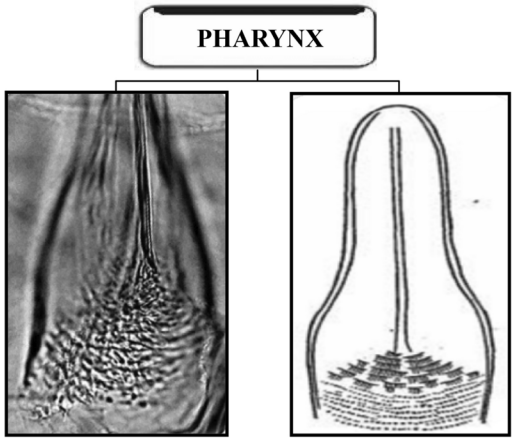
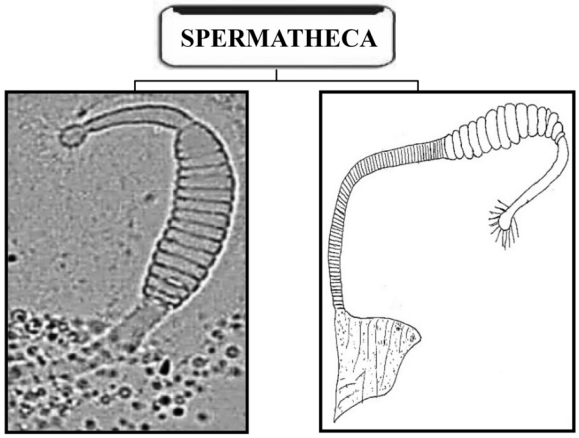


Figure N°29d





30. *Phlebotomus galilaeus*
Male

- Antennal formula: 2/III-VIII, 1/IX-XV.
- Long parameral sheath (0.17–0.19 mm) with transparent part. Rounded, longer and narrower than *Ph. p. perfiliewi* and *Ph. p. galilaeus*.
- Tiny teeth on the distal part of the parameral sheath.
- Narrow gonocoxite with 20 scattered hairs (Figures N°30c,d).

Figure N°30a

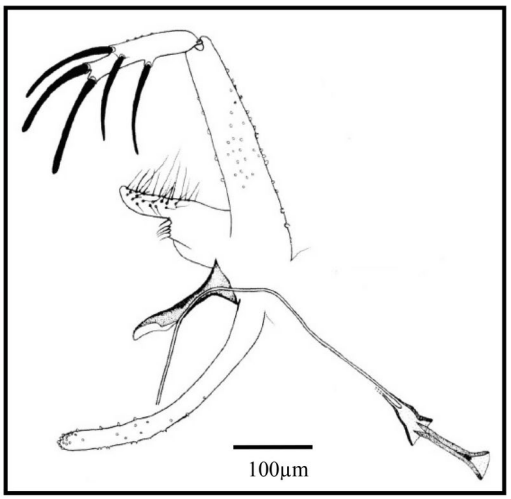
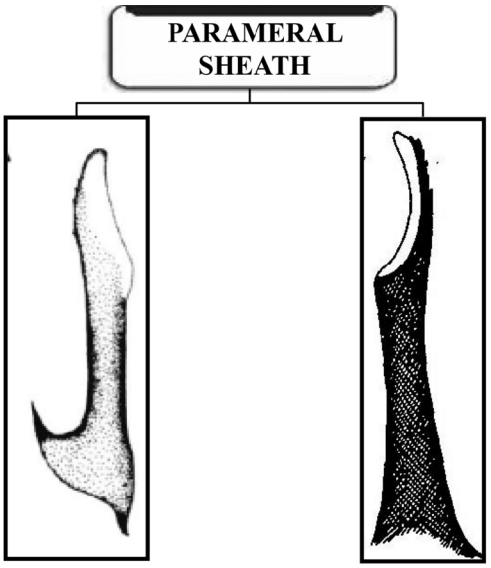
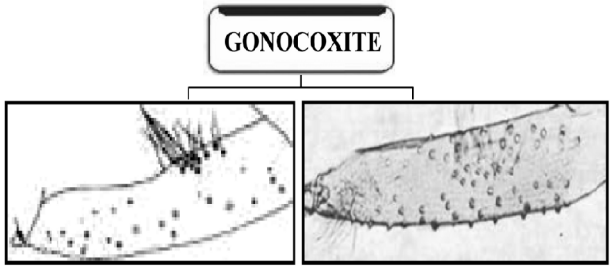


Figure N°30b





Female

- Asymmetric large lateral pocket near the spermathecal duct opening. The blunt tip of pocket rounded, with lines of chitin encircling it.
- Indistinguishable from *Ph. p. galilaeus* and *Ph. p. transcaucasicus* (Figures N°30c,d).

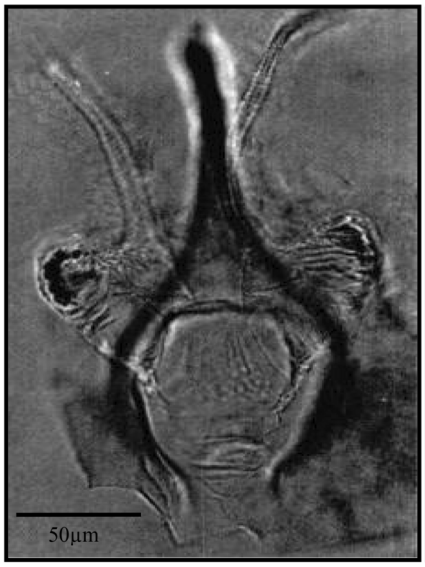


Figure N°30c

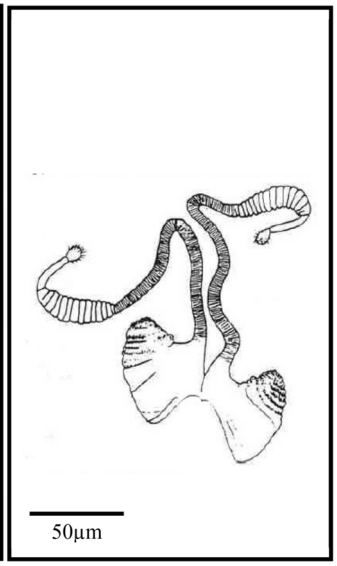
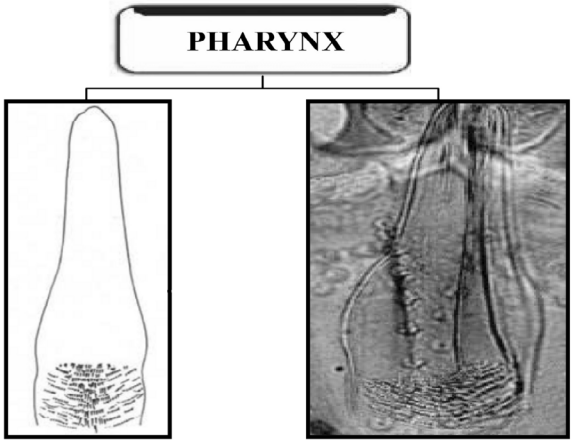
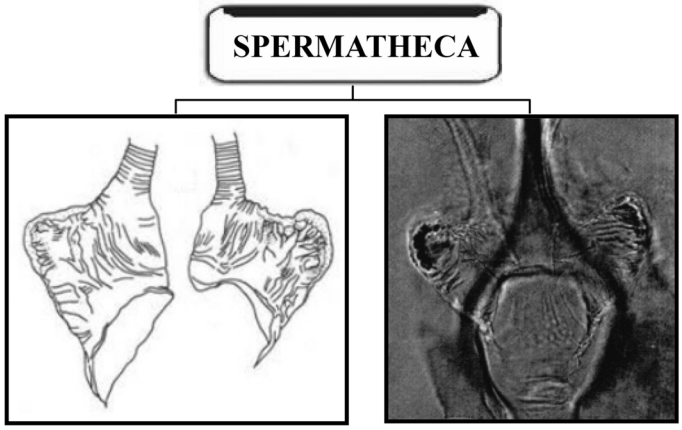


Figure N°30d





31. *Phlebotomus transcaucasicus*
Male

- Antennal formula: 2/III- XV (differs from *Ph. p. galilaeus*).
- Parameral sheath narrow and nearly straight, with transparent tip larger and more concave than *Ph. p. perfiliewi* and *Ph. p. galilaeus* (Figures N°31a,b).

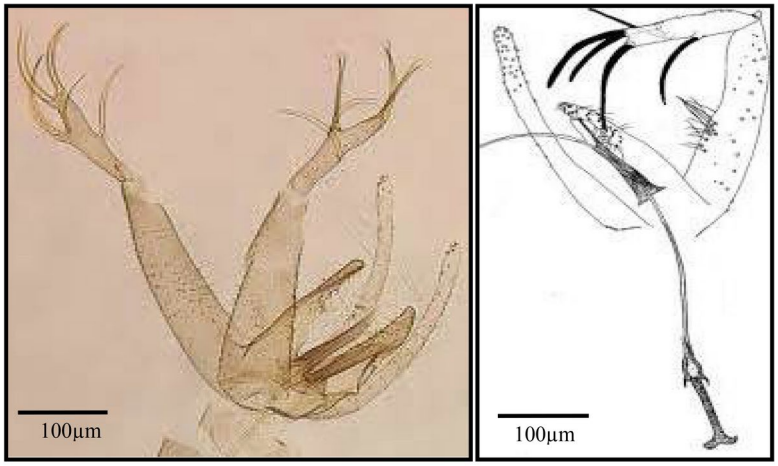
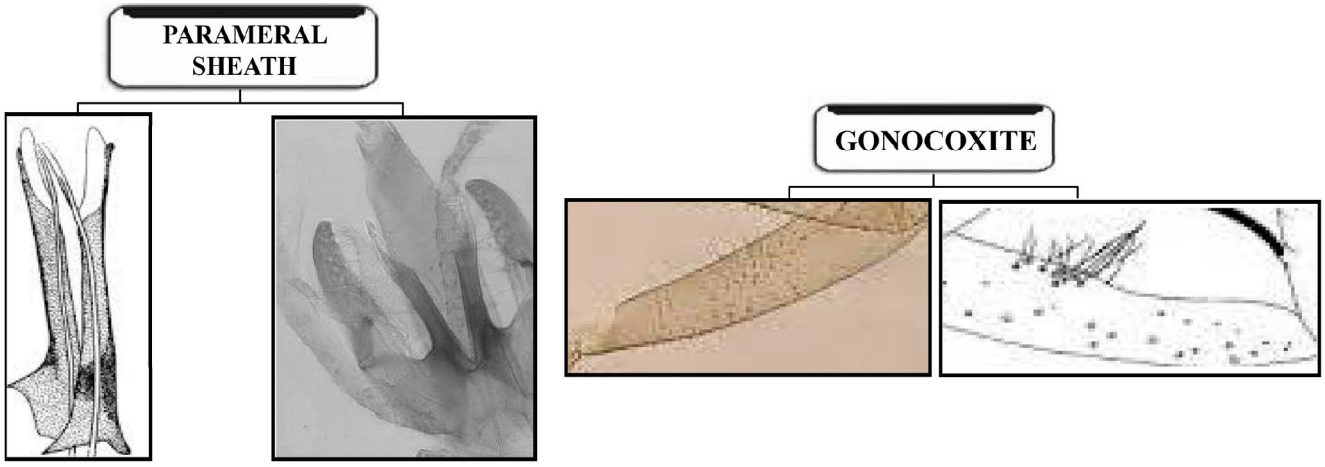


Figure N°31a **Figure N°31b**



Female

- Indistinguishable from *Ph. p. perfiliewi* and *Ph. p. galilaeus* (Figures N°31c,d).

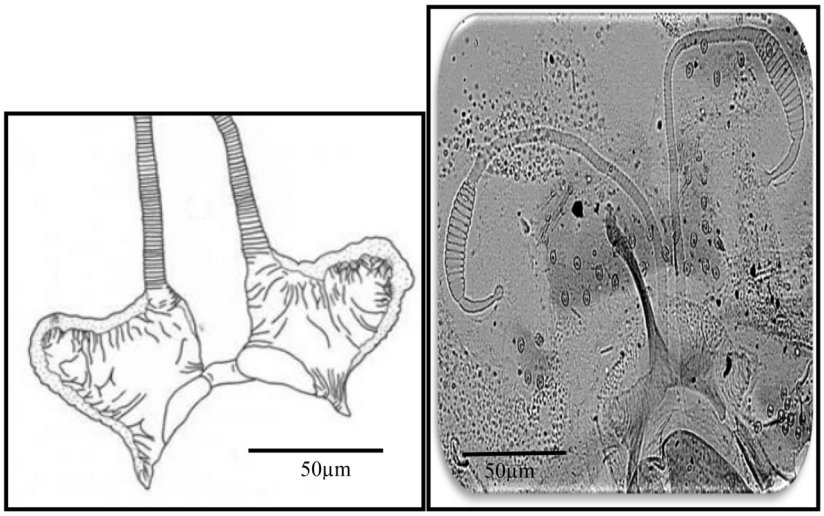
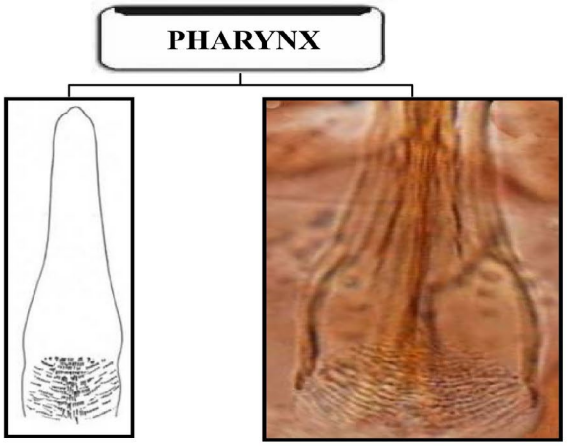
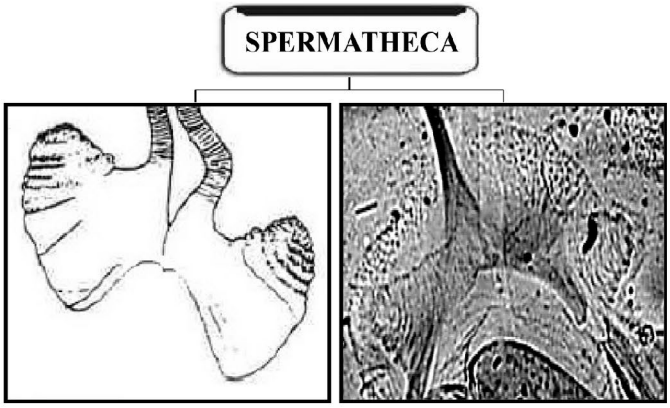


Figure N°31c **Figure N°31d**





32.*Phlebotomus perniciosus*
Male

- Antennal formula: 2/III-VII, 1/VIII-XV.
- Bifurcated parameral sheath with 2 subequal sharp tips.
- Gonocoxite with 10–20 hairs (Figures N°32a,b).

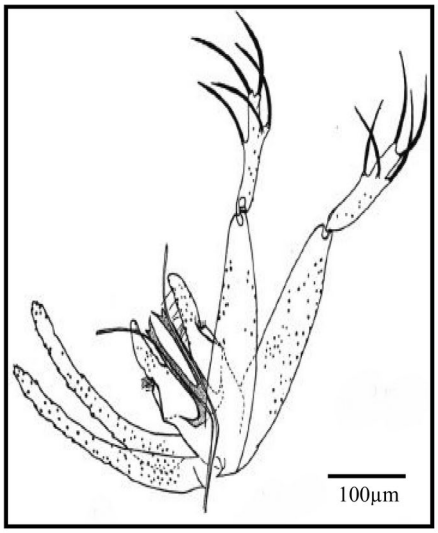


Figure N°32a

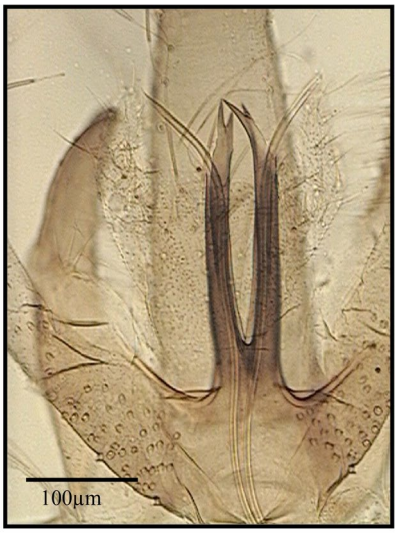
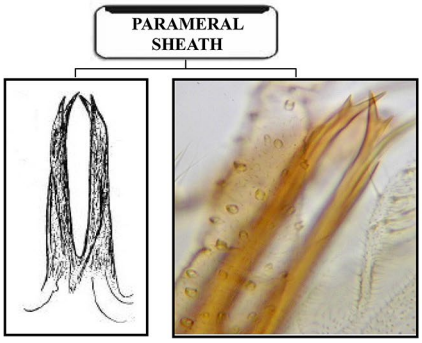
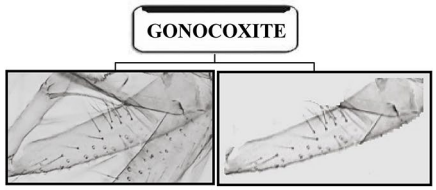


Figure N°32b





Female

- Spermathecal base ducts have a separate sub-terminal lateral bulb (branch-shaped form) of 20 µm in width (Figures N°32c,d).

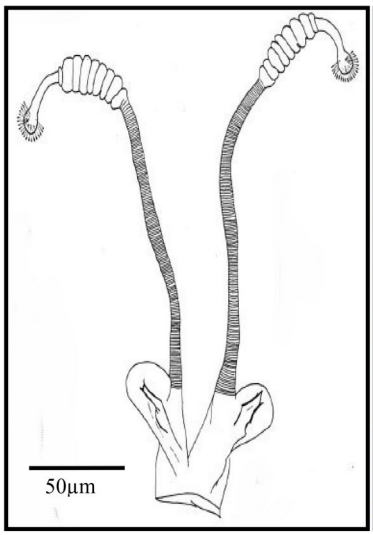


Figure N°32c

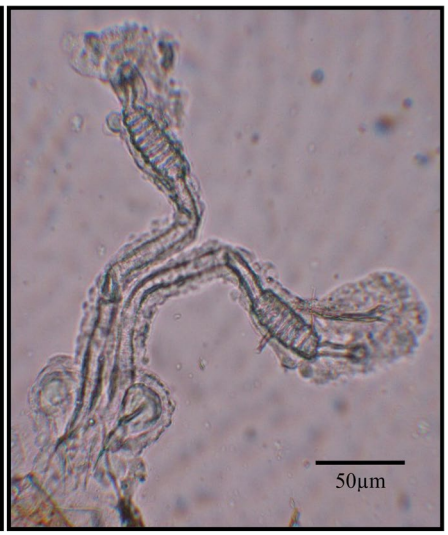
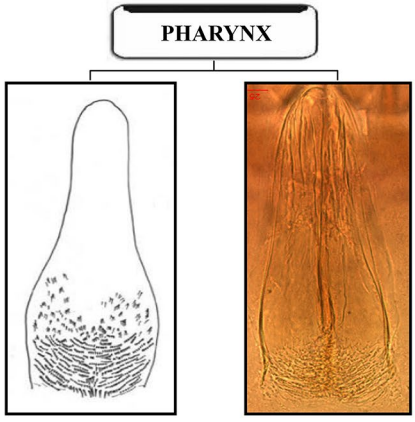
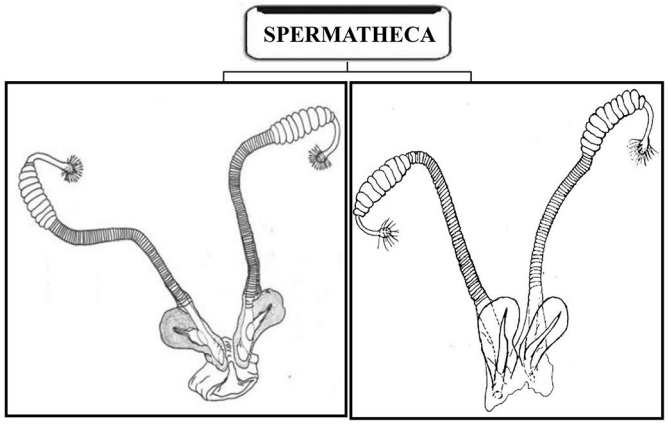


Figure N°32d





33. *Phlebotomus tobbi*
Male

- Bifid parameral sheath with unequal width tips.
- Distal branch of parameral sheath rounded.
- Gonocoxite with 20 hairs (Figures N°33a,b).

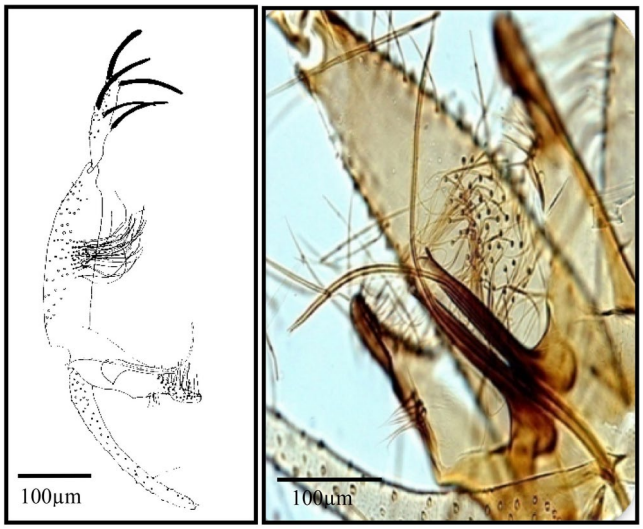
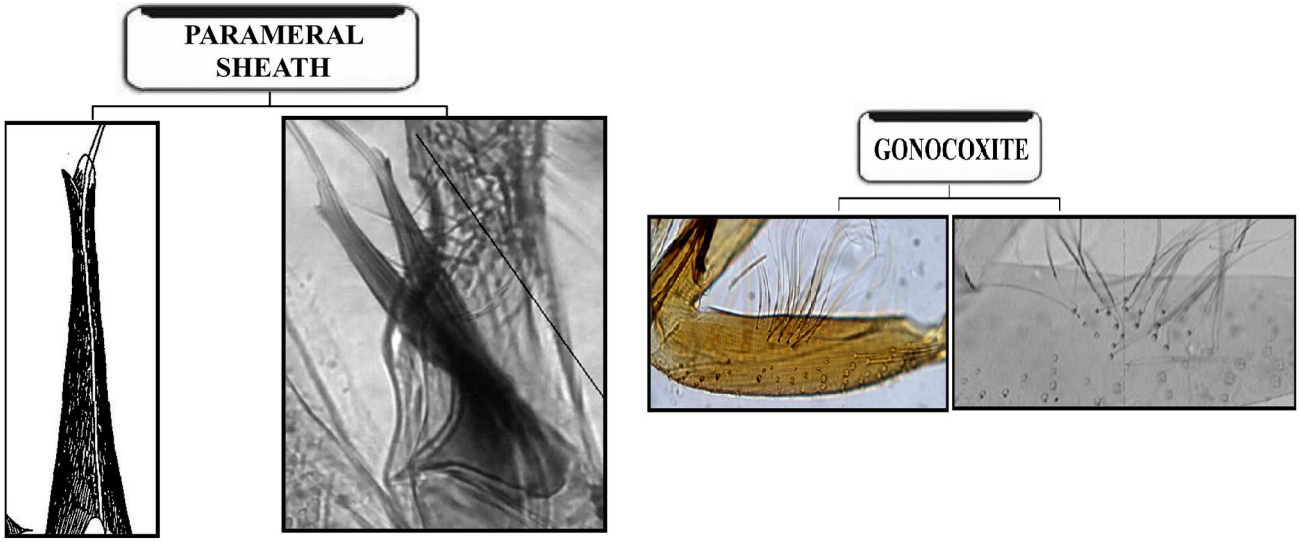


Figure N°33a Figure N°33b



Female

- Asymmetric bell-shaped swellings on the outer side of the spermathecal duct with a marked lip (Figures N°33c,d).

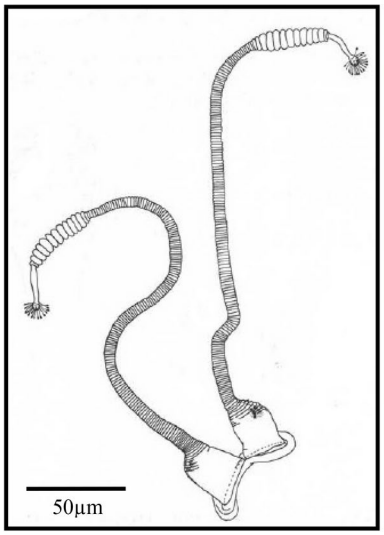
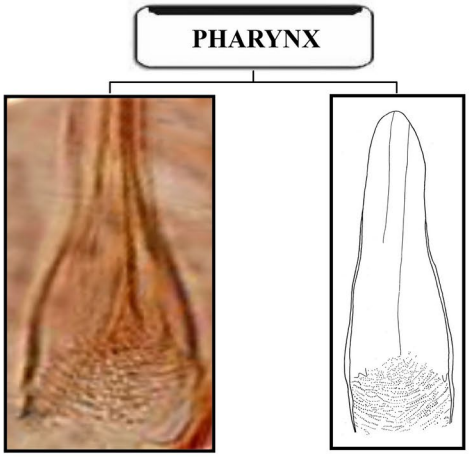
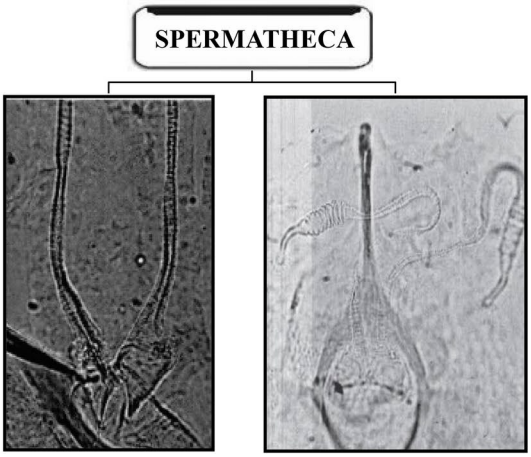


Figure N°33c

Figure N°33d





34. *Phlebotomus wenyoni*
Male

- Ascoid formula: 2/III-VIII, 1/IX-XV.
- Pharengeal armatur occupying ½ of the pharynx, featuring large teeth.
- Long and narrow gonocoxite with 20–30 internal hairs.
- Long parameral sheath with narrow and smooth parallel sides and rounded end.
- Short genital filaments. Filament/Pump = 3–4 (Figures N°34a,b).

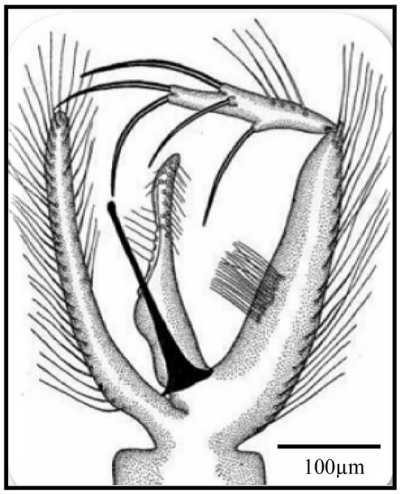
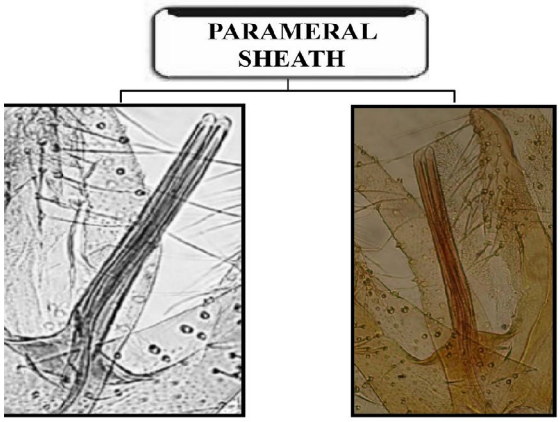
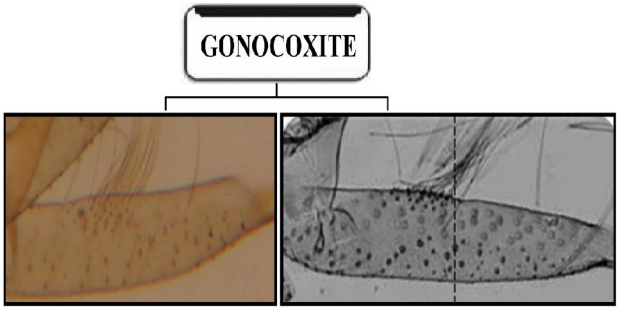


Figure N°34a

Figure N°34b





Female

- Punctiform pharyngeal armature occupying 1/2 of the pharynx.
- Spermatheca ducts merging in a long duct (Figures N°34c,d).

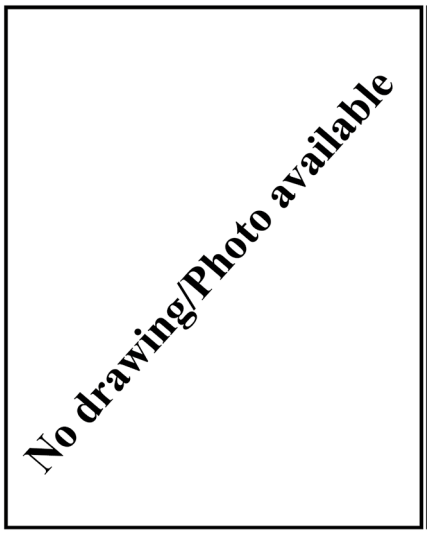


Figure N°34c

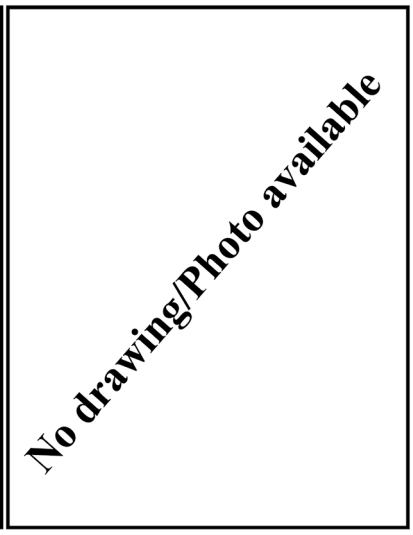
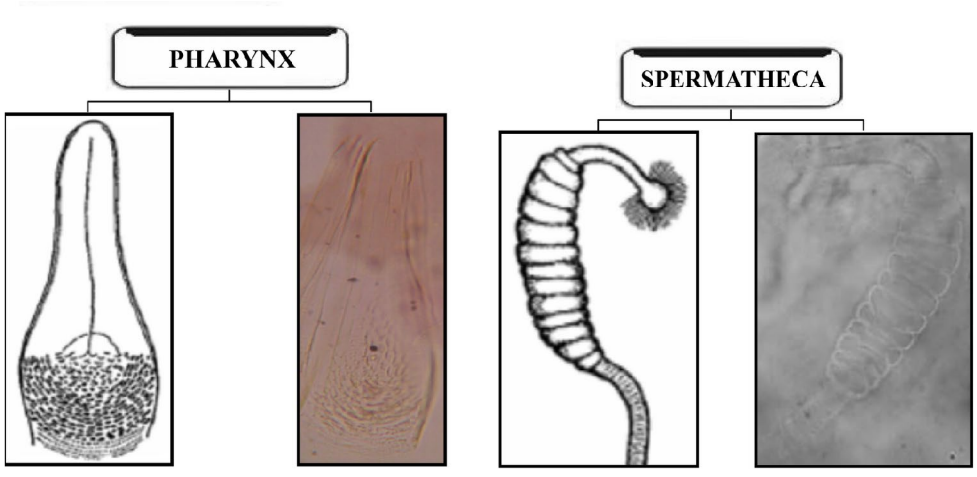


Figure N°34d



Subgenus *Adlerius*

Male: Gonocoxite without lobe, with 10 to 100 hairs ventrally-directed hairs in the middle of its inner side. Gonostyle with 5 spines, 2 terminals, and 3 medians. Long parameral sheath with smooth margin and a small subterminal tubercle near the apex. Long genital filament sometimes more than 10 times longer than the genital pump. Paramere is not truncated without ventral process. Unarmed lateral lobes.
Female: Pharyngeal armature well developed, with distinct teeth. Spermatheca incompletely segmented. Spermathecal ducts are long and separated, several times longer than the capsule. Antennal formula: 2/III-XV. Currently undistinguishable based on morphological characters.
Type: *Phlebotomus chinensis* Newstead, 1843

35. *Phlebotomus arabicus*
Male

- Antennal formula: 2/III-VIII, 1/IX-XV (sometimes 2/III-VII and 1/VIII-XV), A3 = 400-430 µm.
- Gonocoxite with 50–60 hairs in proximal half.
- Subapical tubercle of parameral sheath located 20µm from the apex (Figures N°35a,b).

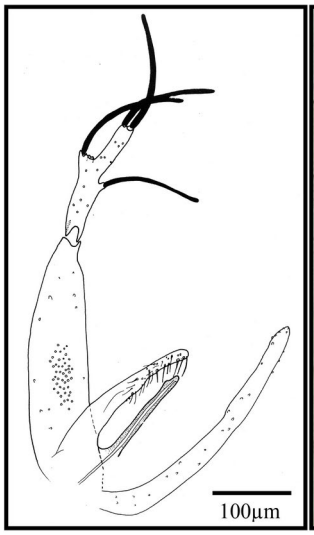
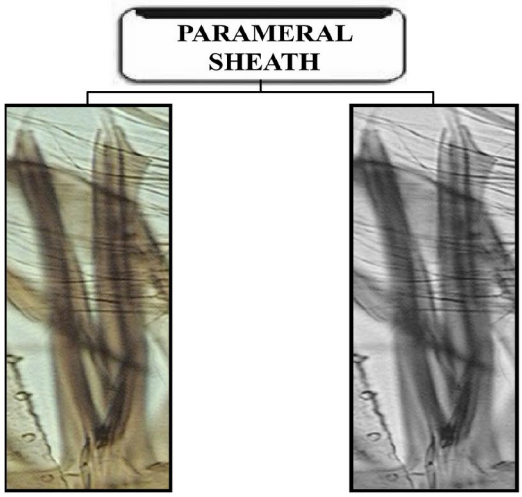
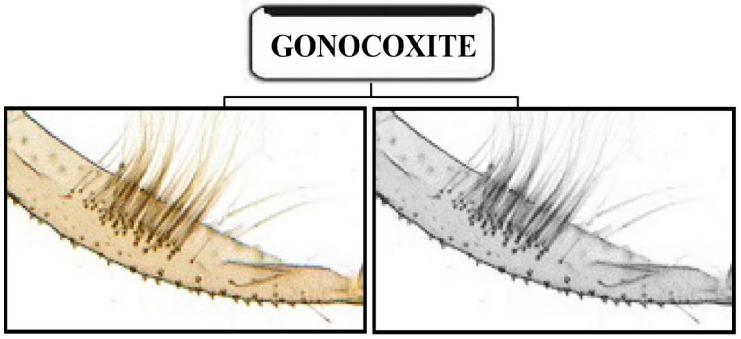


Figure N°35a

Figure N°35b





36. *Phlebotomus balcanicus*
Male

- Antennal formula: 2/III-V and 1/VI-XV.
- Gonocoxite with 90–130 hairs in the median portion.
- Parameral sheath with subapical tubercle 15µm from the apex (Figures N°36a,b).

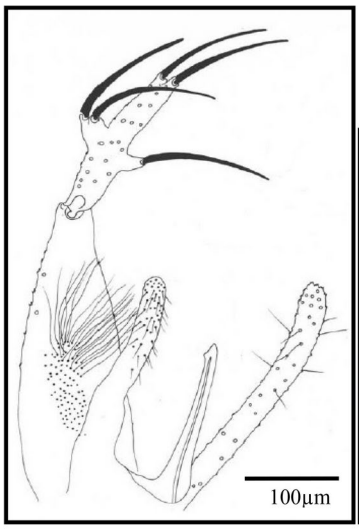


Figure N°36a

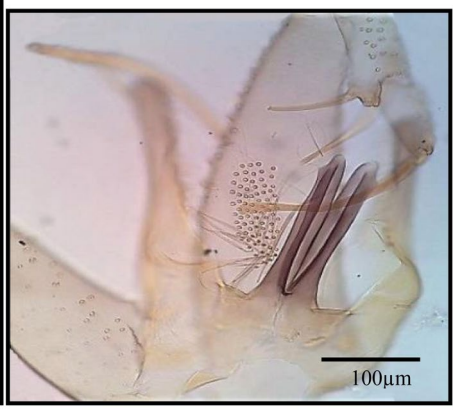
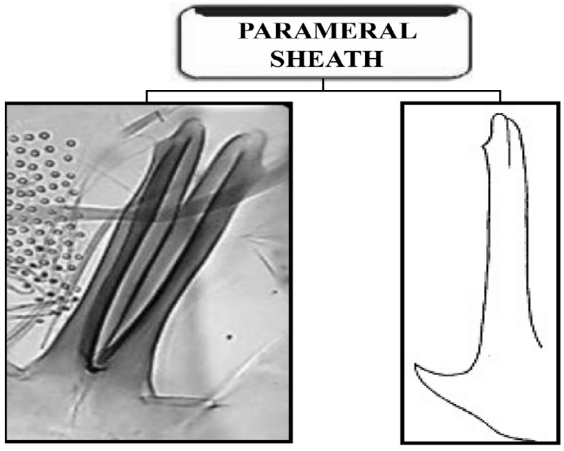
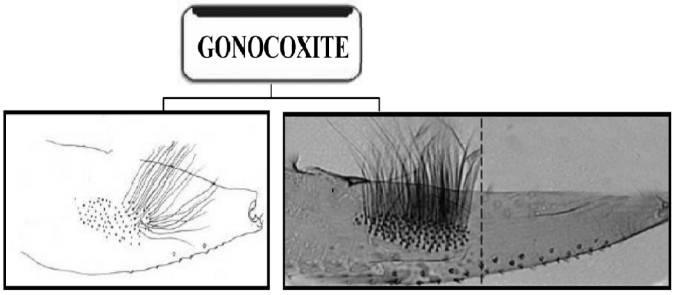


Figure N°36b





37. *Phlebotomus brevis*
Male

- Antennal formula: 2/III-VIII, 1/IX-XV.
- Gonocoxite with 17–27 hairs in its basal portion.
- Parameral sheath with a subapical tubercle at 19–28 µm of the apex (Figures N°37a,b).

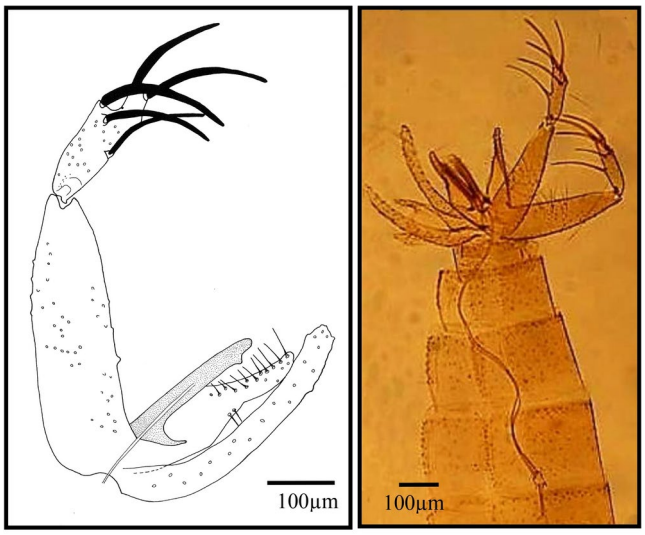
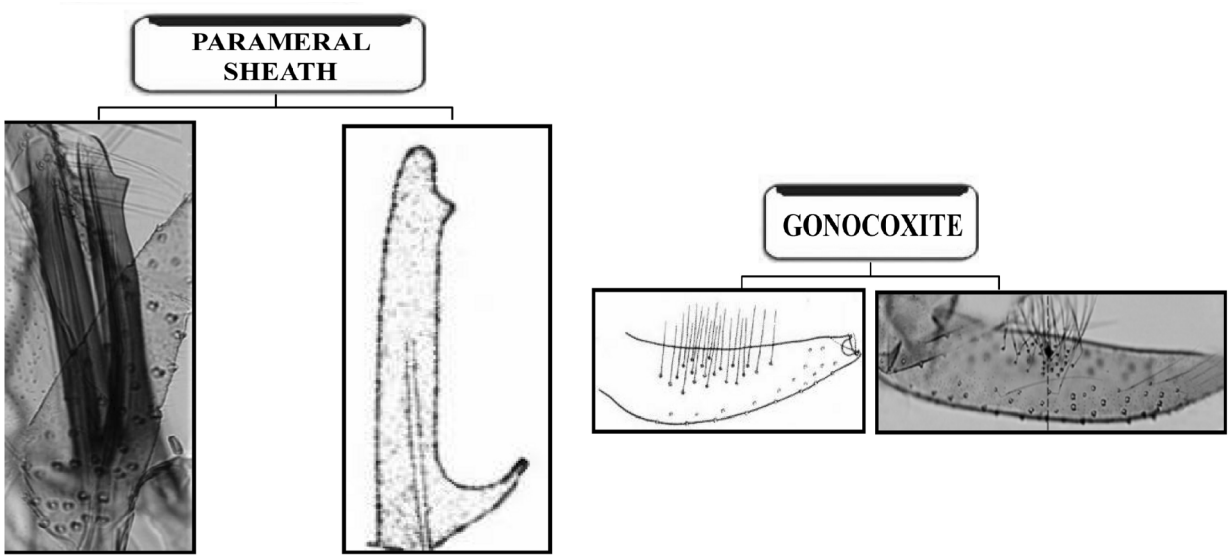


Figure N°37a **Figure N°37b**



38. *Phlebotomus comatus*
Male

- Antennal formula 2/III-V, 1/VI-XV.
- Gonocoxite moderately wide with 125–220 hairs on its basal half.
- Parameral sheath with a subterminal tubercle at 14µm from the end.
- Long genital filaments. Filament/Pump = 7.7 (6.6–8.8) (Figures N°38a,b).

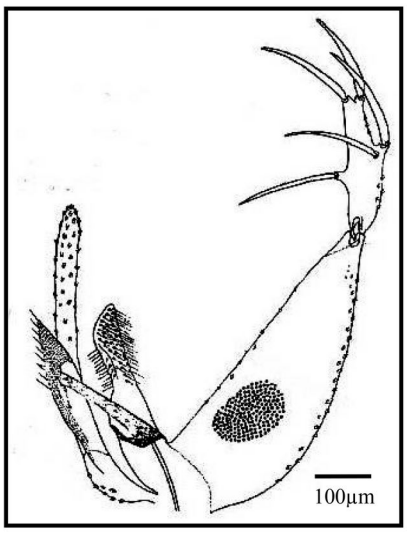
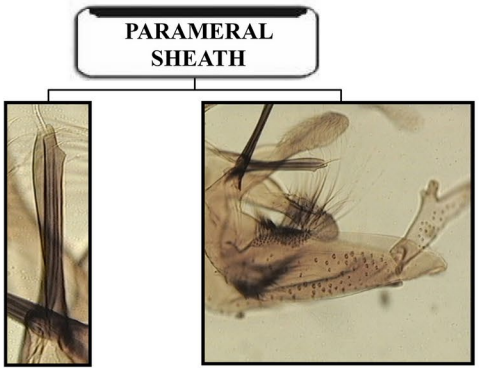
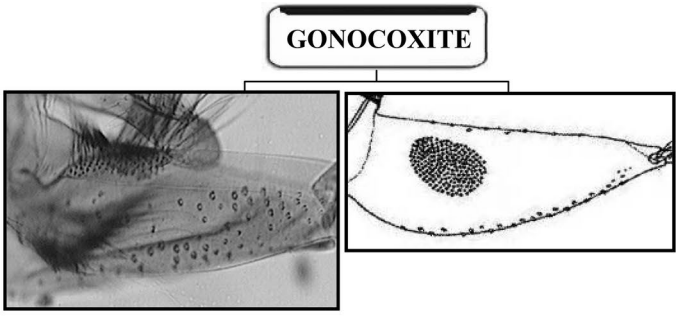


Figure N°38a

Figure N°38b





39. *Phlebotomus creticus*
Male

- Ascoid formula: 2/III, 1/IV-XIII.
- Gonocoxite with 54–85 hairs on internal surface, equally distributed between proximal and distal halves (Figures N°39a,b).

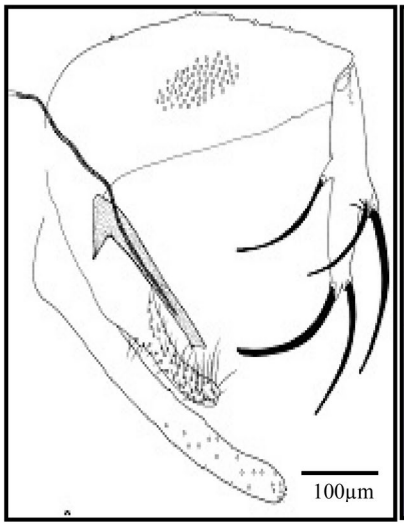
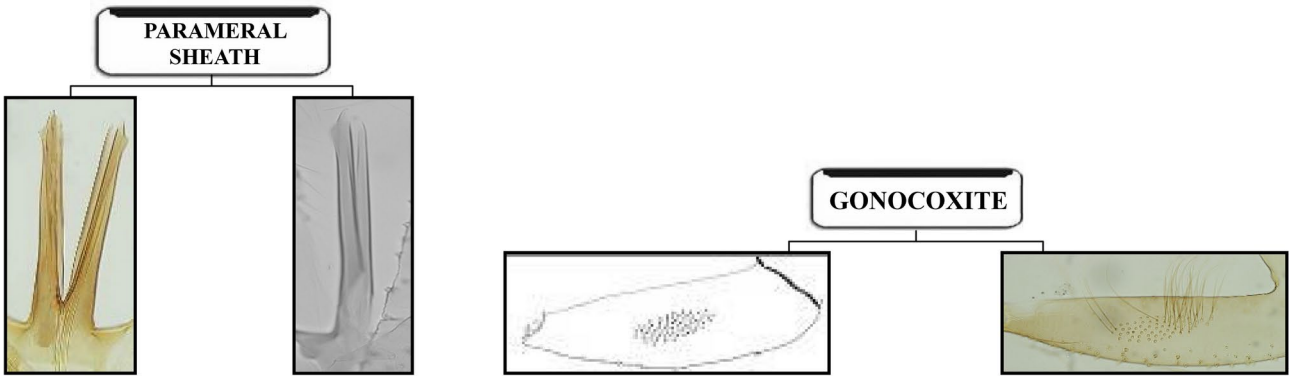


Figure N°39a

Figure N°39b



40. *Phlebotomus halepensis*
Male

- Antennal formula: 2/III-VIII, 1/IX-XV.
- Parameral sheath with a subterminal tubercle forming an angle of 90˚.
- Gonocoxite with 34–53 hairs in middle and basal parts (Figures N°40a,b).

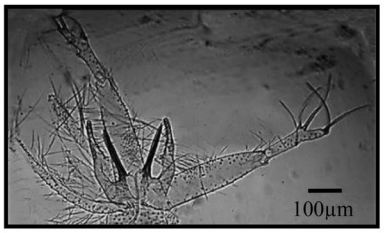
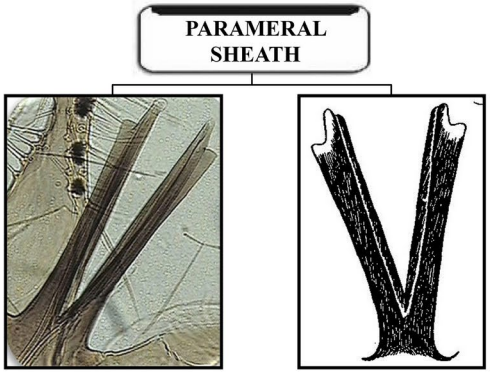
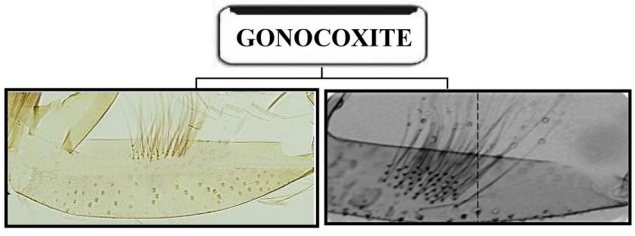


Figure N°40a

Figure N°40b





41. *Phlebotomus kabulensis*
Male

- Antennal formula: 2/III-VIII, 1/IX-XV.
- Gonocoxite moderately wide with 27–50 hairs on its median-basal half.
- Parameral sheath with subterminal tubercle at 14µm from the end.
- Long genital filaments. Filament/Pump = 7.7 (6.6–8.8) (Figures 41a,b).

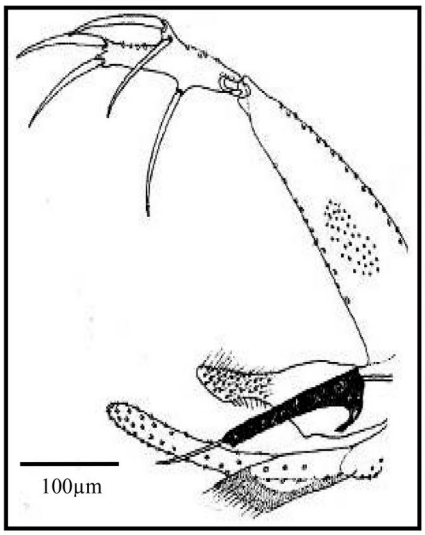


Figure N°41a

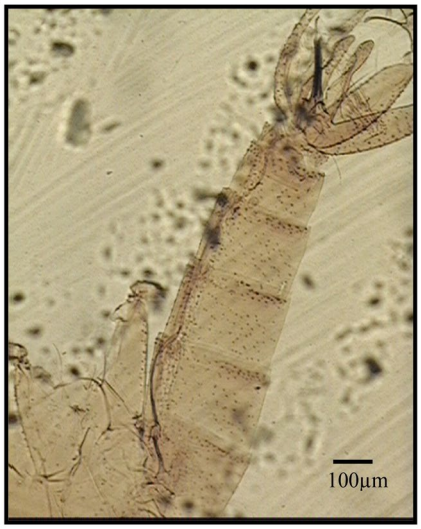
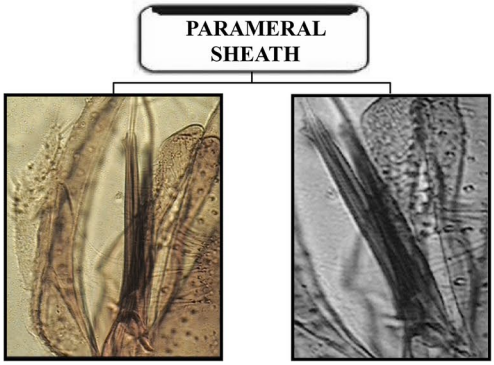
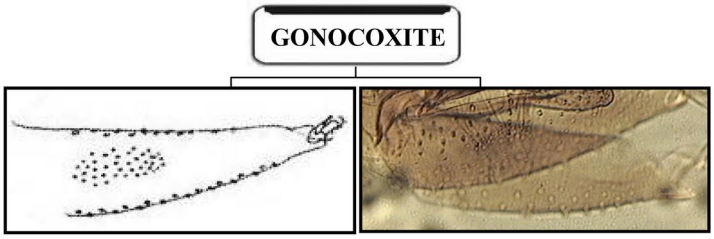


Figure N°41b





42. *Phlebotomus kyreniae*
Male

- Antennal formula: 2/III-V and 1/VI-XV.
- Gonocoxite carrying 30–40 hairs in its median part.
- Parameral sheath with a subterminal tubercle at 10–14µm from the apex (Figures N°42a,b).

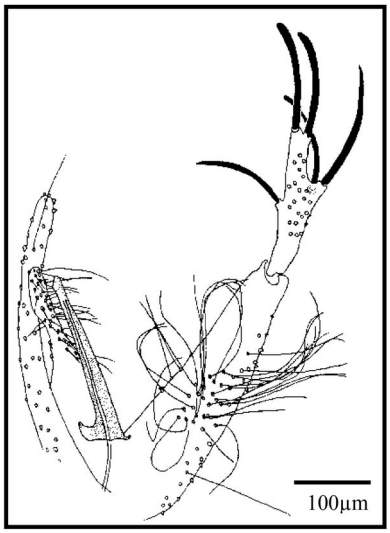


Figure N°42a

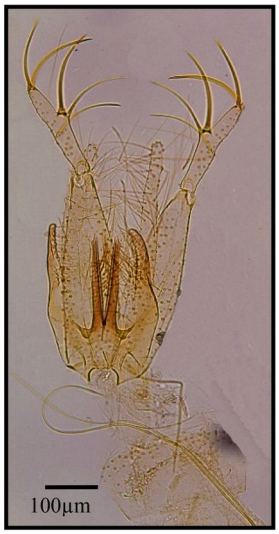
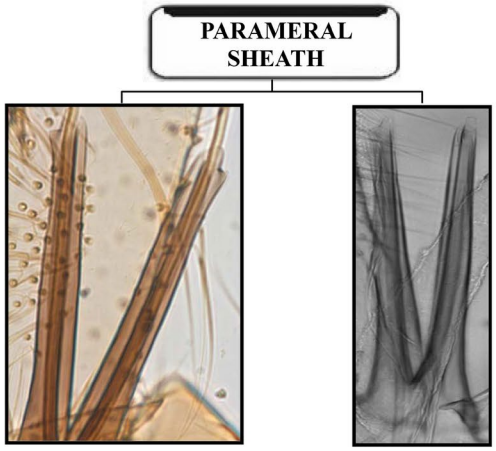
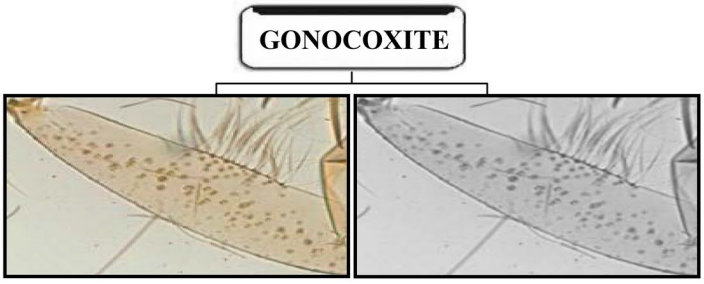


Figure N°42b





43. *Phlebotomus longiductus*
Male

- Antennal formula: 2/III-VIII and 1/IX-XV.
- Gonocoxite with 50–85 hairs in its middle.
- Parameral sheath with subterminal tubercle at 12–24µm from the apex.
- Very long genital filaments (1200–1700µm) (Figures N°43a,b).

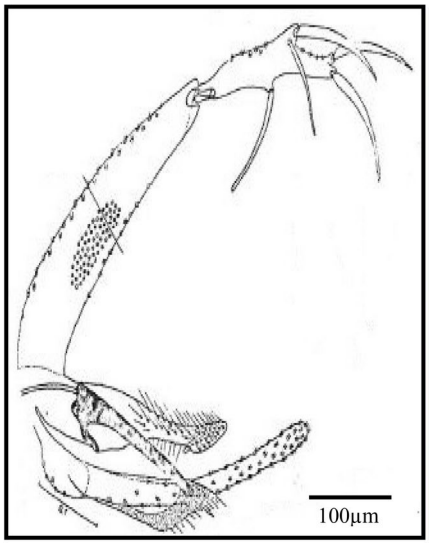
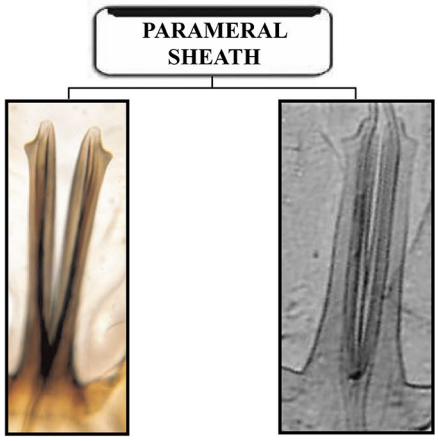
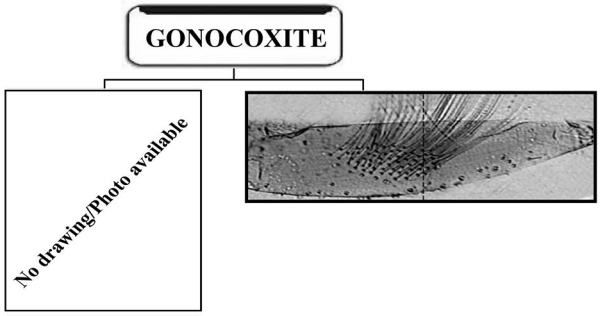


Figure N°43a

Figure N°43b





44. *Phlebotomus naqbenius*
Male

- Antennal formula: 2/III-VIII, 1/IX-XV, A3 = 400 µm.
- Gonocoxite with 54–98 hairs in the proximal part.
- Parameral sheath with a subterminal tubercle at 20µm from the apex (Figures N°44a,b).

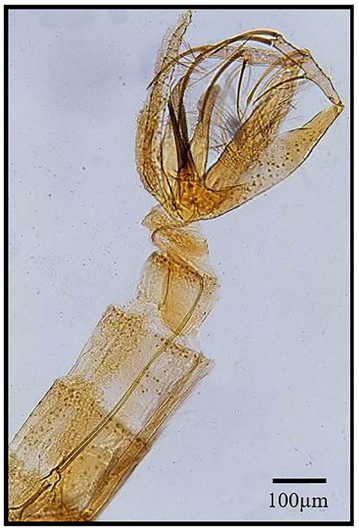


Figure N°44a

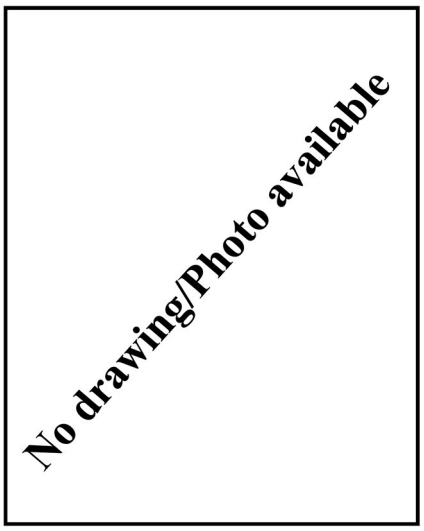
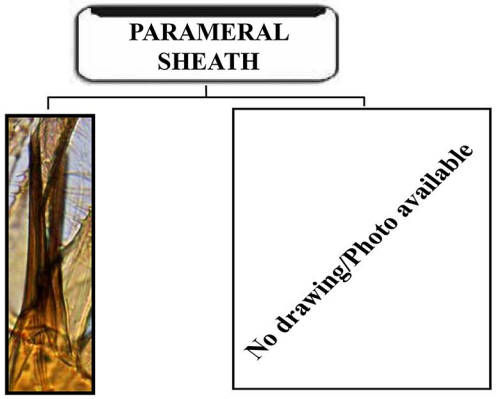
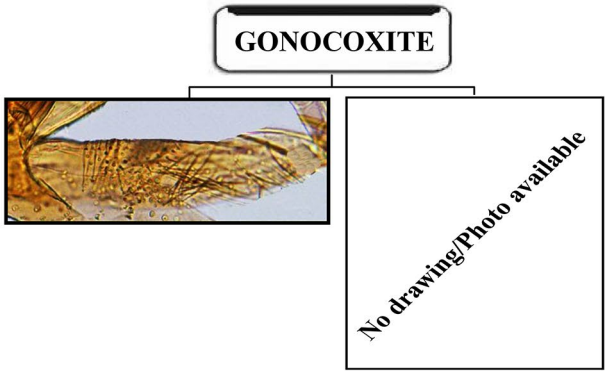


Figure N°44b





45. *Phlebotomus salangensis*
Male

- Antennal formula 2/III-V, 1/VI-XV.
- Gonocoxite moderately wide with 40–85 hairs on the basal half.
- Parameral sheath with subterminal tubercle at 10–20µm from the end.
- Long genital filaments. Filament/Pump = 7.7 (6.6–8.8) (Figures N°45a,b).

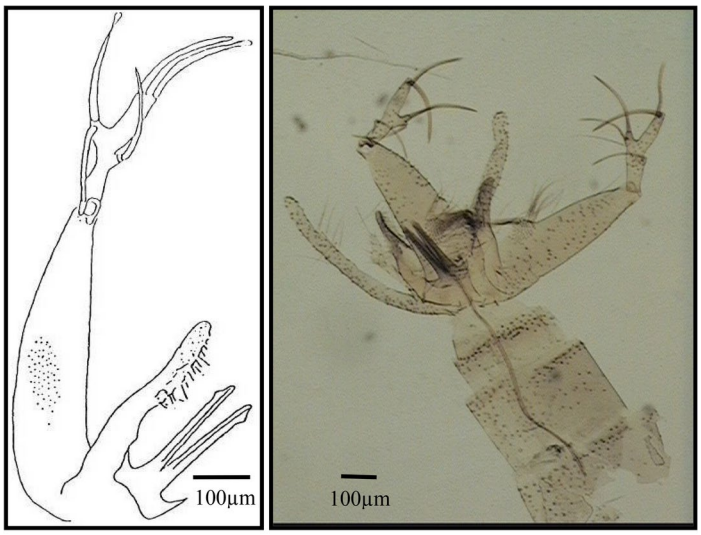
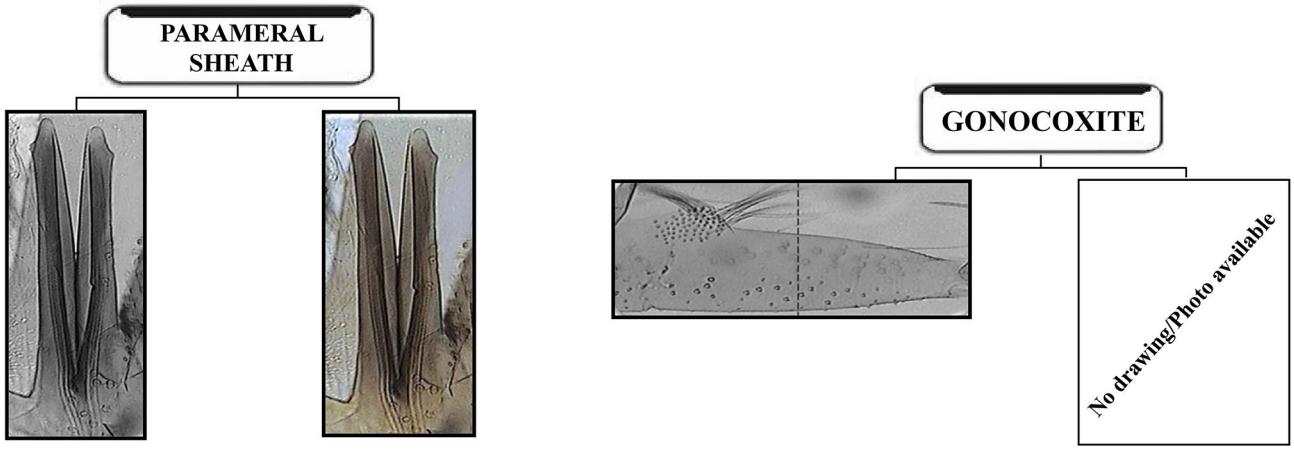


Figure N°45a **Figure N°45b**



46. *Phlebotomus simici*
Male

- Antennal formula: 2/III-VX.
- Gonocoxite with 20 internal hairs.
- Parameral sheath with a subapical tubercle at 6–8 µm from the apex (Figures N°46a,b).

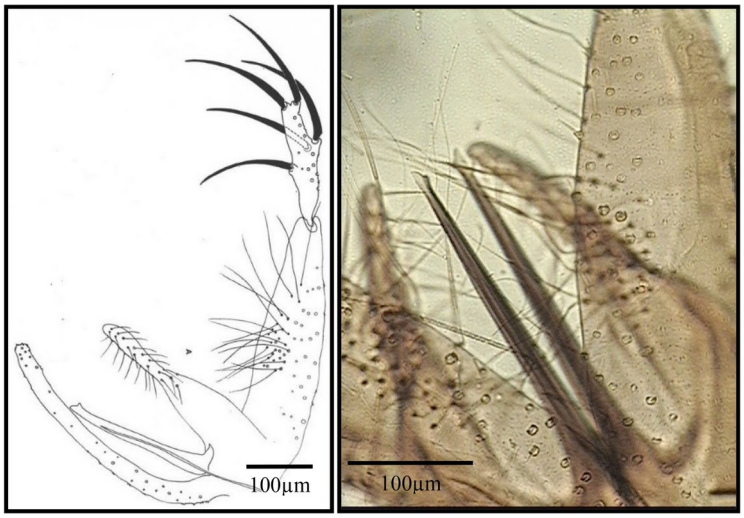
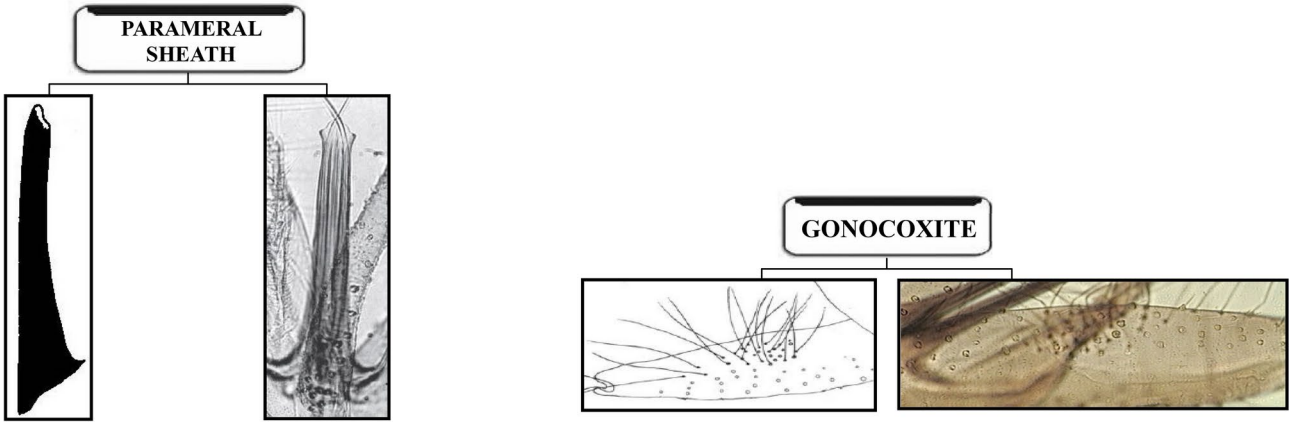


Figure N°46a **Figure N°46b**



47. *Phlebotomus turanicus*
Male

- Antennal formula: 2/III-VIII, 1/IX-XV.
- Gonocoxite with 17–27 hairs on basal and distal halves.
- Parameral sheath with subterminal tubercle at 6–16µm from the end.
- Long genital filaments. Filament/Pump = 7.8 (6.6–8.9) (Figures N°47a,b).

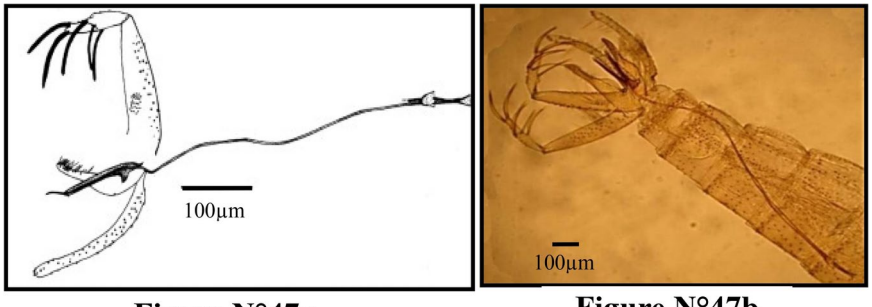
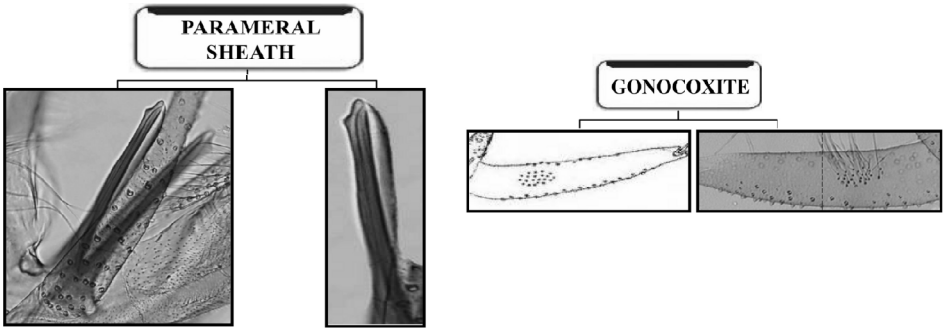


Figure N°47a **Figure N°47b**



Subgenus *Synphlebotomus*

Male: Short gonostyle, with 5 long spines, of which 2 terminals and 3 medians; short conical parameral sheath.
Female: Pharyngeal armature appears as irregular lines of small and large teeth. Segmented spermathecae, without enlarged terminal segment. Antennal formula: 2/III-XV.
Type: *Phlebotomus martini* Parrot, 1936

48. *Phlebotomus ansarii*
Male

- Wide gonocoxite with a long thick basal process, and long hairs on its ventral top.
- Paramere and parameral sheath similar to *Paraphlebotomus* (Figures N°48a,b).

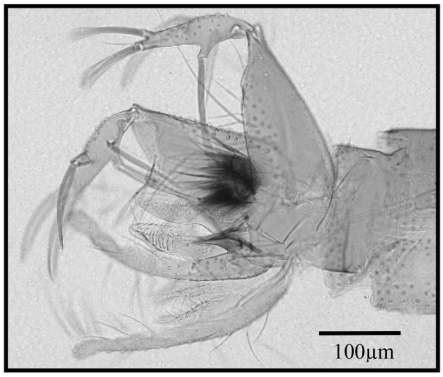
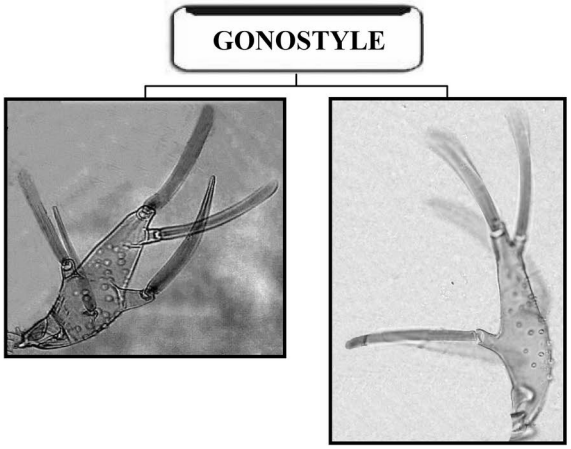
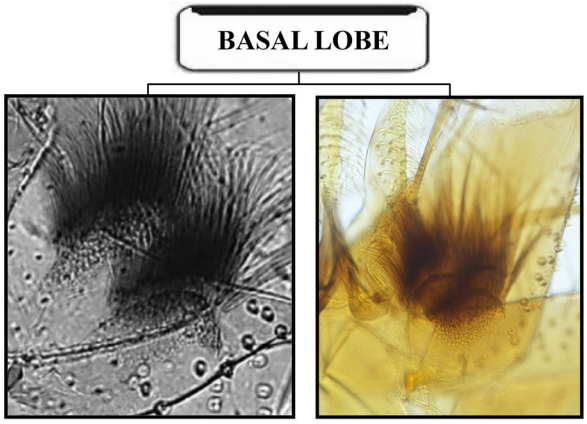


Figure N°48a

Figure N°48b





Female

- Pharynx with numerous rows of punctiform teeth.
- Spermatheca with 13 uniform segments and a narrow head (Figures N°48c,d).

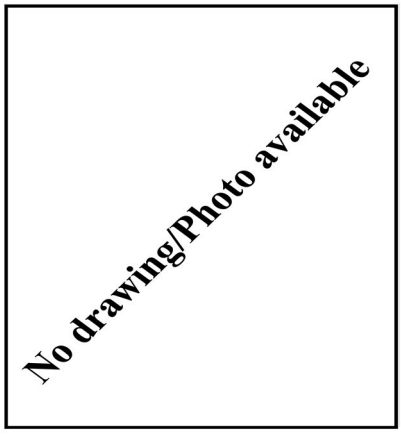


Figure N°48c

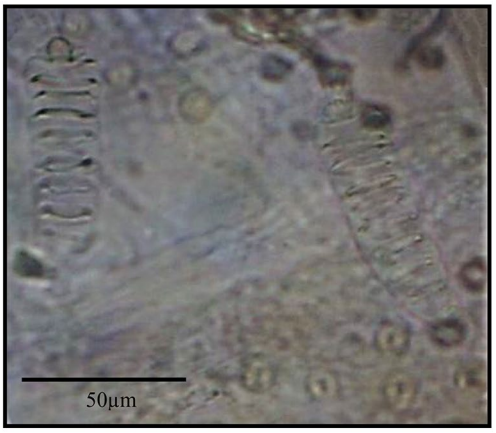
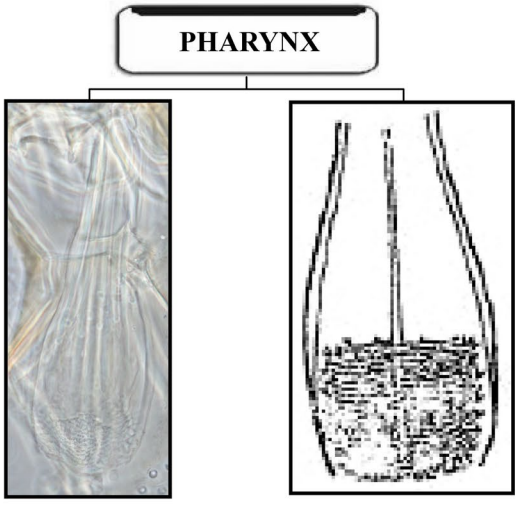
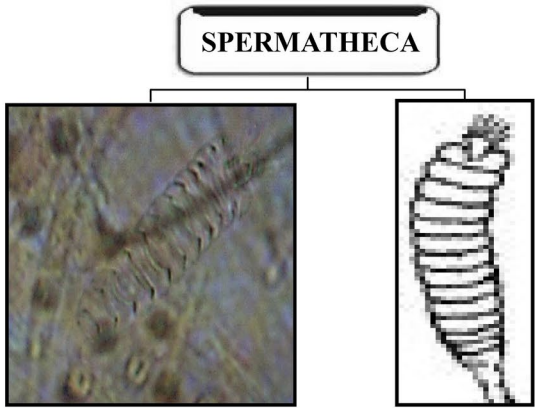


Figure N°48d





49. *Phlebotomus eleanorae*
Male

- Wide gonocoxite with a short and narrow basal lobe and 12 hairs at its end.
- Paramere and parameral sheath similar to *Paraphlebotomus* (Figures N°49a,b).

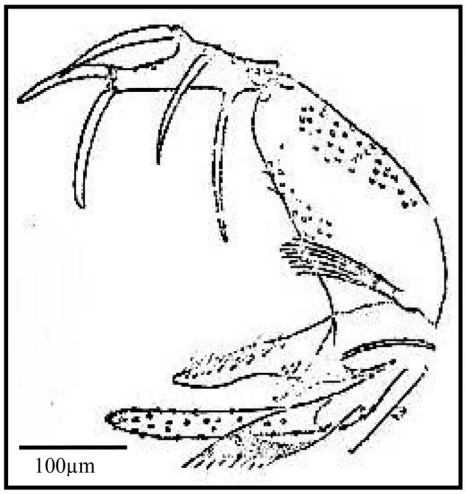
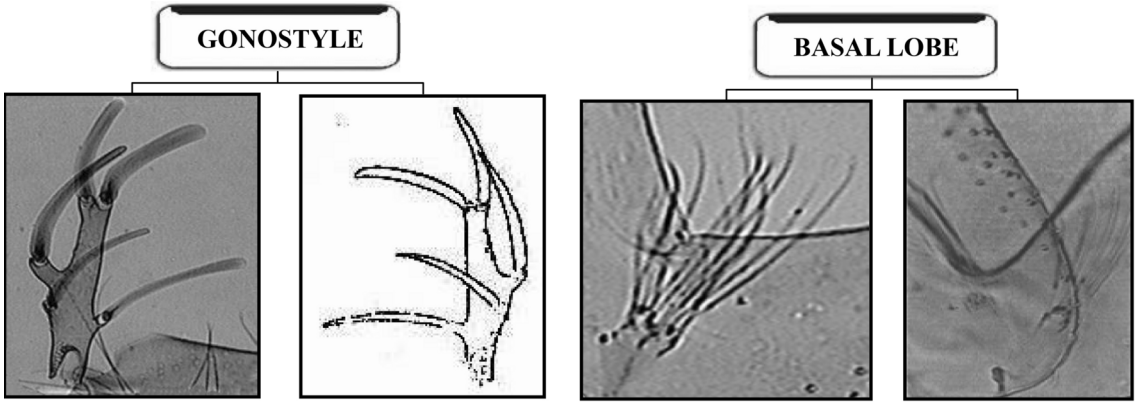


Figure N°49a

Figure N°49b



Female

- Pharynx with coarse pigmented teeth, pharyngeal armature projecting forward at a straight angle.
- Cylindrical spermatheca with 9 segments, a narrow head, and long separated ducts (Figures N°49c,d).

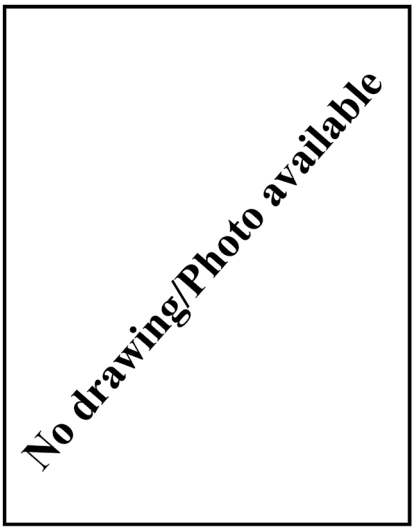


Figure N°49c

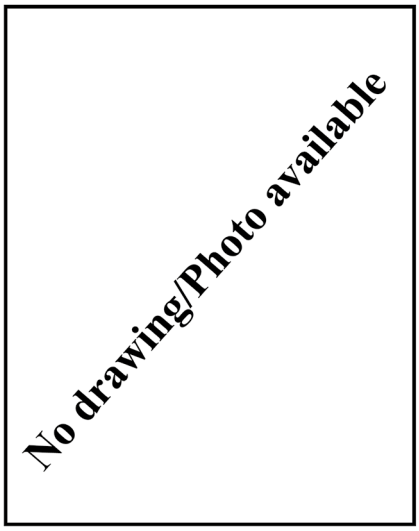
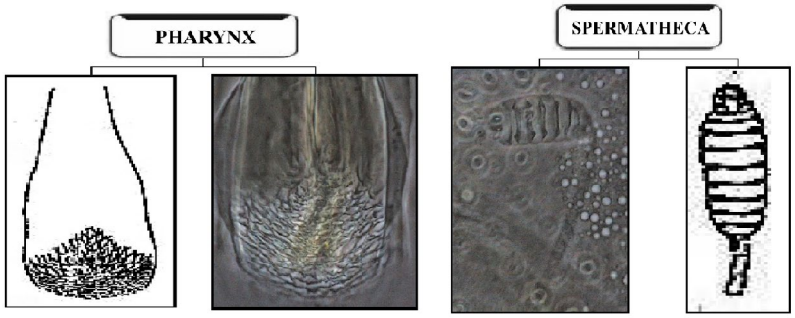


Figure N°49d

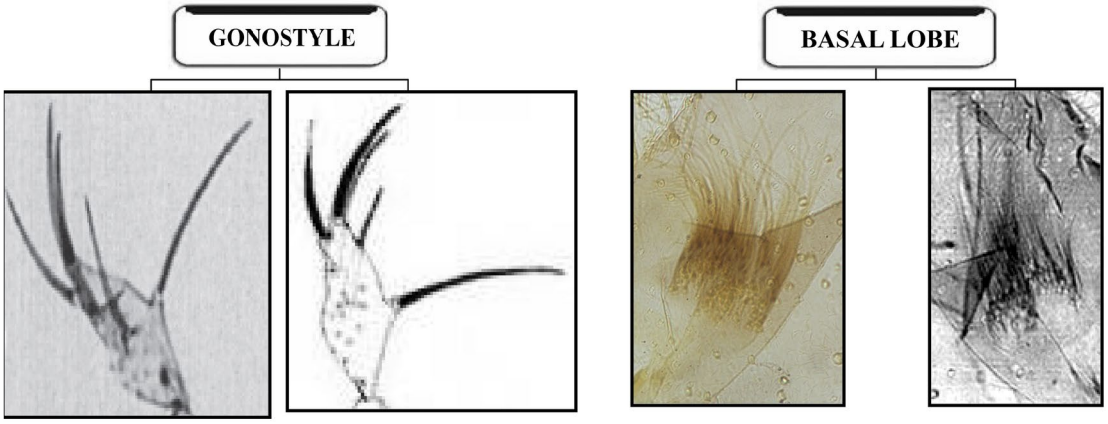


50. *Phlebotomus saltiae*
Male

- Antennal formula: 2/III-XV.
- Gonocoxite has an asymmetric basal lobe with 20 short hairs.
- Parameter ending in a rounded tip with short and fine hairs.
- Filament/Pump = 1.6 (Figures N°50a,b).

Figure N°50a

Figure N°50b



Female

- Antennal formula: 2/III-XIII.
- Pharynx moderately armed with large saw teeth.
- 6 segmented spermatheca with a tulip-shaped or flame-shaped head.
- Mesanepisterne carrying 1 or 2 antero-inferior hairs (Figures N°50c,d).

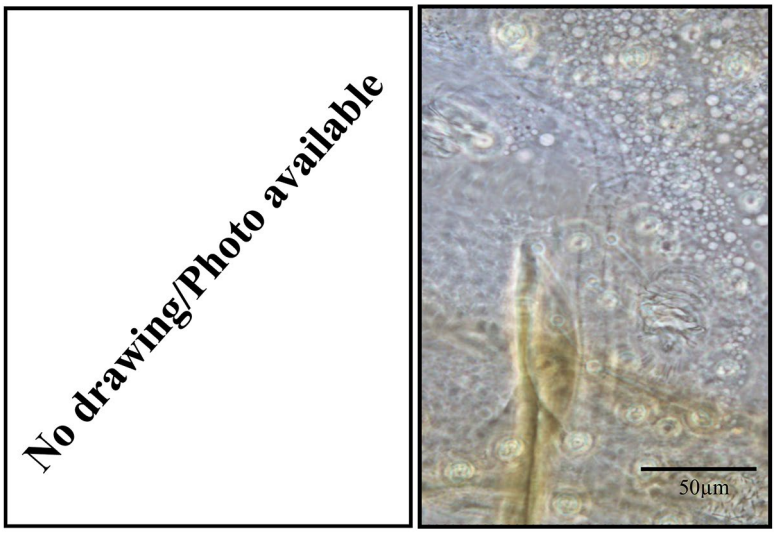
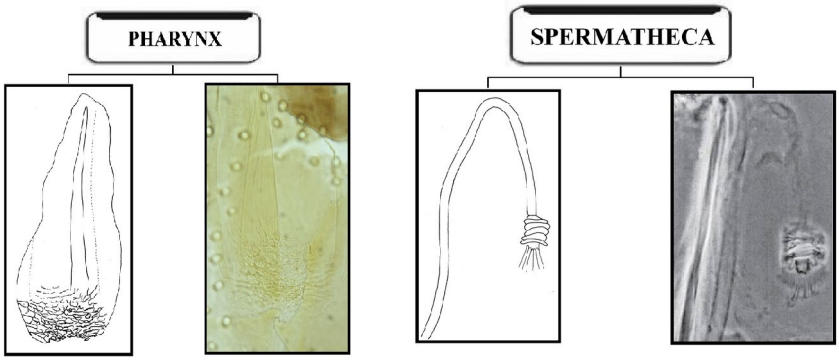


Figure N°50c **Figure N°50d**



Subgenus *Euphlebotomus*

Male: Gonocoxite without basal lobes. Gonostyle with 5 spines, and paramere with 3 lobes. Short and conical parameral sheath.
Female: Pharyngeal armature with small teeth in the middle and rows of lines at the basis. Spermathecae segmented with enlarged terminal segment. Antennal formula: 2/III-XV.
Type: *Phlebotomus argentipes* Annandale & Brunetti, 1908

51. *Phlebotomus mesghalii*
Male

- Pharynx with coarse teeth obliquely arranged, small ones in irregular rows.
- Cylindrical gonocoxite with 12–14 long ventral hairs.
- Paramere with a short and elegant ventral process.
- Parameral sheath bowed downward, with brushed side located on the right.

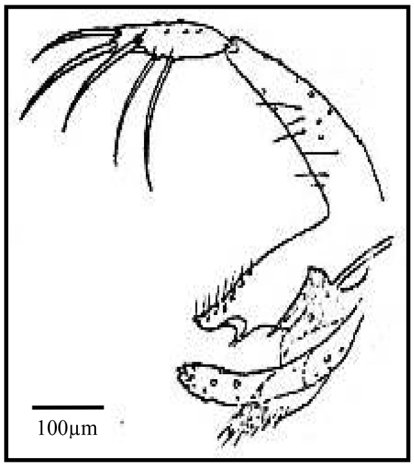


Figure N°51a

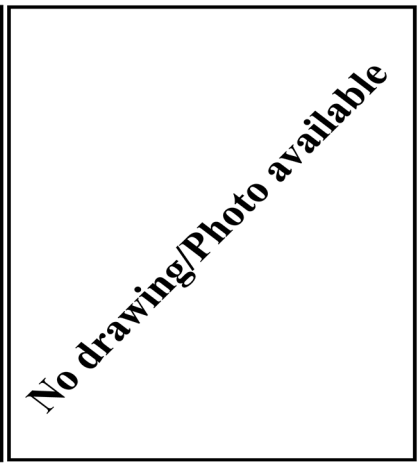
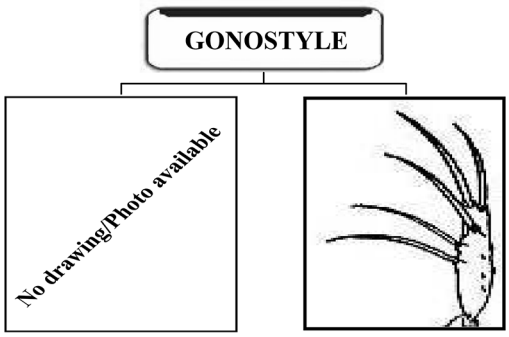
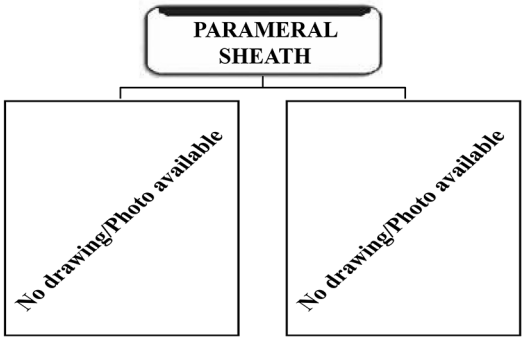


Figure N°51b





Female

- Pharyngeal armature with reinforced and colored teeth in the middle.
- Short spermatheca with a large apical segment and 15 indistinct segments (Figures N°51c,d).

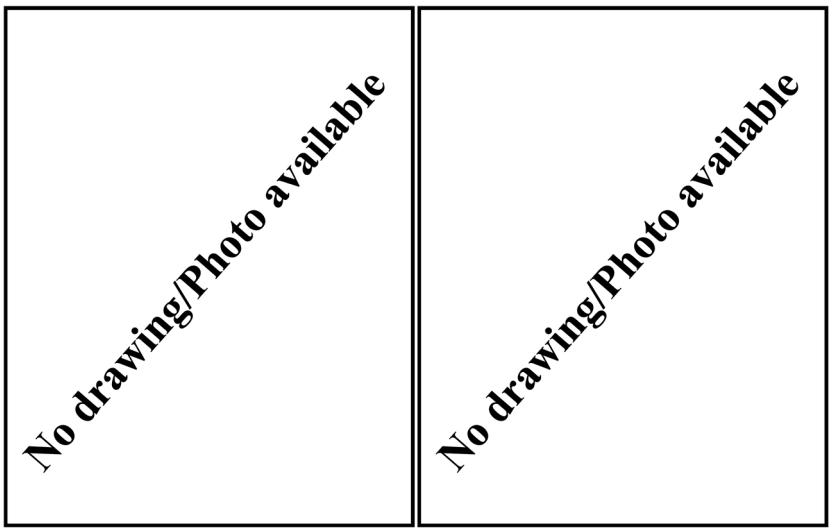
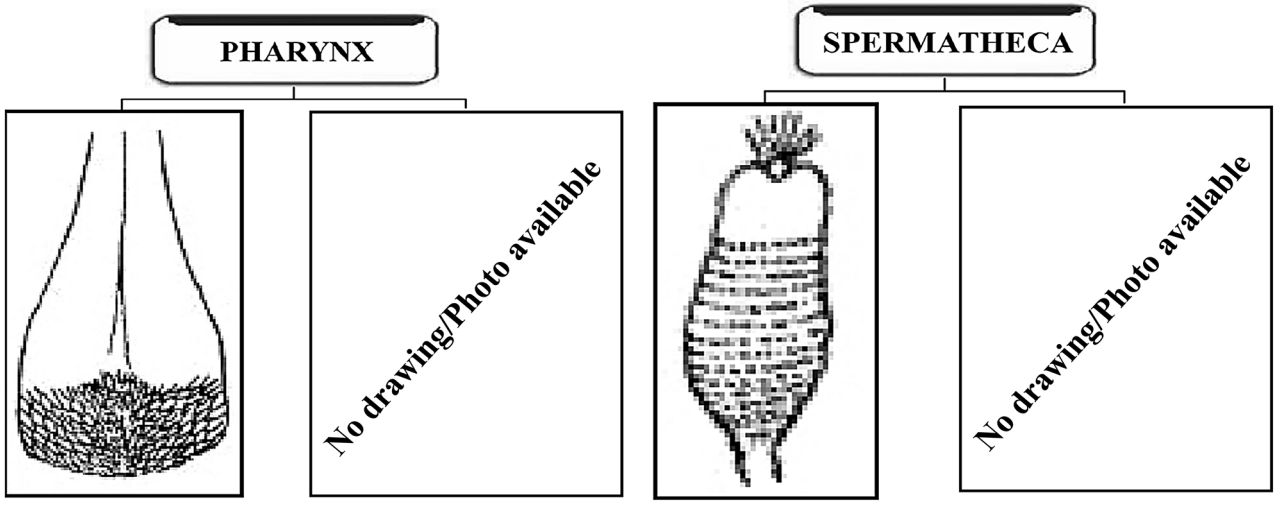


Figure N°51c **Figure N°51d**



52. *Phlebotomus nadimi*
Male

- A3 = A4 + A5.
- Pharyngeal armature covers about 1/5 of the length of the pharynx and consists of parallel dotted lines rows.
- Finger-shaped paramere narrowing at 1/3 with a small narrow process and a visible ventral tubercle.
- Parameral sheath with straight lateral spins and a bent-down end (Figures N°52a,b).

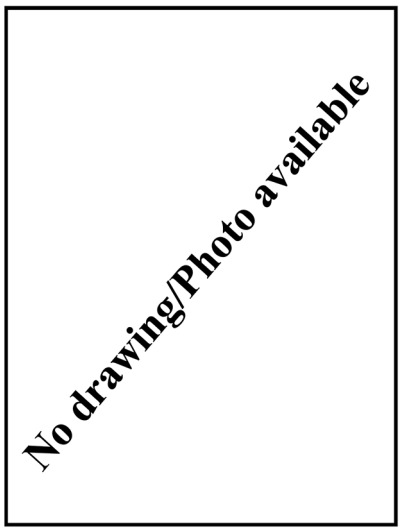
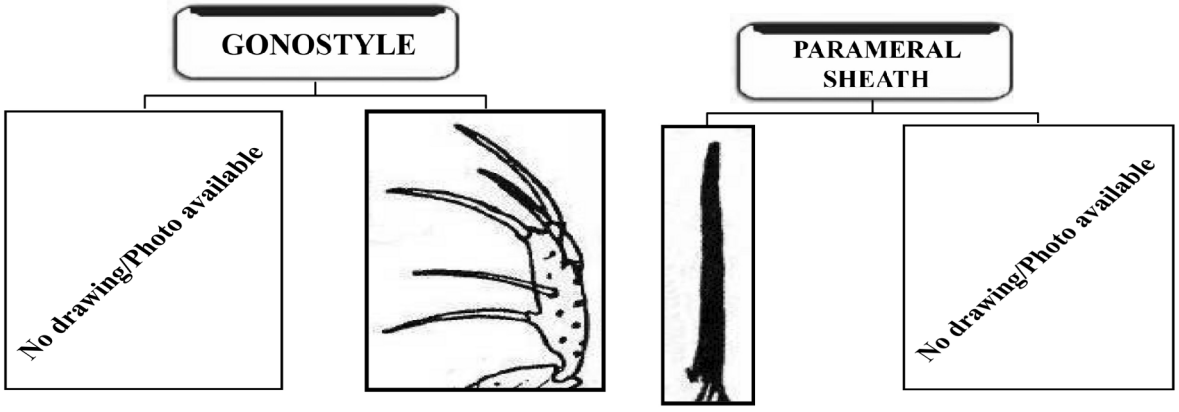


Figure N°52a **Figure N°52b**



Female

- Undescribed.

Subgenus *Transphlebotomus*

Male: Gonostyle with 5 (2 terminals and 3 medians) spines. Stocky parameral sheath, tapering slightly with a blunt tip.
Female: Pharynx with large irregular teeth. Spermatheca not segmented with transverse striation in the distal part possessing a wide duct but without neck.
Type: *Phlebotomus mascitii* Grassi, 1908

53. *Phlebotomus anatolicus*
Male

- Third antennal segment < 300 µm.
- AIII > AIV + AV, Antennal formula: 2/III–XI, 1/XII–XIII.
- Pharynx with a well-developed pharyngeal armature occupying the 1/4 of the pharynx. Longer anterior teeth, and dot-like posterior ones.
- Gonocoxite with 26–38 densely grouped hairs in the middle.
- Genital filaments/pump ratio: 3.46.
- Surgonostyle longer than the gonocoxite (Figures N°53a,b).

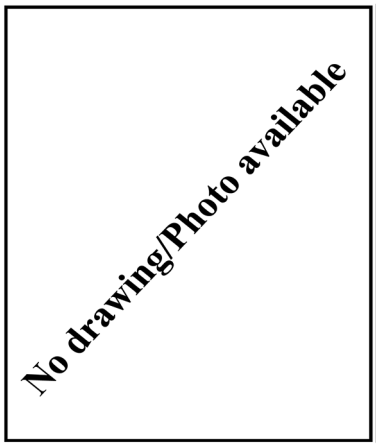


Figure N°53a

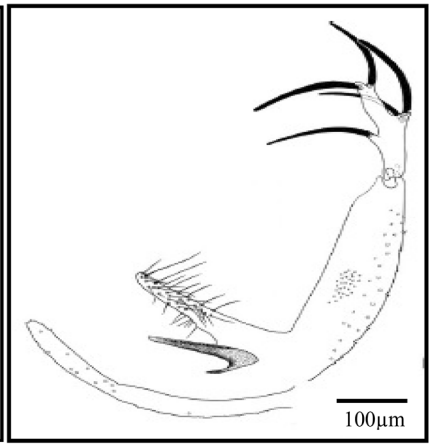
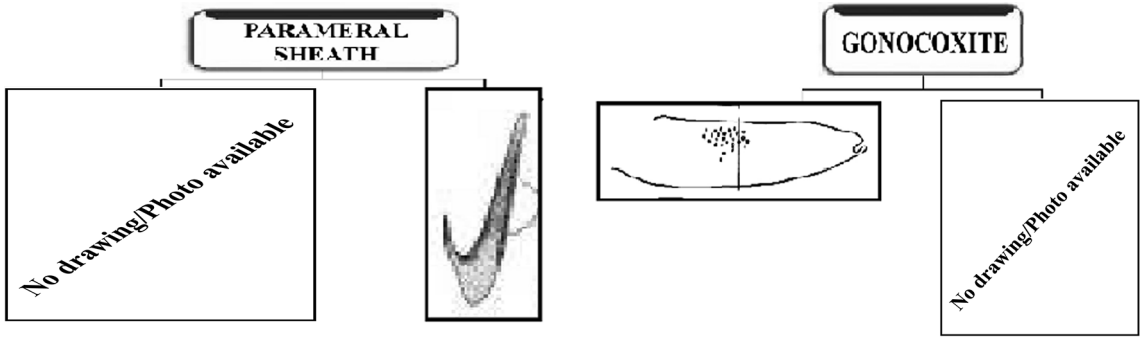


Figure N°53b



Female

- AIII > AIV + AV, Antennal formula: 2/III–XV.
- Well-developed pharyngeal armature occupying the last third of the pharynx. Two types of teeth.
- Cylindrical and striated spermatheca with a round-shaped head (Figures N°53c,d).

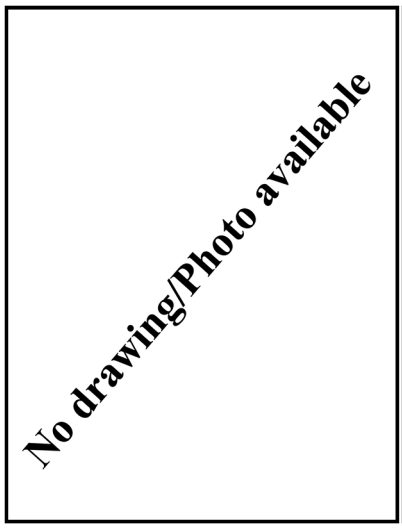


Figure N°53c

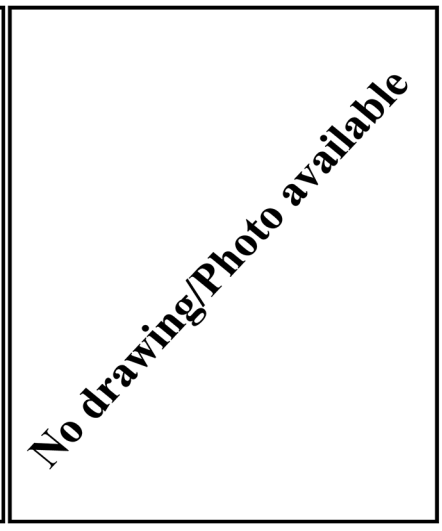
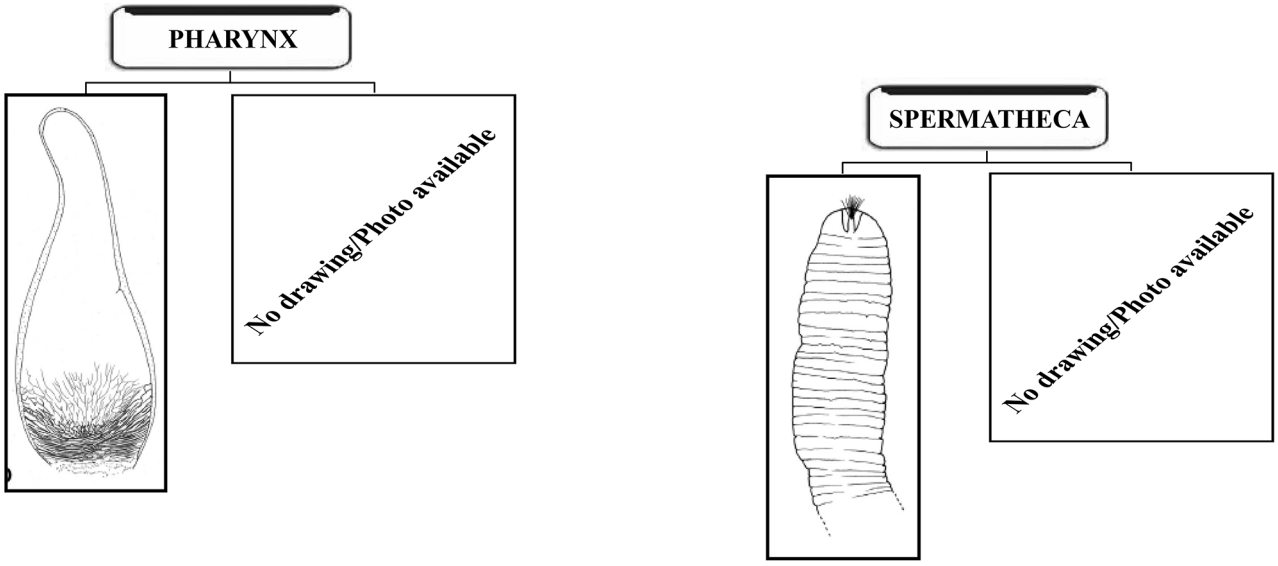


Figure N°53d



54. *Phlebotomus canaaniticus*
Male

- Differs from *Ph. mascittii* by shorter AIII (300-400 µm, comparing to 450 µm for *Ph. mascittii*) and the gonostyle/gonocoxite length ratio < 0.5 (> 0.5 in *Ph. mascittii*).
- Gonocoxite with a tuft of 21–27 hairs.
- Parameral sheath ending in a blunt point (Figures N°54a,b).

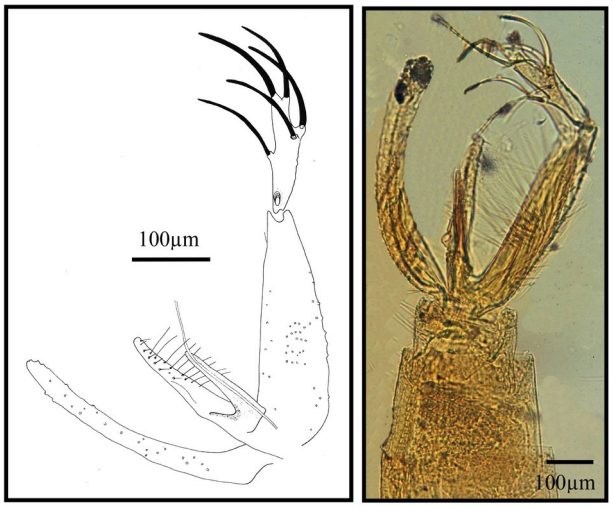
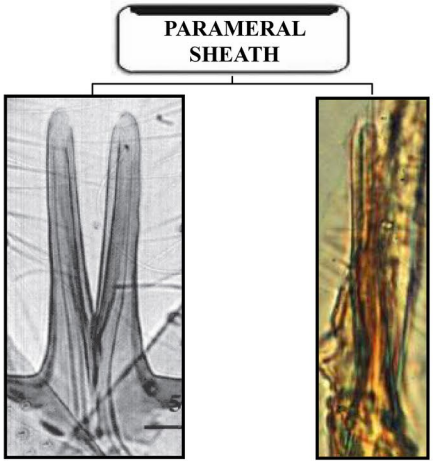
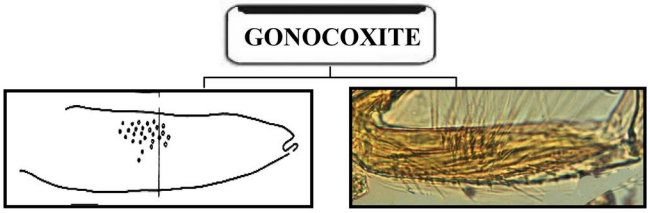


Figure N°54a **Figure N°54b**





Female

- Striated spermatheca opening, swollen duct in its proximal part.
- Second and third palpes longer than *Ph. mascittii*.

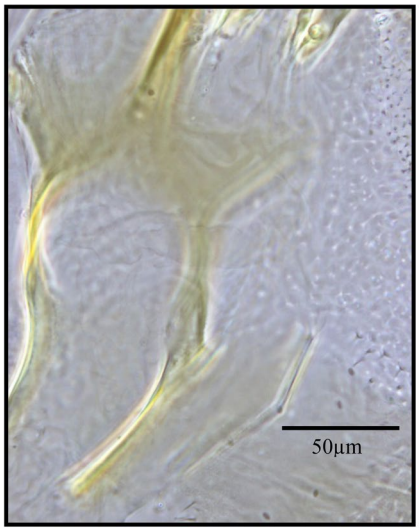


Figure N°54c

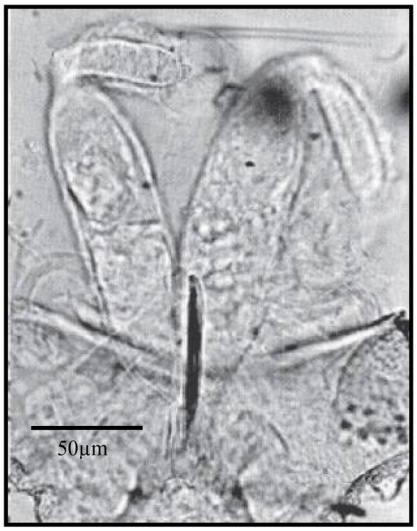
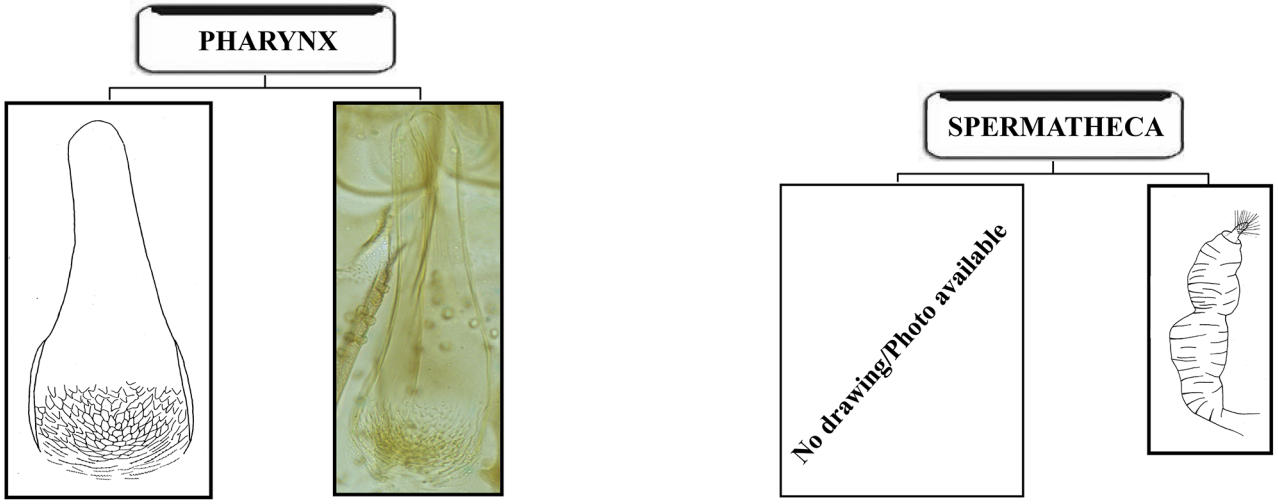


Figure N°54d



55. *Phlebotomus economidesi*

Male

- AIII = (369–457 µm) > AIV + AV.
- Parameral sheath often narrowed in its middle, ending with a rounded foam tip. Filament/pump = 3–4.5.
- Gonocoxite > 300 µm with 35–40 hairs.
- Gonostyle > 200 µm with 4–6 spines.
- Surgonostyle slightly longer than gonocoxite (Figures N°55a,b).

Figure N°55a

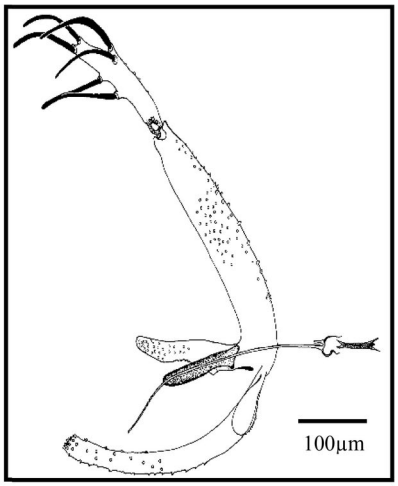
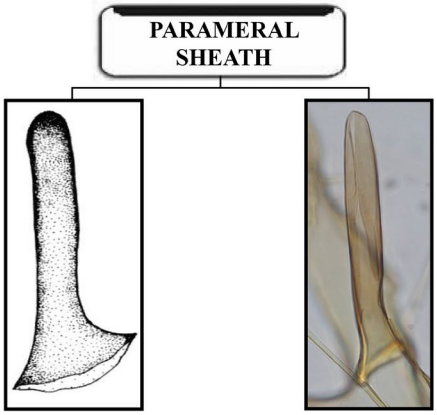
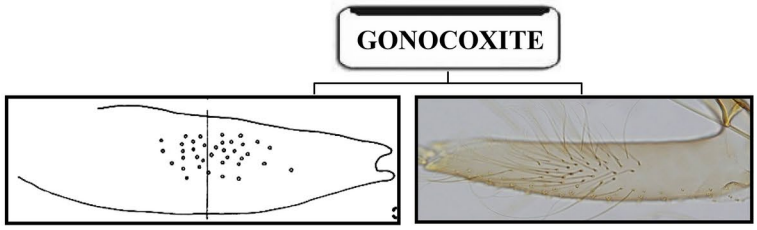


Figure N°55b





Female

- Antennal formula: 2/III-XV, A3 (AIII = 333-411µm) > AIV + AV.
- Pharyngeal framework not extensive, narrowing distally with candle-light scales arranged in circle arcs oriented towards the center. Few anterior scales.
- Spermatheca with a double-walled striated cylindrical body, zigzag ridged. Prominent sessile head surrounded by a circular bead. Wide and short individual duct, with transversely ridged walls (Figures N°55c,d).

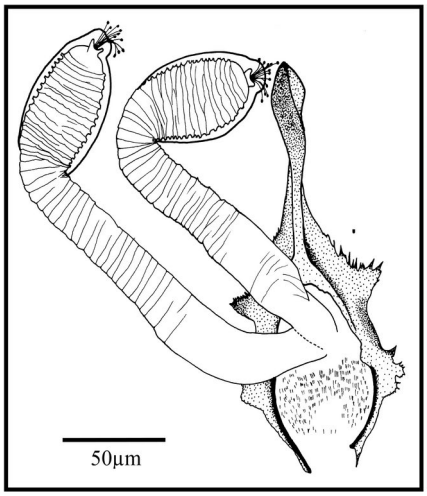


Figure N°55c

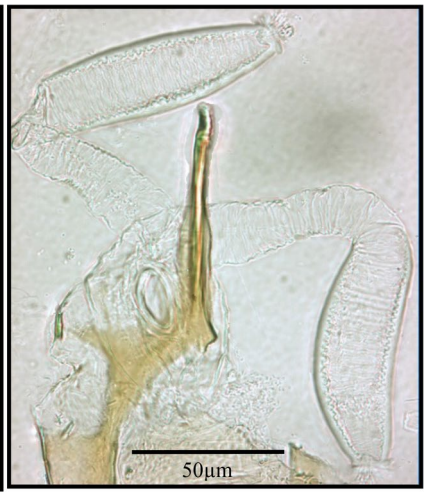
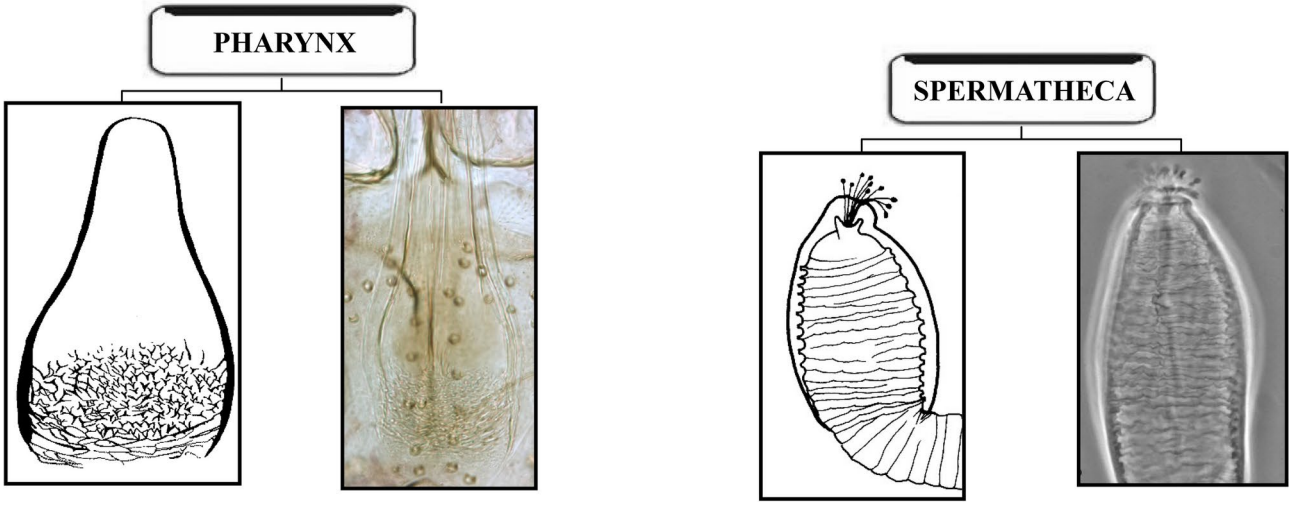


Figure N°55d



56. *Phlebotomus killicki*

Male

- A3 > A4 + A5, third antennal segment > 300 µm.
- Antennal formula: 2/III-XV.
- Thin Pharynx with a well-developed pharyngeal armature occupying its last third. Anterior teeth pointed and oriented back, and fot-like posterior ones, tighter against each other than the anterior ones.
- Gonocoxite length < 300 µm with 10–21 scattered hairs in middle and distal parts (Figures N°56a,b).

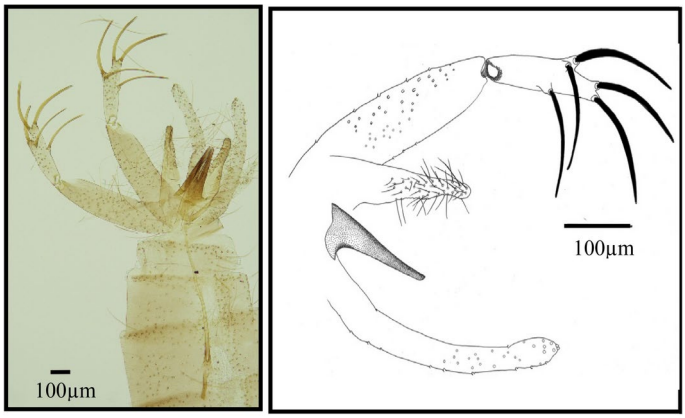
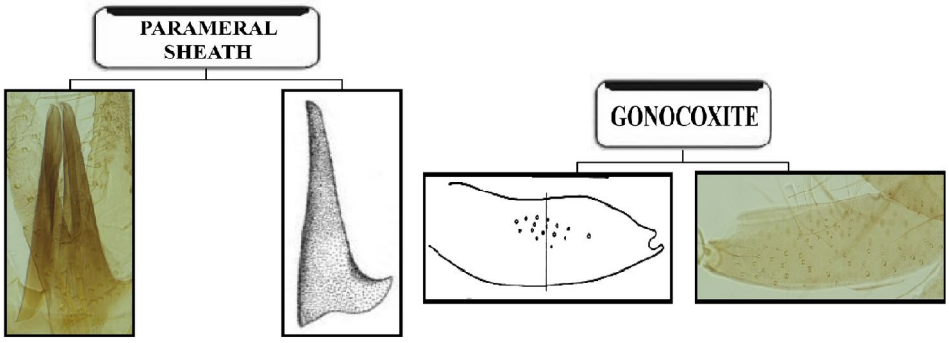


Figure N°56a **Figure N°56b**



Female

- A3 > AIV + AV, antennal formula: 2/III–XV.
- Well-developed pharyngeal armature occupying the last third of the pharynx. Anterior teeth relatively long and dot-like posterior ones (Figures N°56c,d).

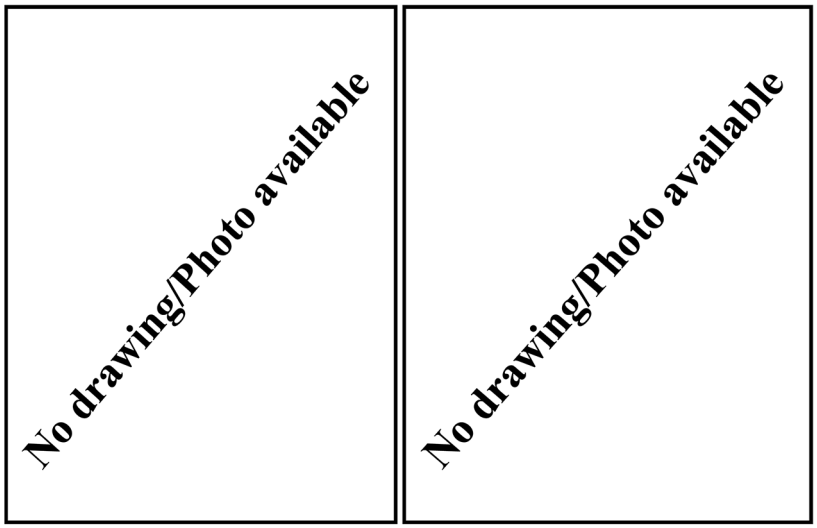
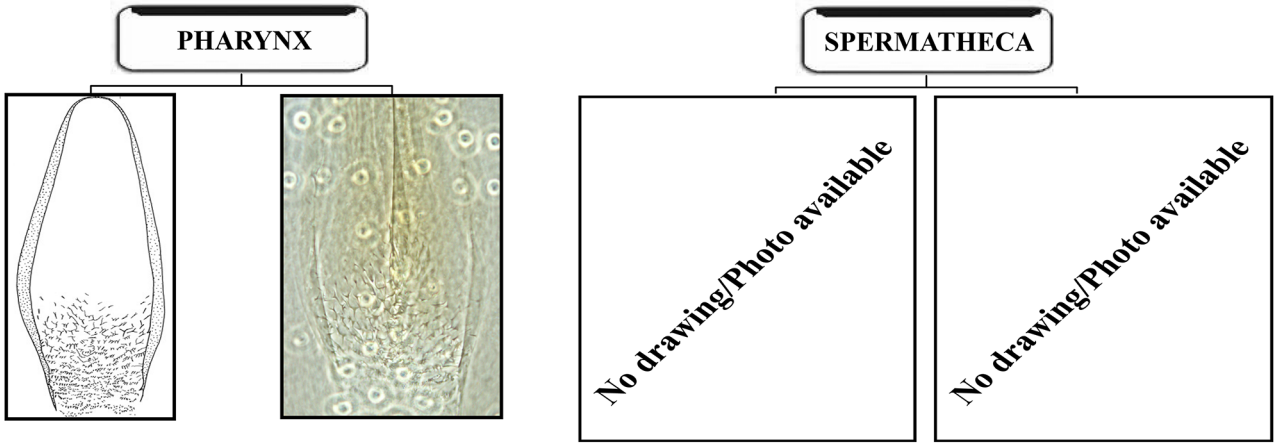


Figure N°56c **Figure N°56d**



57. *Phlebotomus mascitti*
Male

- Parameral sheath tapered regularly and terminated by a foam tip, indistinguishable from *Ph. canaaniticus*.
- Longer AIII (450 µm versus 300–400 µm in *Ph. canaaniticus*).
- Gonostyle/gonocoxite length > 0.5 (< 0.5 in *Ph. canaaniticus*).
- Gonocoxite with a tuft of 35–45 medial hairs (Figures N°57a,b).

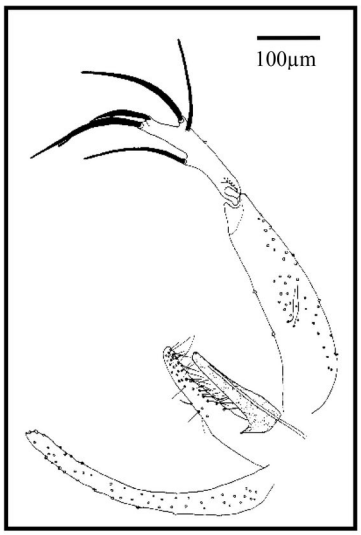
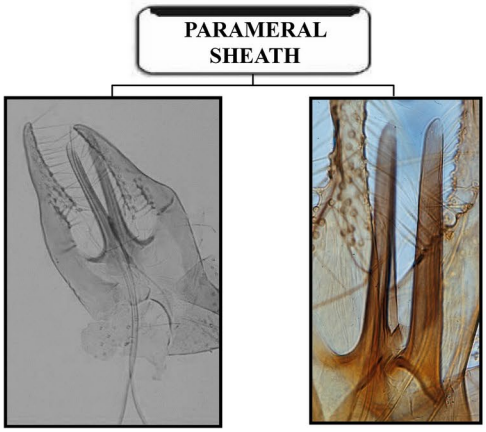
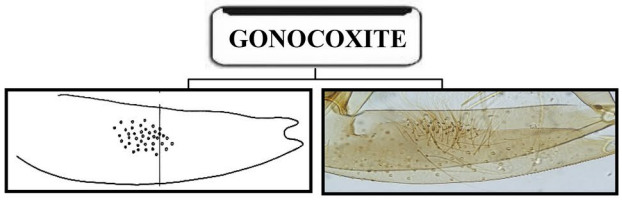


Figure N°57a

Figure N°57b





Female

- Striated spermatheca opening into a swollen duct in the proximal part.
- Second and third palpes shorter than *Ph. canaaniticus* (Figures N°57c,d).

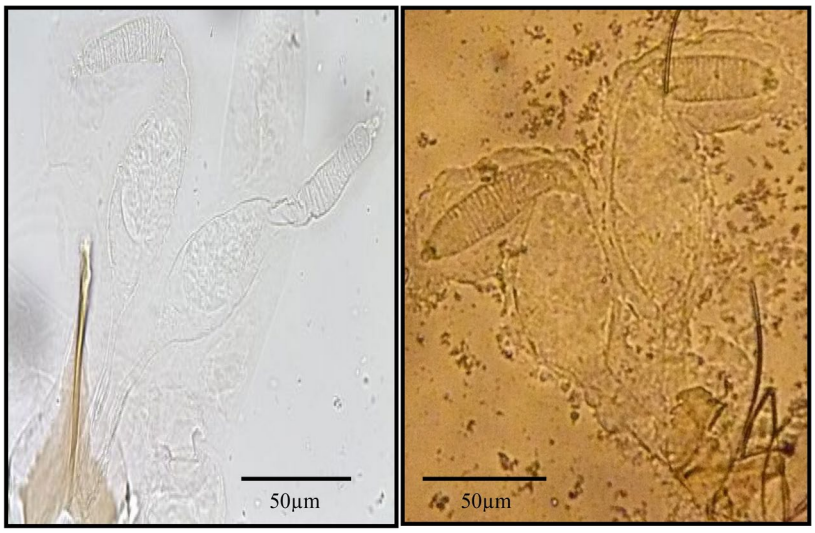
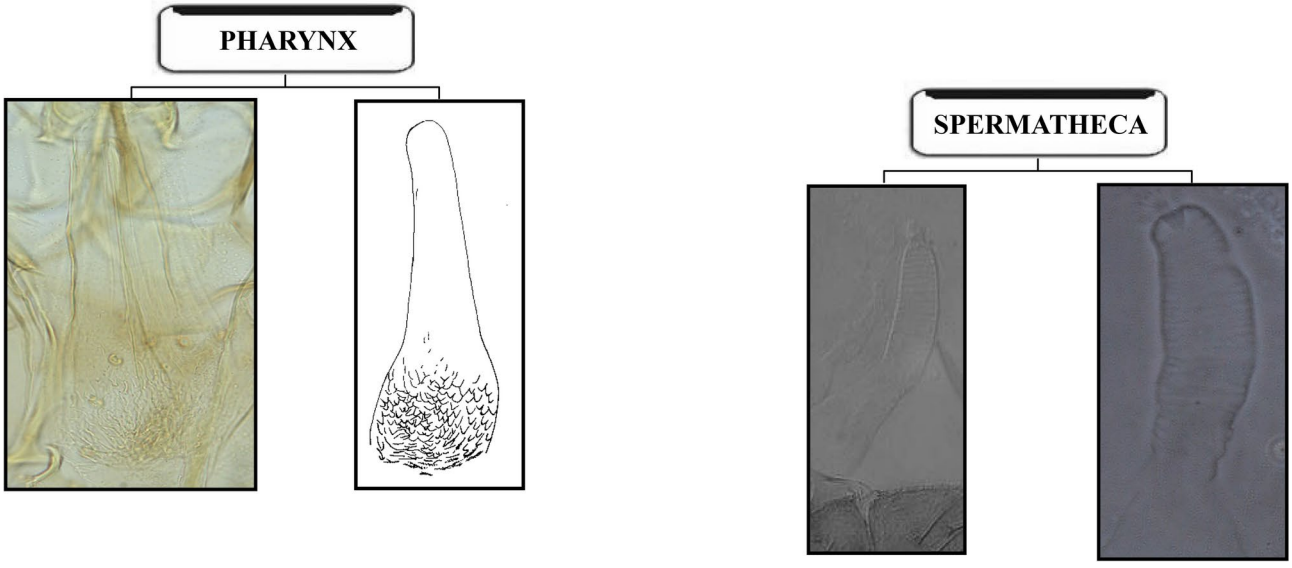


Figure N°57c **Figure N°57d**



58. *Phlebotomus simonahalepae*
Male
Undescribed.
Female

- Pharyngeal armature well developed, occupying the last third of the pharynx, made with small dots-like and long triangular teeth.
- Cylindrical spermatheca, striated and capsulated. Terminal knob round-shaped with 9 finger-like prolongations connected by a thin neck.
- Absence of common duct (Figures N°58a,b).

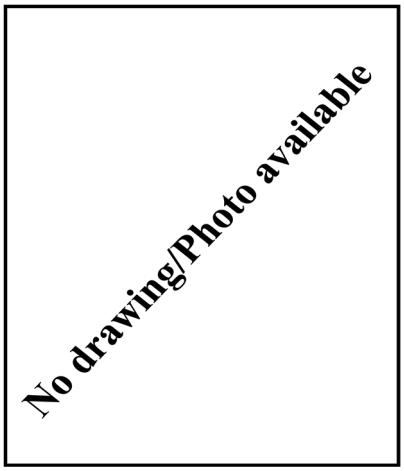


Figure N°58a

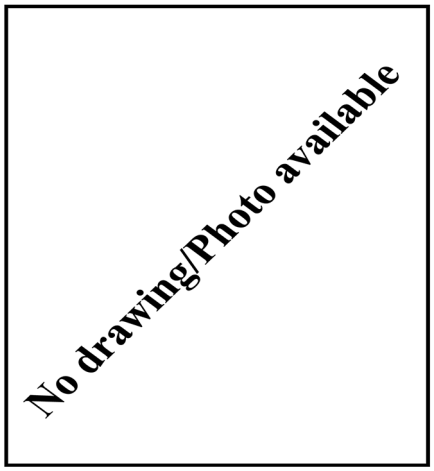
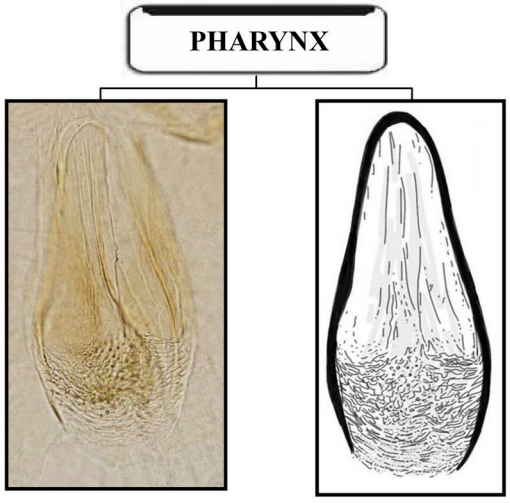
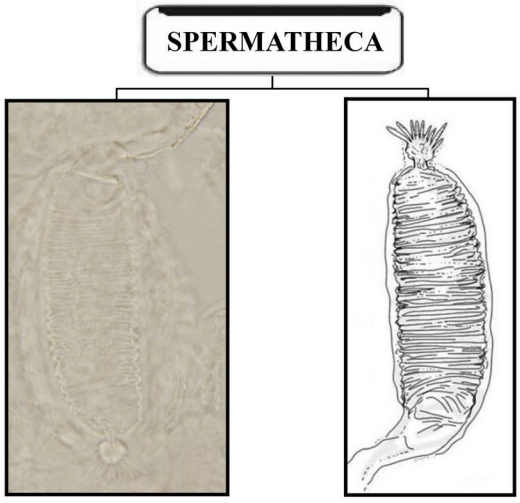


Figure N°58b





Subgenus *Abonnencius*

Male: Gonostyle with 5 spines, conical parameral sheath valves with half-moon-shaped spines attached. Long genital filaments. Non-lobed parameres.
Female: Smooth spermatheca with long ducts ending at proximal location .
Type: *Phlebotomus fortunatarum* Ubeda Ontiveros et al., 1982

59. *Phlebotomus fortunatarum*
Male

- Antennal formula: 2/III-VIII, 1/IX-XV.
- AIII (371 µm) > AIV + AV.
- Tapered parameral sheath with characteristic crescent appendage.
- Long genital filament with genital pump at the third abdominal segment level (Figures N°59a,b).

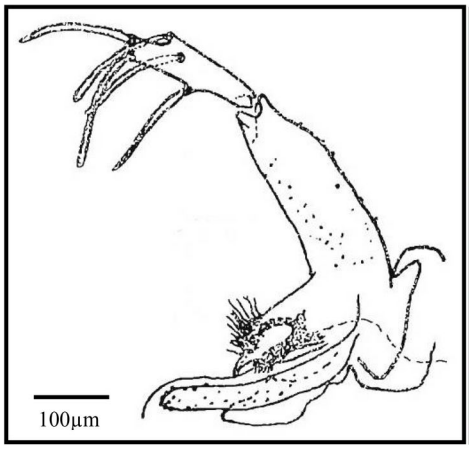
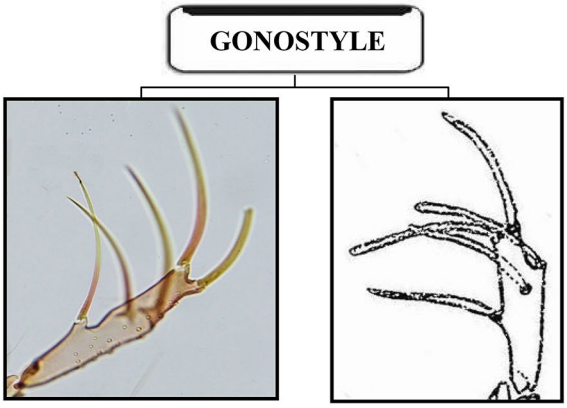
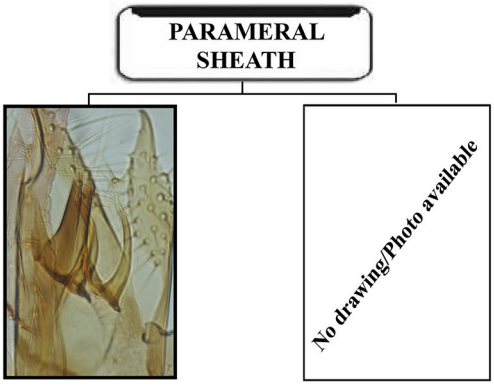


Figure N°59a

Figure N°59b





Female

- Tubular, long and narrow spermatheca (Figures N°59c,d).

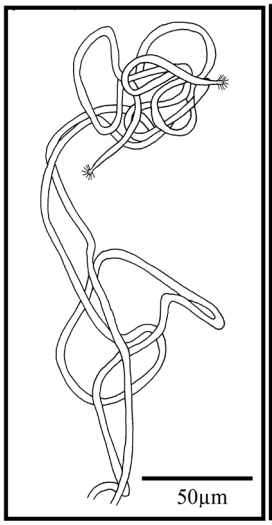


Figure N°59c

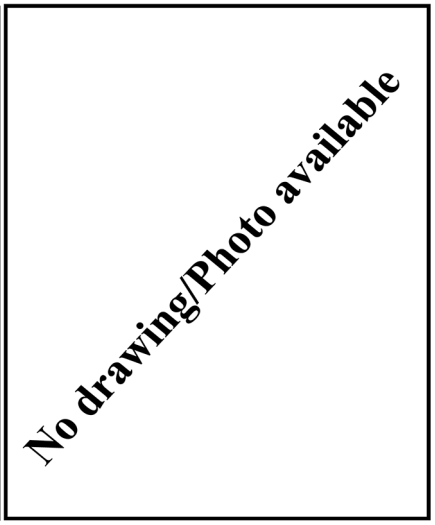
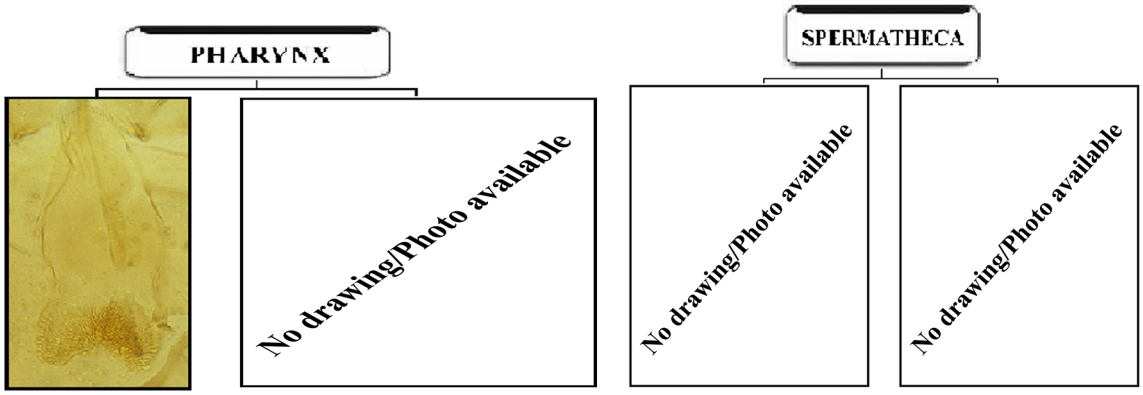
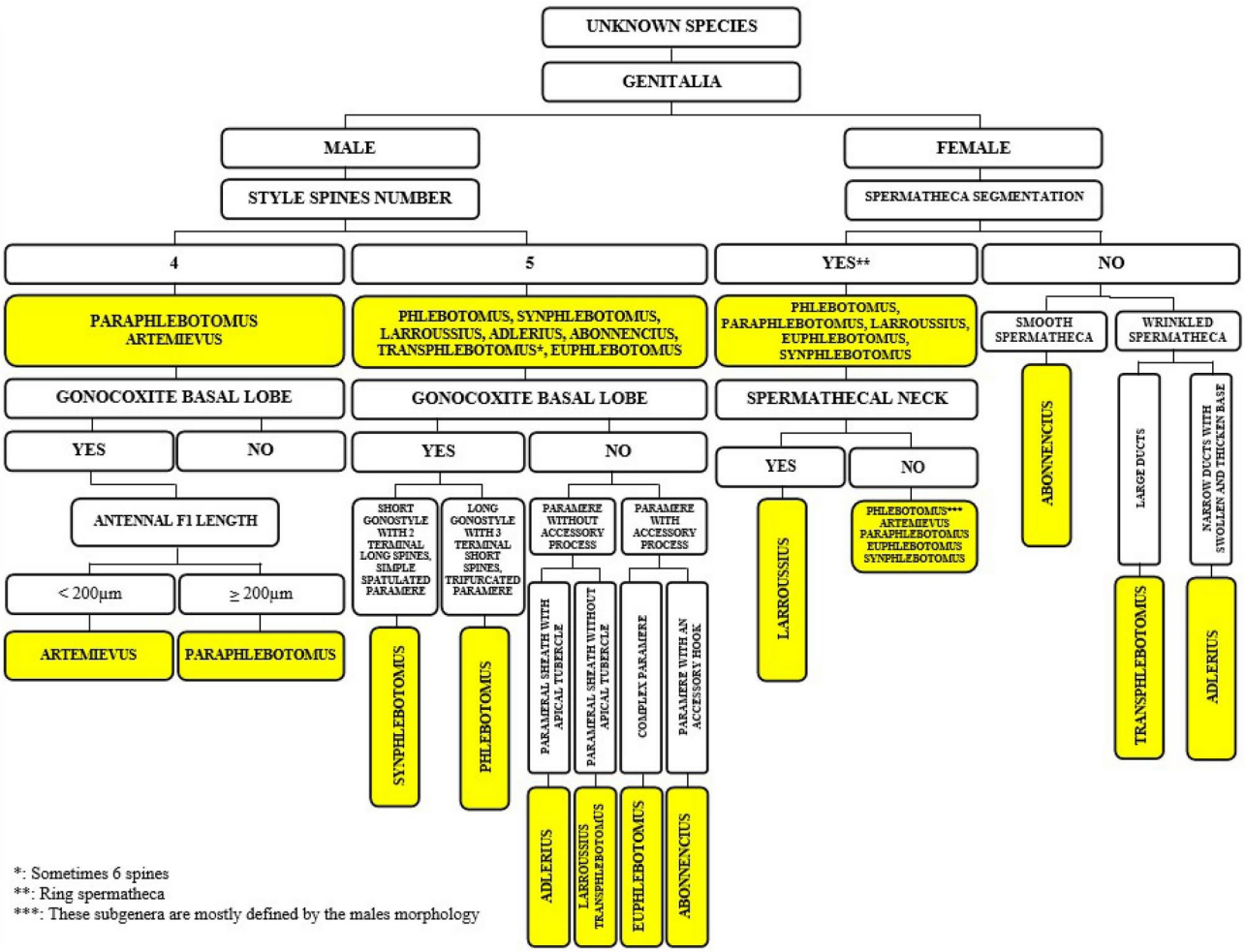


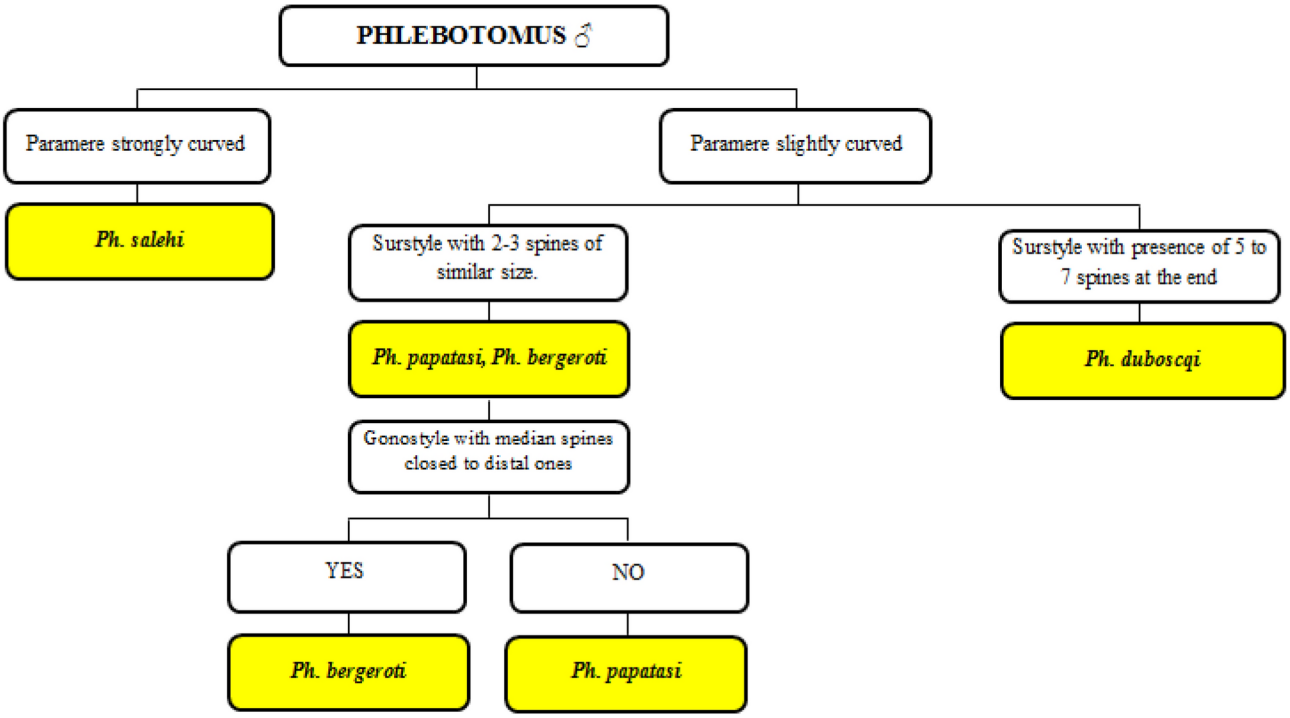
Figure N°59d



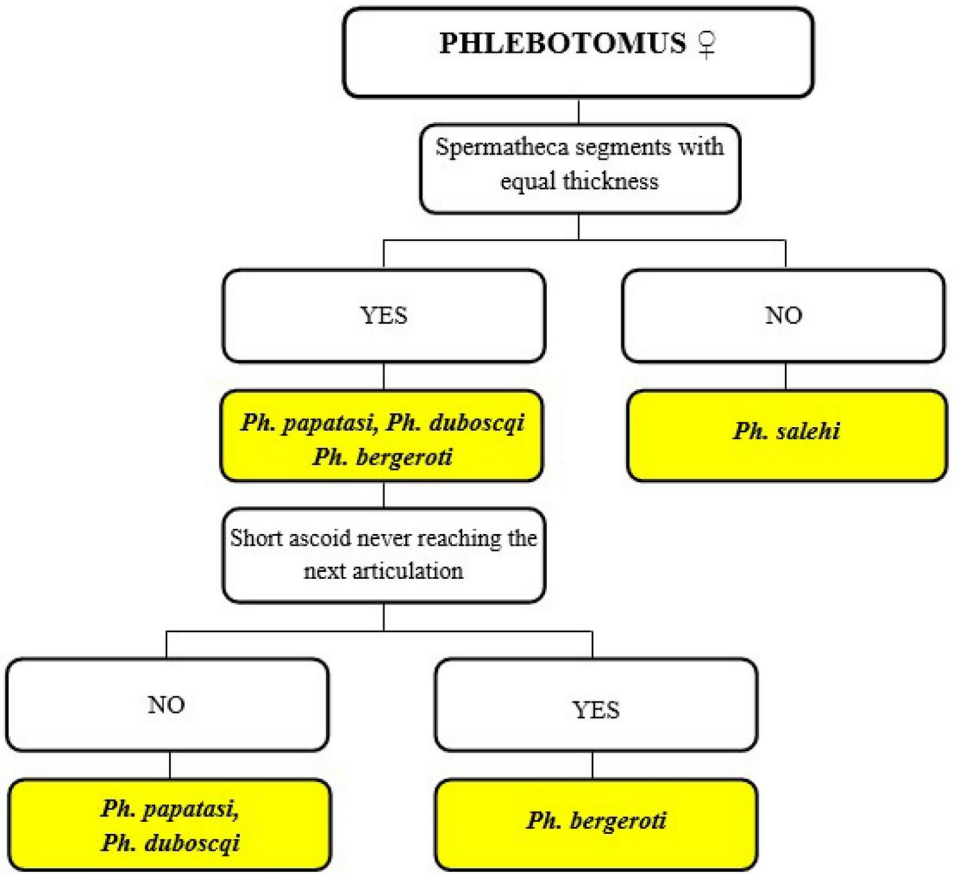
Dichotomous identification key



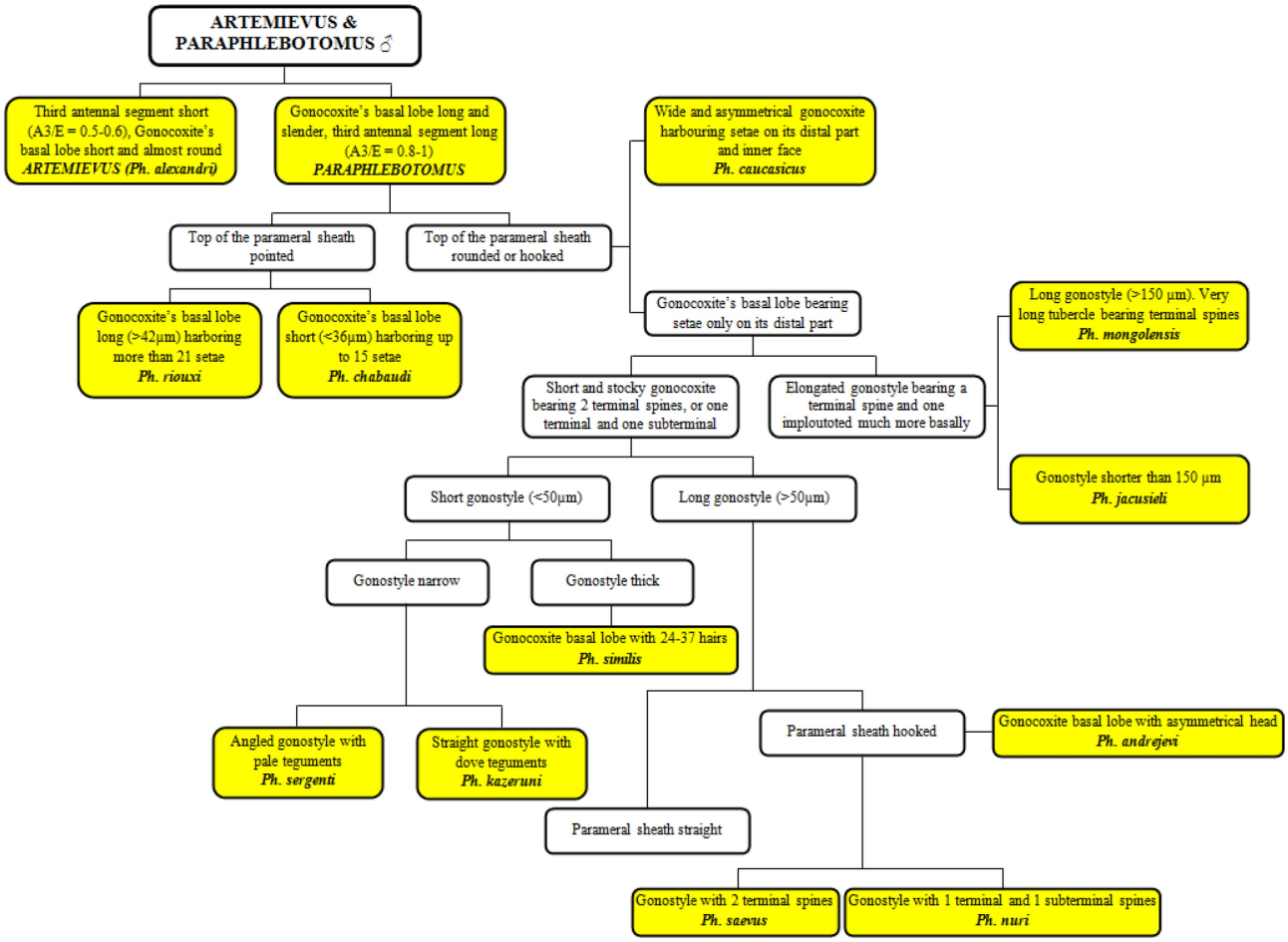
Phlebotomus ♂



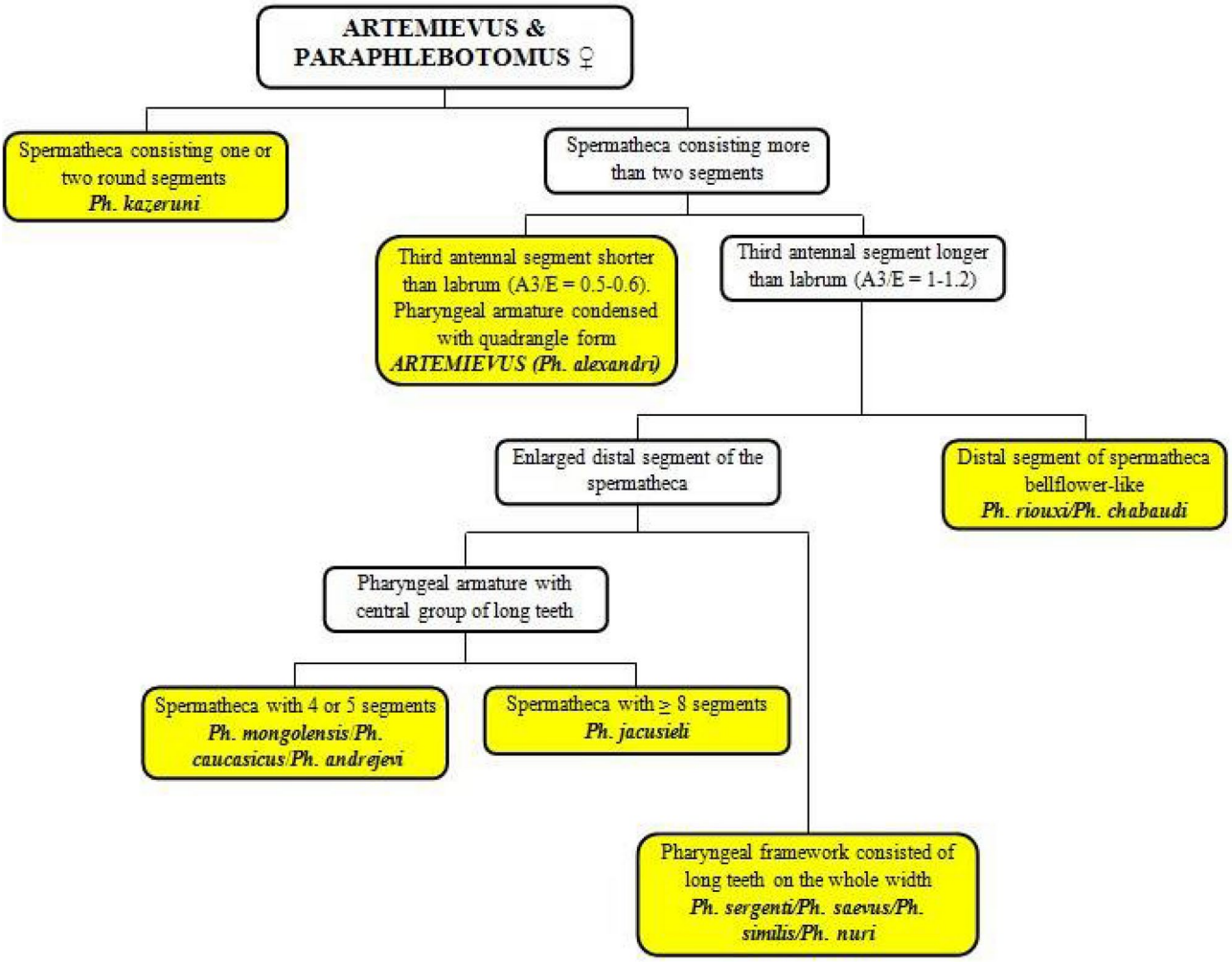
Phlebotomus ♀



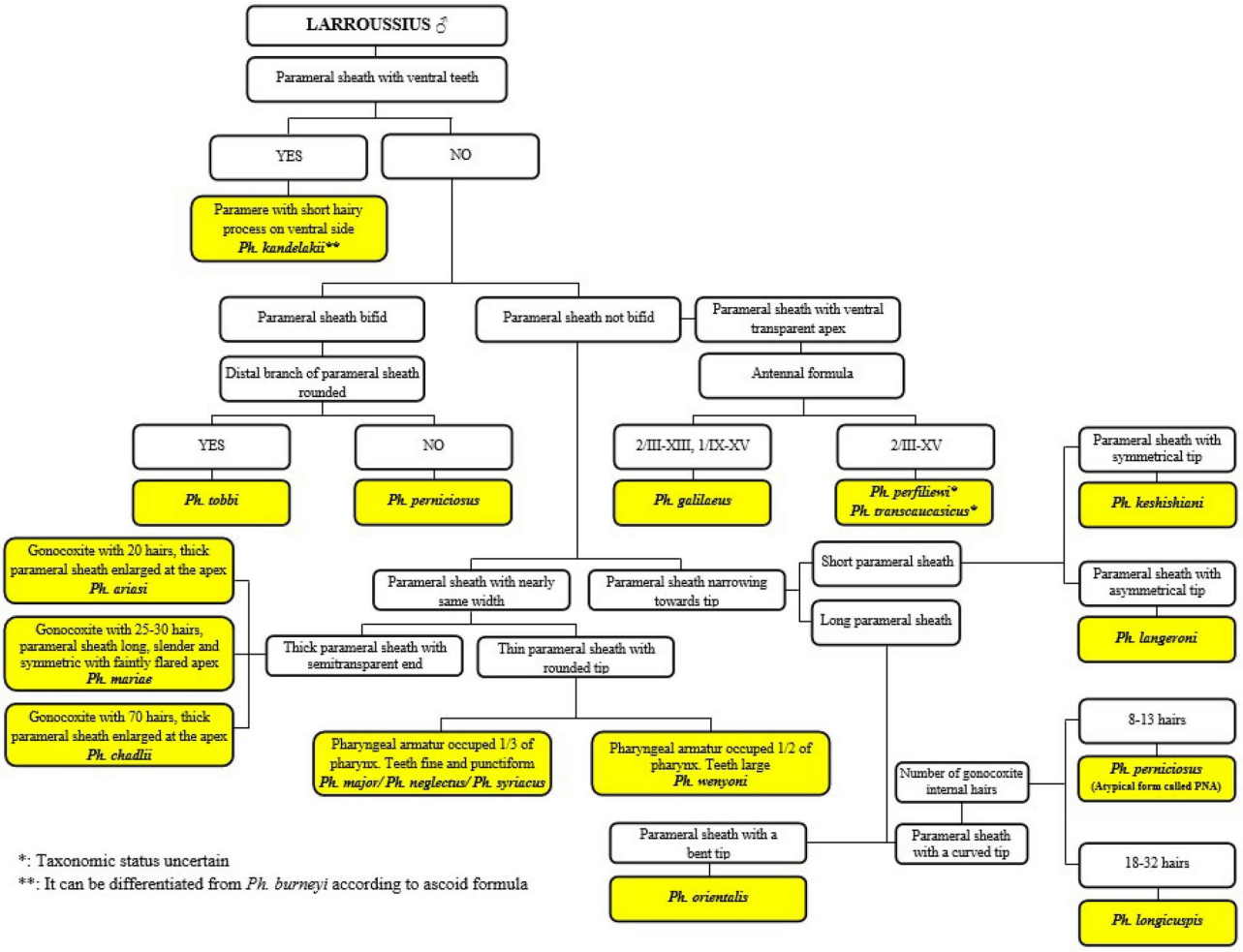
***Artemievus* & *Paraphlebotomus* ♂**



***Artemievus* & *Paraphlebotomus* ♀**

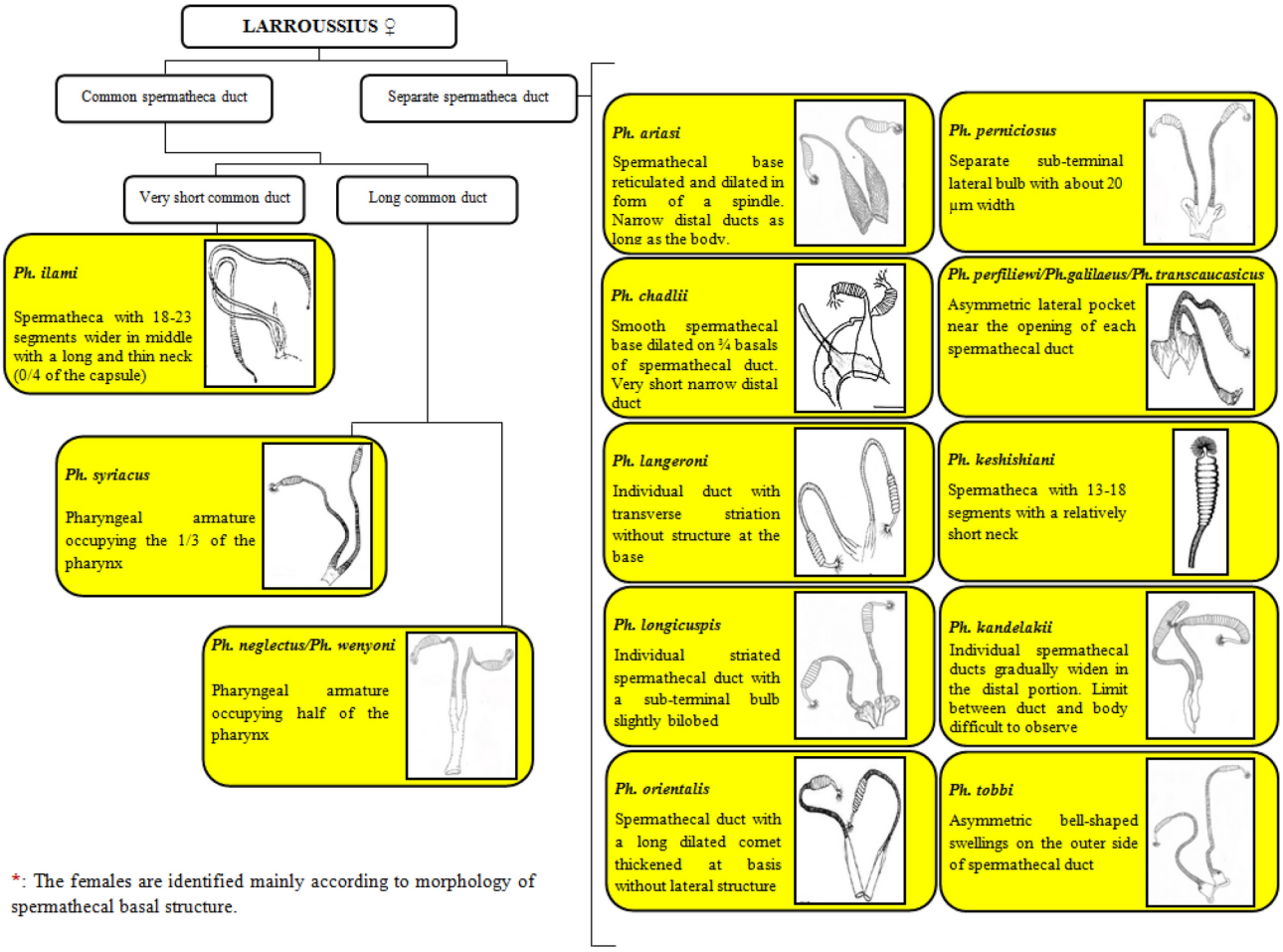


Larroussius ♂



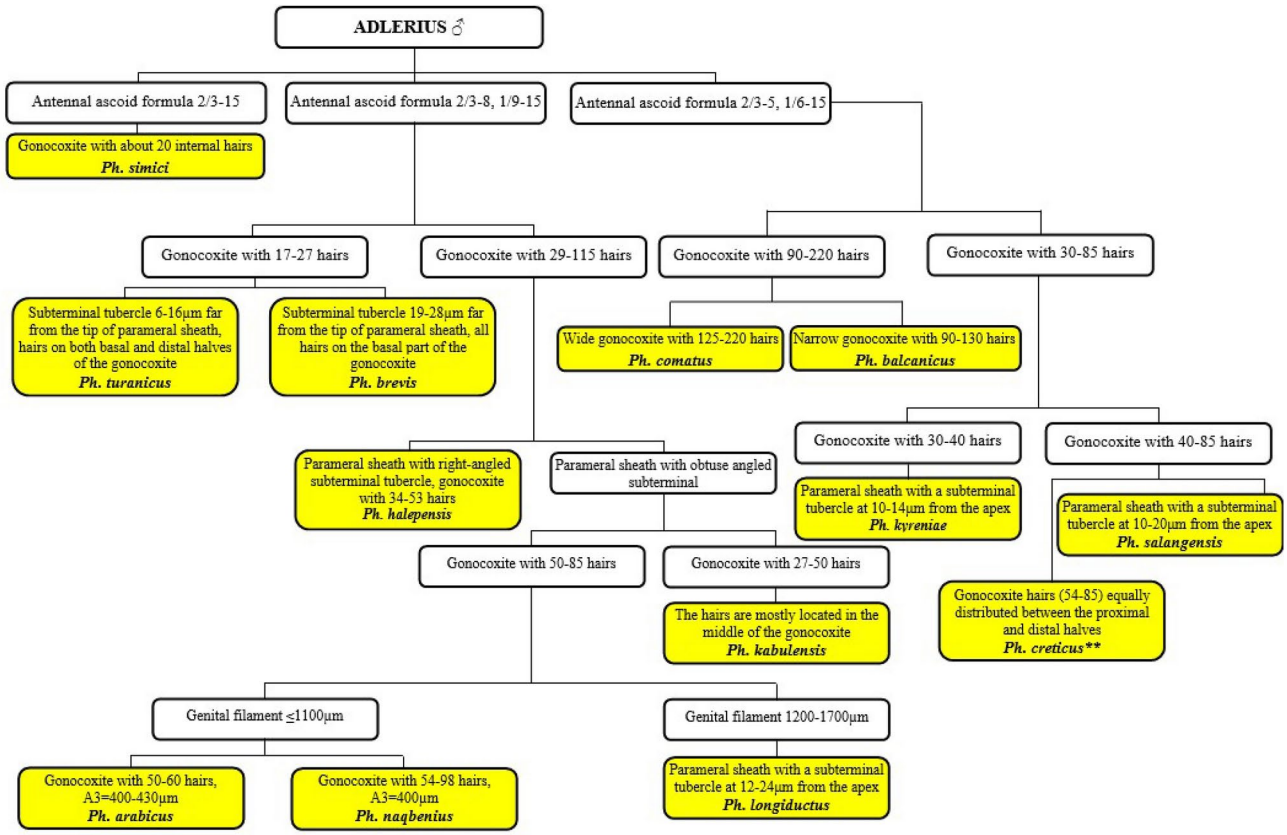
*: Taxonomic status uncertain
**: It can be differentiated from *Ph. burneyi* according to ascoid formula

Larroussius ♀



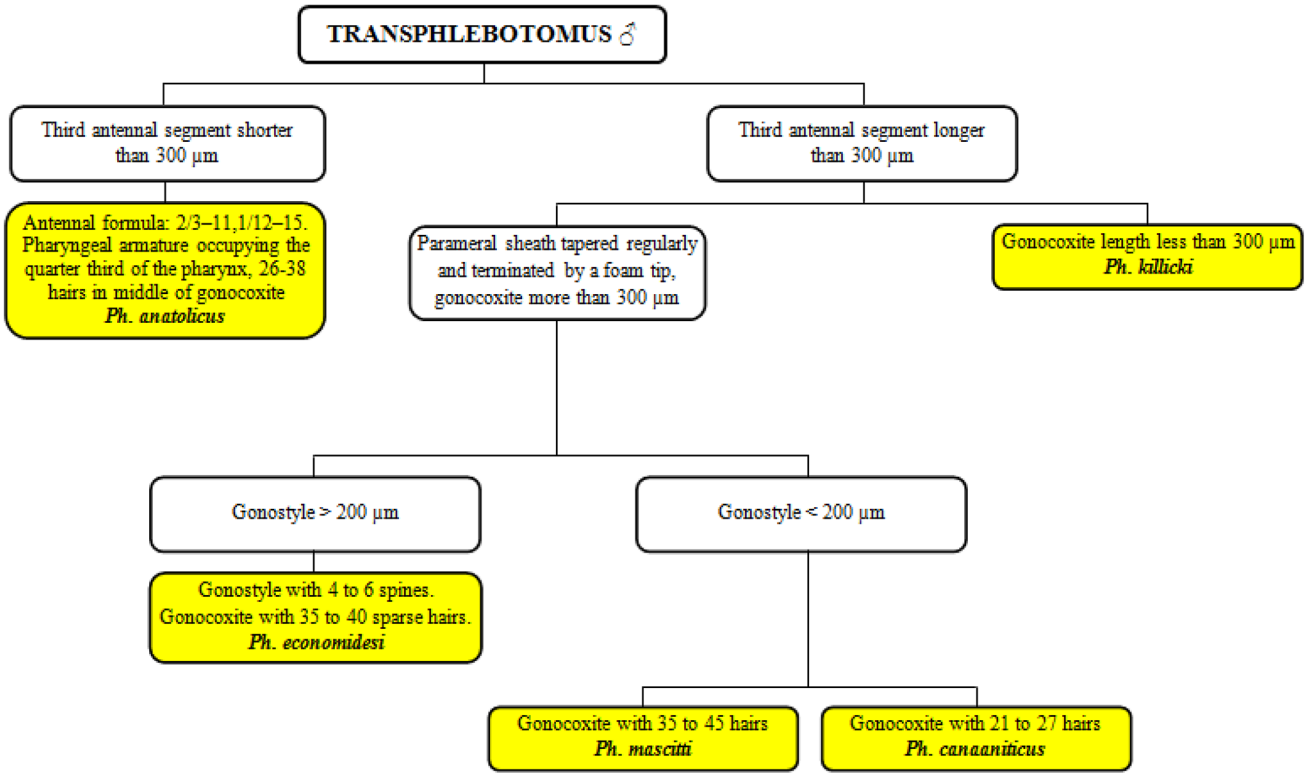
*: The females are identified mainly according to morphology of spermathecal basal structure.

Adlerius ♂*

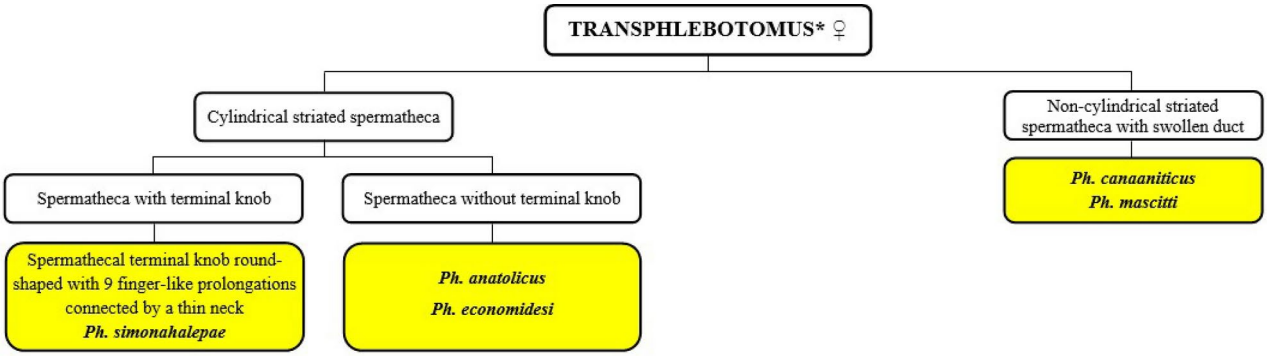


* : The females are morphologically indistinguishable from each other and identified based on the male specimens.
**: Variation in antennal formula

***Transphlebotomus*♂**



Transphlebotomus ♀



*: Taking into account the spermatheca of *Ph. killicki* has never been described. We excluded this species from the dichotomic key.

N°1a	Rioux et al. 1975	N°15b	Akhoundi collection	N°30c	Depaquit et al. 2001
N°1b	Akhoundi collection	N°15c	Akhoundi collection	N°30d	Depaquit collection
N°1c	IRD collection	N°15d	Depaquit collection	N°31a	WRBU
N°1d	Azzedine Bounamous thesis	N°16a	Depaquit collection	N°31b	Depaquit et al. 2013
N°2a	Abonnenc 1972	N°16b	Akhoundi collection	N°31c	Léger et al. 1983
N°2b	IRD collection	N°16c	IRD collection	N°31d	Akhoundi collection
N°2c	Izri collection	N°16d	Akhoundi collection	N°32a	Léger et al. 1991
N°2d	Akhoundi collection	N°17a	Rioux collection	N°32b	Akhoundi collection
N°3a	Perfiliev 1966	N°17b	Guemaoui collection	N°32c	Léger et al. 1991
N°3b	Izri collection	N°17c	Izri collection	N°32d	Izri collection
N°3c	Gat et al. 2009	N°17d	Depaquit collection	N°33a	Depaquit collection
N°3d	Akhoundi collection	N°18a	Depaquit collection	N°33b	Absavaran et al. 2009
N°4a	Lane 1993	N°18b	Azzedine Bounamous thesis	N°33c	Léger et al. 1983
N°4b	Akhoundi collection	N°18c	Berdjane-Brouk et al. 2011	N°33d	Akhoundi collection
N°4c	Akhoundi collection	N°18d	Berdjane-Brouk et al. 2011	N°34a	Perfiliev 1966
N°4d	Akhoundi collection	N°19a	Javadian et al. 1997	N°34b	Akhoundi collection
N°5a	Depaquit collection	N°19b		N°34c	
N°5b	Akhoundi collection	N°20a	Perfiliev 1966	N°34d	
N°5c	Depaquit collection	N°20b	Depaquit collection	N°35a	Depaquit collection
N°5d	Akhoundi collection	N°20c	Léger et al. 1983	N°35b	Depaquit collection
N°6a	Depaquit collection	N°20d	Akhoundi collection	N°35c*	IRD collection
N°6b	Akhoundi collection	N°21a	Perfiliev 1966	N°35d*	IRD collection
N°6c	Absavaran et al. 2019	N°21b	Akhoundi collection (Moin-Vaziri V)	N°36a	Léger et al. 1979
N°6d	Absavaran et al. 2019	N°21c		N°36b	Akhoundi collection
N°7a	Depaquit collection	N°21d		N°36c*	Léger et al. 1979
N°7b	Azzedine Bounamous thesis	N°22a	Depaquit collection	N°36d	
N°7c	Depaquit collection	N°22b	Depaquit collection	N°37a	Depaquit collection
N°7d	Depaquit collection	N°22c	Martinez Ortega et al. 1996	N°37b	Akhoundi collection
N°8a	Depaquit et al. 2001	N°22b	Ghrab et al. 2005	N°37c*	Perrotey et al. 2000
N°8b	Akhoundi collection	N°23a	Léger et al. 1979	N°37d*	Akhoundi collection
N°8c	Akhoundi et al. 2013	N°23b	Guemaoui collection	N°38a	Artemiev 1980 ?
N°8d	Akhoundi collection	N°23c	Léger et al. 1983	N°38b	Akhoundi collection
N°9a	Depaquit collection	N°23d	Izri collection	N°38c	
N°9b	Akhoundi collection	N°24a	Léger et al. 1991	N°38d	
N°9c	Depaquit collection	N°24b	Akhoundi collection	N°39a	Dvorak et al. 2020

N°9d	Depaquit collection	N°24c	Léger et al. 1983	N°39b	Depaquit collection
N°10a	Depaquit collection	N°24d	Akhoundi collection	N°39c*	Dvorak et al. 2020
N°10b	Akhoundi collection	N°25a	Depaquit collection	N°39d*	Depaquit collection
N°10c	Depaquit collection	N°25b	Depaquit collection	N°40a	Akhoundi collection
N°10d	Akhoundi collection	N°25c	Léger et al. 1983	N°40b	Akhoundi collection
N°11a	Depaquit collection	N°25d	Depaquit collection	N°40c*	Akhoundi collection
N°11b	Depaquit collection	N°26a	Haddad et al. 2003	N°40d*	Akhoundi collection
N°11c	Depaquit collection	N°26b	Depaquit collection	N°41a	Artemiev 1980 ?
N°11d		N°26c	Killick-Kendrick et al. 1990	N°41b	Akhoundi collection
N°12a	Depaquit et al. 1998	N°26d	Depaquit collection	N°41c*	Akhoundi collection
N°12b	Akhoundi collection	N°27a	Rioux et al. 1974	N°41d	
N°12c	Depaquit collection	N°27b	Guemaoui collection	N°42a	Léger et al. 1979
N°12d	Depaquit collection	N°28a	IRD collection	N°42b	Depaquit collection
N°13a	Croset et al. 1970	N°28b	R. P. Lane (NHM, London)	N°42c*	Léger et al. 1979
N°13b	Depaquit collection	N°28c	Léger et al. 1979	N°42d	
N°13c	Depaquit collection	N°28d	IRD collection	N°43a	Artemiev 1980 ?
N°13d	Depaquit collection	N°29a	Léger et al. 1991	N°43b	Akhoundi collection
N°14a	Depaquit collection	N°29b	Akhoundi collection	N°43c*	Akhoundi collection
N°14b	Akhoundi collection	N°29c	Depaquit collection	N°43d*	Akhoundi collection
N°14c	Depaquit collection	N°29d	Izri collection	N°44a	Depaquit collection
N°14d	Akhoundi collection	N°30a	Depaquit et al. 2013	N°44b	
N°15a	Depaquit collection	N°30b	Depaquit et al. 2001	N°44c	
N°44d		N°53a			
N°45a	Artemiev 1980	N°53b	Kasap et al. 2015		
N°45b	Depaquit and Akhoundi collection	N°53c			
N°45c		N°53d			
N°45d		N°54a	Depaquit collection		
N°46a	Léger et al. 1979	N°54b	Depaquit collection		
N°46b	Depaquit and Akhoundi collection	N°54c	Depaquit collection		
N°46c*	Perrotey et al. 2000	N°54d	Haddad et al. 2003		
N°46d*	Depaquit collection	N°55a	Depaquit collection		
N°47a	Akhoundi et al. 2012	N°55b	Léger et al. 2000		
N°47b	Akhoundi collection	N°55c	Léger et al. 2000		
N°47c*	Akhoundi et al. 2012	N°55d	Depaquit collection		
N°47d*	Akhoundi collection	N°56a	Depaquit collection		
N°48a	Depaquit collection	N°56b	Kasap et al. 2015		
N°48b	Akhoundi collection	N°56c			
N°48c		N°56d			
N°48d	Akhoundi collection	N°57a	Depaquit collection		
N°49a	Lewis et al. 1979	N°57b	Depaquit collection		
N°49b	Akhoundi collection	N°57c	Depaquit collection		
N°49c		N°57d	Izri collection		
N°49d		N°58a	Cazan et al. 2021		
N°50a	Depaquit collection	N°58b	Cazan et al. 2021		
N°50b	Depaquit collection	N°59a	Ubeda-Oniveros et al. 1982		
N°50c		N°59b	Depaquit collection		
N°50d	Depaquit collection	N°59c	Depaquit collection		
N°51a	Seyedi-Rashti and Nadim 1970	N°59d			
N°51b					
N°51c					
N°51d					
N°52a					
N°52b	Javadian et al. 1997				

Table 2. Reference authors of photos and drawings.*Please find these photos and drawings in SI-VIII.

Data availability

All data and related metadata underlying reported findings have been presented in the article.

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Author contributions

The authors contributed proportionally to this study and they were positioned according to the level of their contribution.

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Competing interests

The authors declare no competing interests.

Additional information

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