



## **Taxonomic Morphology of *Sergentomyia (Sergentomyia) babu babu* Annandale (1910), *Sergentomyia palestinensis* Adler and Theodor (1927) and *Sergentomyia baghdadis* Adler and Theodor (1929) (Diptera, Psychodidae) of Pakistan**

Juma-Khan Kakarsulemankhel

Sandflies, Leishmaniasis and Mosquitoes Lab./ Zoology, University of Balochistan, Quetta, Pakistan

**Abstract:** During entomological surveys conducted by the author in the whole of the Balochistan Province in 1996-2001, *Sergentomyia (Sergentomyia) babu babu* (N=165), *Sergentomyia palestinensis* (N=10) and *Sergentomyia baghdadis* (N=145) were collected from 17, 3 and 15 localities, respectively. These localities appear to be the new records of these species in the literature to date. Taxonomic characters not described by earlier workers are described, measured and illustrated here. Keys for identification of Pakistanese species are also constructed. Results are compared with the published data of these species available in the existing literature.

**Key words :** *S. babu babu*, *S. palestinensis*, *S. baghdadis*, sandflies, taxonomic characters

### **INTRODUCTION**

Annandale<sup>[1,2]</sup> was the first who reported *Sergentomyia babu* under the name of *Phlebotomus babu* from Drosh area of Chitral (now in Northern Pakistan) and Rawalpindi areas and gave a very brief and incomplete description. Sinton<sup>[3]</sup> reported buccal armature of ♀ fly with about 30 teeth and sketched it. Sinton<sup>[4]</sup> sketched cibarium of ♂ fly of this species. Lewis<sup>[5]</sup> described and reported this species from Gilgit, Landikotal, Mir Muhammad, Rawalpindi, Saidpur and Taxilla area of Pakistan, but morphometric measurements of cibarium, pharynx, pharyngeal armature, spermatheca, ducts, furca, genital atrium, coxite, style, paramere, aedeagus and surstyle were not furnished nor wing, antennal segments, ascoids, palp, mouth parts and genital atrium were sketched.

*Sergentomyia palestinensis* was first reported from a single ♀ caught in Jericho in the Jordan valley by Adler and Theodor<sup>[6]</sup> in December, 1925. They described pharynx and armature of the buccal cavity (with about 20 teeth stand on a straight line) and furnished figures of pharynx, buccal cavity and spermathecae whereas morphometric measurements and illustrations of other taxonomic characters like wing, proboscis antennal segments, palps, mouth parts, cibarium, pharynx, spermatheca, furca and genital atrium were not supplied. Subsequently, three ♀ were caught in Baghdad in June, 1928, 1 ♀ from AbuGerm in northern Persia in June 1929 and one ♀ from Chugim (at the northern shore of the Dead

sea) in June 1941 and a ♂ was found in material collected in Jericho in July, 1934 by Theodor<sup>[7]</sup>. The ♂ was described by Theodor<sup>[7]</sup> and also by Pringle<sup>[8]</sup> and morphometric measurements of wing of both sexes and figures of male genitalia were furnished. Pringle<sup>[8]</sup> caught 15 ♀ and 1 ♂ of this species from Baghdad city and gave morphometric measurements of antennal segments III, ascoid 4/A4, coxite, style, paramere and aedeagus with illustration of cibarium, pharynx, style and paramere. It was also recorded from Lenkoran (near the Caspian sea) and from Ordubad in Armenia by Perfliev<sup>[9]</sup>. In Iran it was recorded from Kazerun, Abadan, Tehran and Sabzevar<sup>[10,11]</sup>. A sketch of cibarial armature of Iranian form of *S. palestinensis* (♂) was furnished by Theodor and Mesghali<sup>[12]</sup>. From Pakistan this species has been reported from Peshawar by Lewis<sup>[5]</sup> and information about the length of wing, labrum and cibarium (with 16 teeth) were mentioned and a sketch of cibarium was also furnished. However, measurements and figures of taxonomic features like antennal segments, ascoids, palps, mouth parts (hypopharynx, maxilla, mandible) and male terminalia were not supplied.

*Sergentomyia baghdadis* was first reported from Baghdad by Adler and Theodor<sup>[13]</sup> under the name of *Phlebotomus baghdadis*. They did not furnish morphometric measurements of eye, head, wing, proboscis, antennal segments, mouth parts, cibarium, pharynx, spermatheca, ducts, genital atrium, coxite, style, paramere, aedeagus, genital filament, pump and surstyle. Like wise, sketch of antennal segments, palps, mouth

parts, genital furca, genital atrium, wing and pharynx of male, coxite, style, genital filament, pump and surstyle were not given. Sinton<sup>[3]</sup> recorded this fly from west and north west part of the United Indian sub continent and described only number of buccal teeth and supplied figures of cibarium only. From Iran, *S. baghdadis* was recorded from Kazerun, Bander Abbas and southern parts by Mesghali<sup>[10,14]</sup> and he neither described nor illustrated the taxonomic characters of this species. Nadim and Javadian<sup>[15]</sup> described number of cibarial teeth in ♂ (1-2 rows of very weak, dot like teeth) and ♀ (16-18 cibarial teeth) in Iranian *S. baghdadis*. Lewis<sup>[5]</sup> reported this species from Punjab and Sindh provinces of Pakistan but morphometric measurements of eye, head, proboscis, mouth parts, cibarium, cibarial notch, pharyngeal armature, spermatheca, ducts, genital atrium, coxite, style, paramere, aedeagus and surstyle were not provided. Illustrations of wing, antennal segments, palps, mouth parts, genital atrium, genital filament and pump were not furnished and are unknown in the literature from Pakistan, prior to the present study. Artemiev<sup>[16]</sup> reported *S. baghdadis* from southern Afghanistan, but described number of cibarial teeth (16-20) in ♀ specimens and furnished sketches of cibarium, pharynx and spermatheca only. AslamKhan<sup>[17]</sup> reported this fly from Lehri, Sangsila and Dera Bugti areas of Balochistan but he neither described nor illustrated morphology of taxonomic characters of *S. baghdadis*. To fill these gaps of knowledge, a study of species identification of sandflies was conducted out by the present author in the whole of the Balochistan Province and 2013 sandflies comprising of genera *Phlebotomus*, *Sergentomyia* and *Grassomyia* were collected<sup>[18]</sup>. In view of the insufficient description of Adler and Theodor, Annandale, Lewis, Mesghali, Mesghali and Theodor, Perfiliev, Pringle, Sinton, Theodor (*loc. cit.*), these three species are redescribed in detail. Morphology of taxonomic characters not given by earlier workers are also described, measured and illustrated in the present paper.

**MATERIALS AND METHODS**

Flies were collected, processed, preserved, dissected, mounted and for examination of external and internal parts of the body of sandflies, conventional techniques especially those recommended by Johnson *et al.*<sup>[19]</sup>, Killick-Kebdrick<sup>[20]</sup>, Killick-Kendrick *et al.*<sup>[21]</sup>, Lawyer *et al.*<sup>[22]</sup> and Lewis<sup>[23]</sup> were adopted. For species identification keys furnished by Lewis<sup>[5, 24,25]</sup> and Artemiev<sup>[16]</sup> were followed. Measurements are in millimeter (mm) unless otherwise is indicated. All the diagrams were drawn with the camera lucida and are to the given scales. Specimens

are housed in the Author's Collection of sandflies, Department of Zoology, University of Balochistan, Quetta.

**RESULTS**

*Sergentomyia (Parrotomyia) babu babu* Annandale<sup>[1]</sup>

(Text -Figs. 1 and 2 and Table 1)

*Phlebotomus babu* Annandale<sup>[1]</sup>, Rec. Indian Mus., 4:49;<sup>[2]</sup>, Rec. Indian Mus., 4:320. Sinton<sup>[26]</sup>, Indian J. Med. Res., 15:31;<sup>[27]</sup>, 16:185;<sup>[28]</sup> 16:314;<sup>[3]</sup>, 20:60,73;<sup>[4]</sup>, 21:422, 423, Theodor<sup>[29]</sup>, 26:264

*Phlebotomus (Prophlebotomus) babu* Annandale, Parrot<sup>[30]</sup>, Archs.Inst.Pasteur Alger. 18: 311.

*Phlebotomus thepari* Mitra and Roy<sup>[31]</sup>, Indian Med. Gaz., 87:188. Syn. n.

*Phlebotomus (Sergentomyia) babu* Annandale, Quate<sup>[32]</sup>, Proc. Hawaii. Ent. Soc., 18: 157.

*Segentomyia (Parrotomyia) babu* Annandale, Lewis<sup>[5]</sup>, Bull. Brit. Mus. Nat. Hist. (Ent.), 19: 28;<sup>[24]</sup>, Bull. Brit. Mus. Nat Hist. (Ent.), 37: 258, Artemiev<sup>[33]</sup>, Medskaya Parazit., 45: 422;<sup>[16]</sup>, 29.

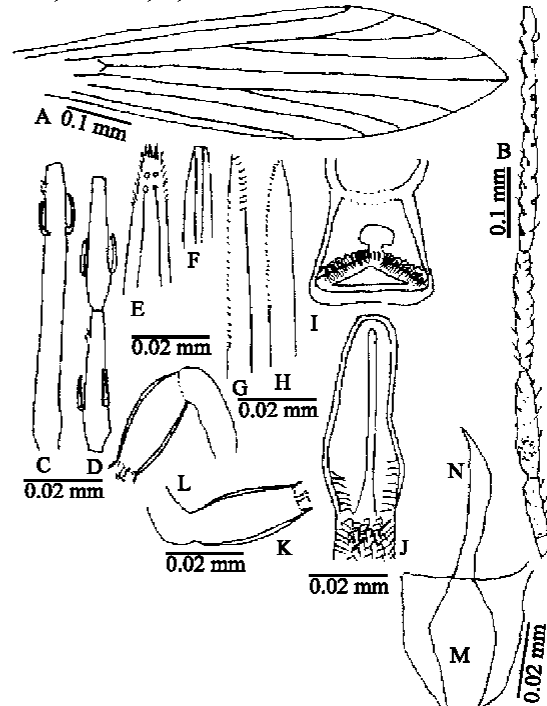


Fig. 1: Camera Lucida drawings of *Sergentomyia (Parrotomyia) babu babu* (♀) from Balochistan showing: wing (A), palps (B), the third (C), fourth (D, lower) and fifth (D, upper) antennal segments, labrum (E), Hypopharynx (F), maxilla (G), mandible (H), cibarium (I), pharynx (J), Spermatheca (K), ducts(L), genital atrium (M), furca (N)

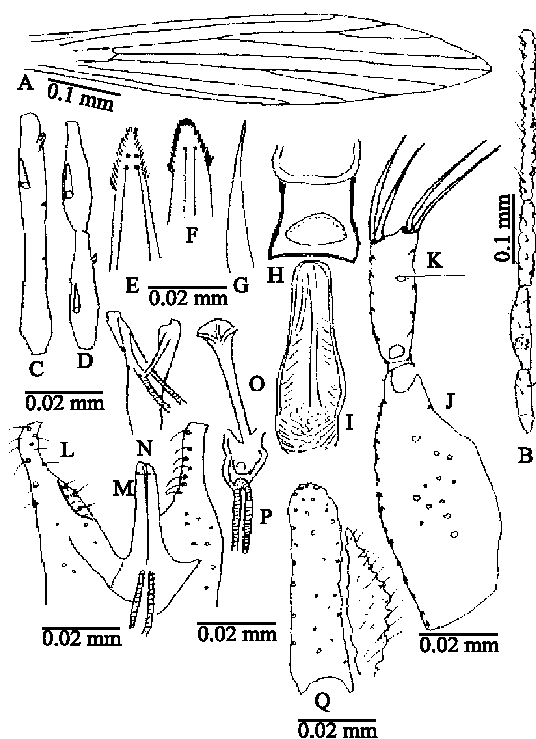


Fig. 2: Camera Lucida drawings of *Sergentomyia (Parrotomyia) babu babu* (♂) showing: wing (A), palps (B), the third (C), fourth (D, lower) and fifth (D, upper), antennal segments, labrum (E), hypopharynx (F), maxilla (G), cibarium (H), pharynx (I), coxite (J), style (K), paramere (L), aedeagus (M) a different view of aedeagus at a different angle (N), genital pump (O), filament (P), surstyle (Q)

**Female:** 49 specimens were examined (Fig. 1). Eye 0.23 (0.20-0.25) mm long, 0.185 (0.17-0.20) mm broad, distance between eyes 0.225 (0.21-0.24) mm, head 0.425 (0.41-0.44) mm long, 0.445 (0.43-0.46) mm broad. Wing (Fig. 1A) 1.43 (1.36-1.50) mm long, 0.33 (0.32-0.34) mm broad,  $\alpha=0.20$  (0.16-0.24) mm long, but in one specimen from Sibi, a shortest  $\alpha$  0.08 mm long is measured,  $\beta=0.29$  (0.26-0.32) mm long,  $\delta=0.085$  (0.065-0.104) mm long, but in one specimen from Sibi, a zero  $\delta$  is measured, other specimens showed a positive shortest  $\delta=+0.037$  mm, another specimen is found having a negative shortest  $\delta=-0.06$  mm,  $\gamma=0.27$  (0.22-0.32) mm long, but in one specimen from Dhadar a longest  $\gamma=0.352$  mm is observed,  $\pi=0.09$  (0.06-0.12) mm, alar index=0.615-0.75. Proboscis 0.19 (0.18-0.20) mm long. Palps (Fig. 1B) 0.65 (0.58-0.72) mm long with relative length 1:2.28:4.05:4.22:8.26, commonest formula 1,2,3,4,5 but also 1,2,3-4,5. P3 has 10-15 Newstead's sensilla at middle third, other palpal segments have none. A3 (Fig. 1C) 0.178 (0.16-0.19) mm long, 0.124x length of wing, 1.078x length of labrum, 1.059x length of A4+5, ascoid an

A3 0.028 (0.026-0.03) mm long and is 0.157x length of segment. A4 (Fig. 1D, lower) 0.085 (0.07-0.10) mm long, ascoid on A4=0.028 (0.026-0.03) mm long and was 0.329x length of segment. A5 (Fig. 1D, upper) 0.083 (0.07-0.09) mm long, ascoid on A5=0.028 (0.026-0.03) mm long and was 0.337x length of segment. Antennal segments III and IV have a single prominent papilla (Fig. 1C-1D). It is usually by the side of the ascoid, but is occasionally anterior to the ascoid. The positions of the papilla on the segments are: AIII, 0.88 and AIV, 0.6. AIII is greater than AIV+AV. The positions of the ascoids on the segments are: AIII, 0.673 (N=45), AIV, 0.3 (N=42) and AV, 0.25 (N=42). There are two ascoids on segments III to XV. Labrum (Fig. 1E) 0.165 (0.16-0.17) mm long, 0.115x length of wing, with 4 long (0.008 mm), stout median apical sensilla whereas adorals smaller and fine, sensilla depth 0.028 mm. Hypopharynx (Fig. 1F) with smooth apical and lateral margins. Maxilla (Fig. 1G) with 9 lateral and 28 ventral teeth, dental depth 0.08 mm. Mandible (Fig. 1H) long and narrow, with 4 fine uniform teeth per 0.004 mm, a dental depth of 0.056 mm. Cibarium (Fig. 1I) 0.058 (0.05-0.065) mm broad, with a convex row of about 30-32 almost equal sized teeth (27 lateral conspicuous teeth with a slightly broader base and 5 central thinner teeth), ventral plate angular darkly pigmented with a deep median notch of variable shape (0.014 mm long and 0.01 mm broad), on each side of median notch lower margins of ventral plate has 2-3 protrusions, ventral plate becomes dark gray posteriorly, chitinous arch ill-developed, a longer pigment patch present but not developed. Pharynx (Fig. 1J) 0.135 (0.13-0.14) mm long, 3.04-3.42x hind width, posterior width 1.461-1.533 times fore width, height of pharyngeal armature 0.028 (0.02-0.036) mm and was 0.207x length of pharynx, pharyngeal bulb width=0.042 (0.038-0.046) mm, basal width=0.037 (0.034-0.04) mm. The anterior edge of armature formed an almost straight line, armature is in the form of 4-5 rows of scales with pointed hind ends and also longer basal spicules, most of the armature is confined in the basal part of the pharyngeal bulb, lateral walls of the pharynx in side the bulb bears 5-8 sparsely arranged long spicules pointing anteriorly. Female genitalia: spermatheca (Fig. 1K) 0.060 (0.056-0.065) mm long, oblong, elliptical and thick walled, fore width of spermathecal capsule 0.017 (0.016-0.018) mm, central width 0.033 (0.032-0.034) mm, basal width of spermathecal capsule 0.019 (0.018-0.02) mm, spermathecal ducts (Fig. 1L) 0.016 mm broad with a joint opening into genital atrium (Fig. 1M) which was 0.04 (0.032-0.05) mm broad and genital furca (Fig. 1N) 0.082 (0.08-0.084) mm long.

**Male :** 85 specimens were examined (Fig. 2). Small or middle sized dark sandfly. Eye 0.215 (0.195-0.225) mm long,

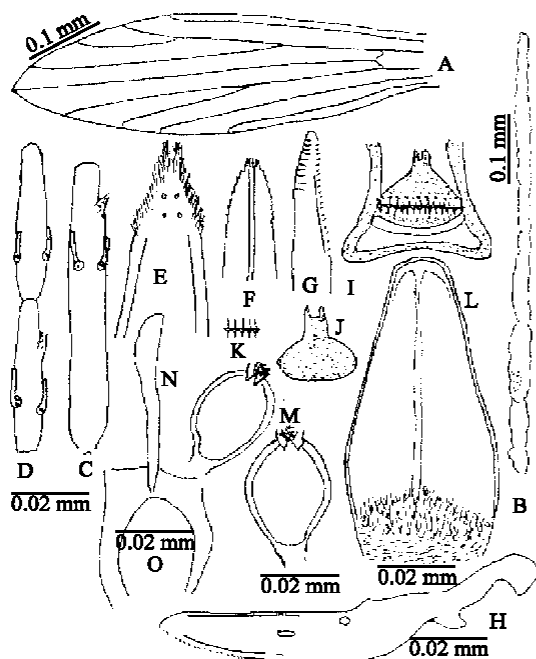


Fig. 3: Camera Lucida drawings of *Sergentomyia palestinensis* (♀) from Balochistan showing: wing (A), palp (B), the third (C), fourth (D, lower) and fifth (D, upper) antennal segments, labrum (E) hypopharynx (F), maxilla (G), mandible (H), cibarium (I), pigment patch (J), cibarial teeth (K), pharynx (L), spermatheca (M), furca (N), genital atrium (O)

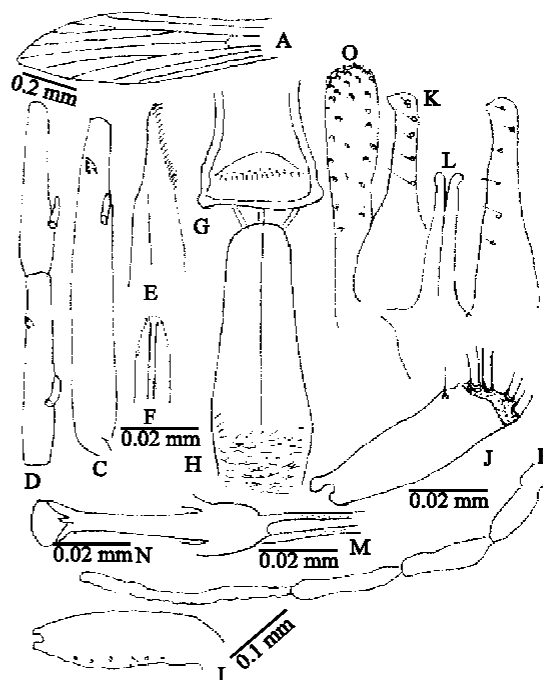


Fig. 4: Camera Lucida drawings of *Sergentomyia palestinensis* (♂) showing: wing (A), palp (B), the third (C), fourth (D, lower) and fifth (D, upper) antennal segments, labrum (E) hypopharynx (F), cibarium (G), pharynx (H), coxite (I), style (J), paramere (K), aedeagus (L), genital filament (M), pump (N), surstyle (O)

0.625x length of head, 0.17 (0.16-0.185) mm broad, distance between eyes 0.216 (0.20-0.225) mm, head 0.37 (0.344-0.416) mm long, 0.42 (0.40-0.44) mm broad. Wing (Fig. 2A) 1.359 (1.237-1.60) mm long, 0.29 (0.24-0.344) mm broad,  $\alpha=0.16$  (0.12-0.2) mm, but in 2 specimens from Chaman, one shortest  $\alpha=0.08$  mm long is measured, the other is a longest  $\alpha=0.24$  mm long,  $\beta=0.25$  (0.224-0.28) mm long, but in one specimen from Khuzdar, a longest  $\beta=0.32$  mm long is measured,  $\delta=0.065$  (0.04-0.096) mm long, but in four specimens from Chaman, 2 specimens showed  $\delta=$ zero, whereas in one specimen a positive shortest (+ 0.016 mm)  $\delta$  is noticed, in other specimen a negative shortest (- 0.016 mm long)  $\delta$  is measured, from Nal a shortest  $\delta + 0.024$  mm long was observed.  $\gamma=0.24$  (0.2-0.28) mm long,  $\pi=0.096$  (0.064-0.12) mm, whereas in 3 specimens from Chaman a shortest  $\pi=0.024$  mm and 0.04 mm respectively is measured, whereas a longest  $\pi=0.144$  mm was also noticed. Alar index=0.535-0.714. Proboscis 0.175 (0.16-0.19) mm long. Palp (Fig. 2B) 0.66 (0.59-0.72) mm long, with relative length 1: 2.13:3.31:3.52:7.7 and commonest formula 1,2,3,4,5 but also 1,2,(3-4),5. P3 has about 3-4 but in some specimens 10-13 prominent Newstead's sensilla, other

palpal segments have none. A3 (Fig. 2C) 0.165 (0.14-0.19) mm long, 0.121x length of swing, 0.942x length of proboscis, 0.97x length of A4+5, 1.269x length of labrum, ascoid on A3=0.018 (0.016-0.02) mm long, 0.109x length of segment, ascoid situated at 0.687 of the segment, 1 papilla situated at 0.912 of the segment. A4 (Fig. 2D, lower) 0.085 (0.07-0.1) mm long, ascoid on A4=0.018 (0.016-0.02) mm long, 0.211x length of segment and situated at 0.375 of the segment, 1 papilla situated at 0.75 of the segment. A5 (Fig. 2D, upper) 0.085 (0.07-0.1) mm long, ascoid on A5=0.018 (0.016-0.02) mm long and is 0.211x length of segment and situated at 0.3 of the segment. There is one ascoid on segments III to XV. Antennal segments III and IV have a single prominent papilla (Fig. 2C-2D) on A3 it is usually by the opposite side of the ascoid but is occasionally anterior to it. On A4 the papilla was situated far anterior to the ascoid tip. AIII is shorter than AIV+AV (about x 0.95). Labrum (Fig. 2E) 0.13 (0.12-0.14) mm long, with 3-4 median apical sensilla long, adorals also long, sensilla depth 0.032 mm, labrum is 0.095x length of wing. Hypopharynx (Fig. 2F) with about 18 teeth on each side and a dental depth of 0.034 mm. Maxilla (Fig. 2G) with a maximum breadth of 0.096 mm and anteriorly terminate into a 0.011 mm long

sharp pointed end. Cibarium (Fig. 2H) 0.05 (0.045-0.056) mm broad, 16-18 hardly visible minute teeth arranged on a convex row, additional row of smaller dot like teeth at their bases is inconspicuous, chitinous arch developed, a long anterior process present, cibarial ventral plate is angular but without a deep median notch, pigment patch absent. Pharynx (Fig. 2I) lamp-glass shaped, 0.135 (0.126-0.14) mm long, 3.04-3.331x hind width, hind width 1.437-1.461 times fore width, basal width 0.028 (0.024-0.032) mm, pharyngeal bulb width 0.042 (0.038-0.046) mm, 0.029 (0.026-0.032) mm fore width. The anterior edge of armature formed an almost straight line. Pharyngeal armature weak and confined in the posterior part of the pharyngeal bulb, lateral walls of the pharyngeal bulb bear 7-9 sparsely arranged ridges pointing towards anterior of the pharynx. The posterior and anterior part of armature was in the form of fine, weak, curved as well as straight ridges. Height of armature= 0.028 (0.024-0.032) mm and was 0.19-0.228x length of pharynx. Male terminalia: Coxite (Fig. 2J) 0.195 (0.19-0.204) mm long, 0.065 (0.06-0.07) broad, coxite length/breadth=2.91-3.16, coxite/style=2.04-2.11, coxite/labrum=1.45-1.58, coxite/A3=1.07-1.35. Style (Fig. 2K) 0.095 (0.09-0.1) mm long, 0.29 (0.26-0.32) mm broad, a ventral seta 0.03 mm long and was at 0.711 of the length of style, style with 2 terminal and 2 sub-terminal spines. Paramere (Fig. 2L) 0.15 (0.14-0.16) mm long, the basal and middle part of the body of paramere extend down wards 0.038 (0.032-0.044 mm) broad, with a ventral tubercle 0.018 (0.016-0.02) mm broad, bearing 3 short spinules, body of paramere with 8-10 long bristles, gradually narrowing towards anterior and finally bends laterally like a bird's head. Aedeagus (Fig. 2M) 0.095 (0.09-0.11) long, straight highly pigmented, tapering to an almost rounded and blunt colorless tip, which was 0.008 (0.008-0.009) mm long, a different view of aedeagus at a different angle (Fig. 2N). Genital pump (Fig. 2O) 0.098 (0.09-0.12) mm long, filament (Fig. 2P) with transverse striations 0.25 (0.2-0.3) mm long, 1.282x length of coxite, with filament to pump ratio of 2.222-2.50. Surstyle (Fig. 2Q) 0.175 (0.16-0.19) mm long, 0.897x length of coxite.

**Distribution:** Balochistan. New Record, Present survey: Adampur, Barkhan, Chaman, Dashte Kuddan, Dera Allah Yar, Dhadar, Hairdin, Kahan, Kohlu, Khuzdar, Nal, Nanasaheb ziarat, Panjgour, Sibi, Usta Muhammad, Wadh. These localities are important foci of cutaneous leishmaniasis. Sandflies were collected from indoors and outdoors using mouth aspirators and sticky traps.

*Sergentomyia (Parrotomyia) palestinensis* Adler and Theodor<sup>[6]</sup>  
(Text-Figs. 3 and 4 and Table 2)

*Phlebotomus sp.* Adler and Theodor<sup>[34]</sup>, Bull. ent. Res., 16: 404.

*Phlebotomus palestinensis*, Adler and Theodor<sup>[6]</sup>, Ann. Trop. Med. Parasit., 21: 64.

Theodor<sup>[7]</sup>, Bull. ent. Res., 38: 96, Lewis<sup>[35]</sup>, Ann. Mag. Nat. Hist., 12: 691.

*Sergentomyia (Parrotomyia) palestinensis* Adler and Theodor<sup>[6]</sup>, Theodor<sup>[36]</sup>: 44, Lewis<sup>[5]</sup>, Bull. Brit. Mus. Nat. Hist. (Ent.), 19: 34, Perfiliev<sup>[37]</sup>, 326, Artemiev,<sup>[33]</sup> Medskaya Parazit., 45: 427, Lewis<sup>[24]</sup>, Bull. Brit. Mus. Nat. Hist. (Ent.), 37: 264, Artemiev<sup>[16]</sup>: 28.

**Female** : 6 specimens were examined (Fig. 3). Wing (Fig. 3A) narrow, 1.25-1.28 mm long, 0.30-0.32 mm broad,  $\alpha$ =0.12-0.144 mm long,  $\beta$ =0.24-0.26 mm long,  $\delta$ = 0.04, but in 2 specimens from Bela  $\delta$  is measured to be zero.  $\gamma$ = 0.256-0.28 mm,  $\pi$ =0.096-0.12 mm, alar index= 0.5-0.553. Palp (Fig. 3B), 0.52-0.54 mm long, palpal ratio 1:2:3.66:4:6.66, palpal ratio 1,2,3,4,5. P3 has 15-20 prominent Newstead's sensilla at the basal third of the segment, other palpal segments have none. Proboscis. 0.14-0.155 mm long. A3 (Fig. 3C), 0.13-0.14 mm long, 0.104-0.109x length of head, 0.90-0.93x length of proboscis, 1.08-1.16x length of labrum, 0.915-0.958x A4+5. Ascoid on AIII=0.016-0.018 mm long, 0.123-0.128x length of segment. AIV (Fig. 3D, lower) 0.070-0.072 mm long, ascoid on AIV=0.014-0.016 mm long, 0.20-0.22x length of segment. AV (Fig. 3D, upper) 0.072-0.074 mm long, ascoid on AV=0.016 mm long, 0.021-0.22 x length of segment. Antennal segments III and IV have a single prominent papilla (Fig. 3C-3D). It is always by the side of ascoid and occasionally it is anterior to the ascoid. The positions of the papillae on the segments are: AIII, 0.84 and AIV, 0.67. The positions of the ascoids on the segments are: AIII, 0.63, AIV, 0.28 and AV, 0.22. Antennal segment III was shorter than AIV+AV (0.92-0.96x length of segment). There are two ascoids on segments III to XV. Labrum (Fig. 3E), very broad, 0.12 mm long, 0.03 mm broad, with 4 thin, long, apical sensilla, about 22 lateral sensilla, fine, a dental depth of 0.036 mm. Hypopharynx (Fig. 3F), apex less broad and less tapers, 0.022 mm broad, about 19 re-curved indentations at sides, a dental depth of 0.032 mm. Maxilla (Fig. 3G) 0.012 mm broad, with 10 lateral teeth (the 6th-the bigger one about 0.005 mm long) and 19 ventral, a dental depth of 0.06 mm. Mandible (Fig. 3H), very broad, 0.17 mm long, 0.014 mm minimum breadth, 0.024 mm maximum breadth, 9 teeth per 0.008 mm, a dental depth of 0.036 mm. Cibarium (Fig. 3I), 0.044-0.05 mm broad. The pigmented area large and about 0.036 mm long and 0.022 mm broad (Fig. 3J) apex conical and with a bifid short anterior process, 0.011 mm long and 0.012 mm broad, postero-lateral edges of cibarium kob like. Armature consisting of a straight row of about 15-18 parallel arrow-like teeth (length of a single tooth about 0.006 mm) with moderately long points, each with a nodular thickening near its center (Fig. 3K), a second row of about 19-21

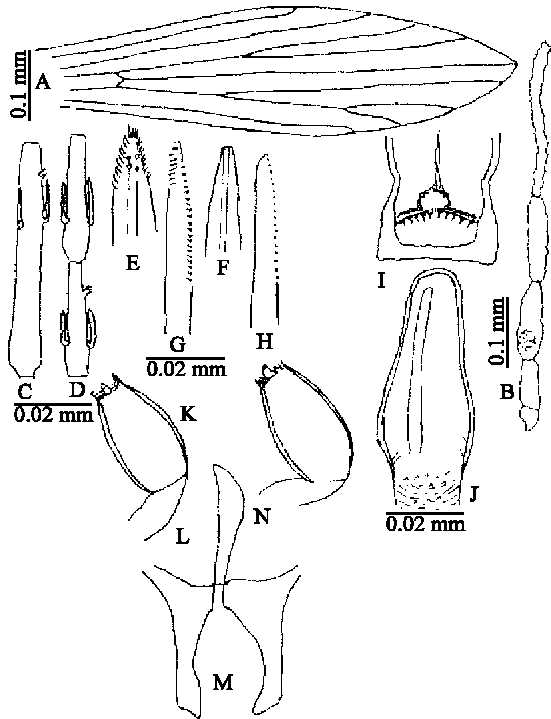


Fig. 5: Camera Lucida drawings of *Sergentomyia (Parrotomyia) baghdadis* (♀) from Balochistan showing: wing (A) palps (B), third (C), fourth (D, lower) and fifth (D, upper) antennal segments, labrum (E), hypopharynx (F), maxilla (G), cibarium (I), pharynx (J), spermatheca (K), duct (L), genital atrium (M), genital furca (N).

punctiform denticles at the base of long ones. Pharynx (Fig. 3L), 0.14 -0.152 mm long, much dilated posteriorly, length 3.45-3.68 times the greatest breadth is 2.25-2.27 times the anterior shortest breadth. The edge of anterior armature is in convex line. Anterior armature is composed of relatively larger teeth in the form of a patch (0.020 mm broad) and the posterior armature is in the form of a patch (0.018 mm broad) and is composed of smaller vertical ridges, armature is 0.27-0.29x length of pharynx. Spermatheca (Fig. 3M) rounded, 0.04-0.044 mm long, 0.032-0.04 mm broad, apical depression 0.012 mm long and 0.013 mm broad, furca (Fig. 3N), 0.08- 0.084 mm long and genital atrium (Fig. 3O) 0.035-0.038 mm broad.

**Male :** 2 specimens were examined (Fig. 4). Wing (Fig. 4A) 1.12-1.20 mm long, 0.24-0.32 mm broad,  $\alpha$ =0.08-0.184 mm,  $\beta$ =0.20-0.28 mm,  $\delta$ =0.024-0.064 mm,  $\gamma$ =0.208-0.24 mm,  $\pi$ = zero to 0.08 mm, alar index=0.4-0.657. Palp (Fig. 4B) 0.44-0.55 mm long, palpal ratio 1, 2.6, 4, 4.2, 8, palp formula 1, 2, 3, 4, 5. A3 (Fig. 4C) 0.12-0.16 mm long, ascoide 0.016 mm long, position of ascoide on A3=0.8, ascoide 3/A3=0.1-0.13, position of a single papilla on A3=0.925. A4 (Fig. 4D,

lower) 0.082-0.084 mm long, ascoide 0.016 mm long, position of ascoide on A4=0.24, ascoide 4/A4=0.19-0.195, position of a single papilla on A4=0.9. A5 (Fig. 4D,upper) 0.080-0.082 mm long, ascoide 0.016 mm long, position of ascoide on A5=0.243, ascoide 5/A5=0.195-0.20. Labrum (Fig. 4E) 0.12-0.14 mm long, 0.017 mm broad, a sensilla depth of 0.036 mm. Hypopharynx (Fig. 4F) apex pointed, a dental depth of 0.028 mm. A3/labrum=1.0-1.142, A3/A4+5=A3 < A4+5 (=0.74-0.96). Cibarium (Fig. 4G) 0.052 mm broad, with about 12-13 uniform, short parallel teeth on a straight line and irregular row of short punctiform denticles at the base of teeth, pigmented area weakly marked chitinous arch and anterior process absent. Pharynx (Fig. 4H) 0.12mm long and 3-3.33 times as long as posterior greatest breadth is 1.33-1.38 times as broad as anterior narrow part. Armature little developed and consists of irregular rows of short spines. Male terminalia: Coxite (Fig. 4I) 0.2-0.22 mm long, 0.06-0.064 mm broad, coxite length/breadth=3.33-3.43, coxite/style=2.2-2.22, coxite/labrum=1.57-1.66, coxite/A3=1.375-1.66. Style (Fig. 4J) 0.09-0.10 mm long, 0.024-0.026 mm broad with 2 apical spines and 2 sub apical spines at about 0.89, spines about 0.086 mm long, a short seta at 0.8. Paramere (Fig. 4K) 0.13 mm long and 0.032-0.034 mm broad, with slightly hooked end. Aedeagus (Fig. 4L) 0.09 mm long, narrow, about 0.012 mm broad, base triangular, with an apical notch at 0.88. Genital filament (Fig. 4M) 0.28-0.30 mm long with slight striations and pump (Fig. 4N) 0.08-0.10 mm long and filament to pump ratio of 3.0-3.5. Surstyle (Fig. 4O) 0.17 mm long 0.77- 0.85x length of coxite.

**Distribution:** Balochistan. New Record, Present survey: Bela, Khuzdar, Uthal These localities are important foci of cutaneous leishmaniasis. Sandflies were collected from human residences through mouth aspirators and sticky traps.

*Sergentomyia (Parrotomyia) baghdadis* Adler and Theodor<sup>[13]</sup>  
(Text-Figs. 5 and 6 and Table 3)

*Phlebotomus baghdadis*, Adler and Theodor<sup>[13]</sup>, Ann. Trop. Med. Parasit., 23: 281, Sinton<sup>[3]</sup>, Indian J. Med. Res., 20: 60,73, Sinton<sup>[4]</sup>, Indian J. Med. Res., 21: 422-423[♀ ♂]

*Parratomyia (Parrotomyia) baghdadis* Adler and Theodor, Lewis<sup>[5]</sup>, Bull. Bri. Mus. Nat. Hist. (Ent.), 19:30, Artemiev<sup>[33]</sup>, Medskaya Parazit., 45:424, Artemiev<sup>[16]</sup>:29, Lewis<sup>[24]</sup>, Bull.Brit. Mus. Nat. Hist. (Ent.), 37: 258.

**Female:** 69 specimens were examined (Fig. 5). Eye=0.22 (0.20-0.24) mm long, 0.511x length of head, 0.19 (0.18-0.20) mm broad, distance between eyes= 0.22 (0.21-0.23) mm. Head=0.43 (0.42-0.44) mm long, 0.44 (0.45- 0.46) mm broad. Wing (Fig. 5A) 1.45 (1.4-1.50)mm long, 0.36 (0.34-0.38)mm

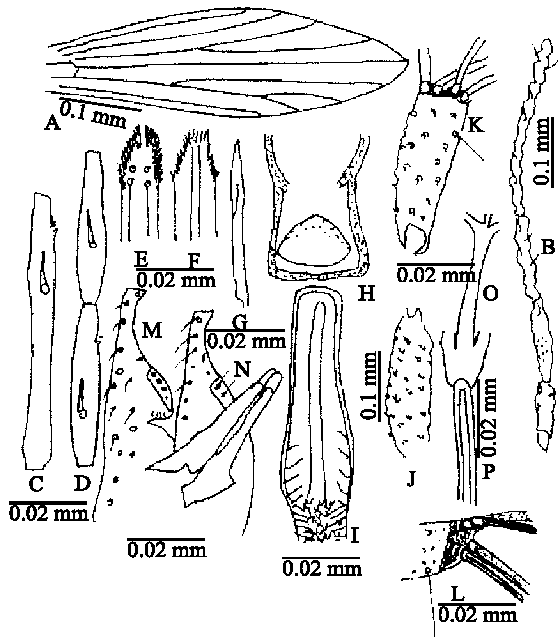


Fig. 6: Camera Lucida drawings of *Sergentomyia (Parrotomyia) baghdadis* ( $\sigma^7$ ) from Balochistan showing: wing (A) palps (B), third (C), fourth (D, lower) and fifth (D, upper) antennal segments, labrum (E), hypopharynx (F), maxilla (G), cibarium (H), pharynx (I), coxite (J), style (K), style with spines (L), paramere (M), aedeagus (N), genital pump (O), filament (P)

broad.  $\alpha=0.19$  (0.16-0.228) mm, in three specimens, one from Sibi and two from Usta Muhammad, the longest  $\alpha=0.248$ , 0.24, 0.256 mm are observed respectively,  $\beta=0.30$  (0.28-0.32) mm,  $\delta=0.062$  (0.04-0.096) mm, in one specimen from Sibi a longest  $\delta=0.112$  mm is measured,  $\gamma=0.29$  (0.22-0.35) mm, in one specimen from Dera Allah Yar a longer  $\gamma=0.416$  mm long is observed,  $\pi=0.088$  (0.08-0.096) mm, a smaller  $\pi=0.048$  mm and a longest  $\pi=0.144$  mm is observed in specimens from Sibi. Alar index 0.633 (0.571-0.712). Proboscis 0.195 (0.19-0.20) mm long. Palps (Fig. 5B) 0.67 (0.65-0.69) mm long, with relative length 1: 2.25:3.83:4.35:8.67, commonest formula 1, 2, 3, 4, 5. P3 has about 15-22, Newstead's sensilla at anterior third of the segment, other palpal segments have none. A3 (Fig. 5C) 0.15 (0.14-0.16) mm long, ascoids on A3=0.025 (0.02-0.03) mm long and is 0.147x length of segment, A3 is 0.103x length of wing, 0.769x length of proboscis, 0.887x length of labrum, 0.980x length of A4+5. A4 (Fig. 5D, lower) 0.078 (0.072-0.085) mm long, ascoid on A4=0.025 (0.02-0.03) mm long, ascoid 4/A4=0.287. A5 (Fig. 5D, upper) 0.075 (0.07-0.08) mm long, ascoid on A5=0.025 (0.02-0.03) mm long and 0.33x length of segment. Ascoid formula 2/3-15. Labrum (Fig. 5E) 0.169 (0.15-0.18) mm long, 0.116x length

of wing, labrum with 4-5 relatively small (0.004 mm long) median apical sensilla, adorals small and fine, sensilla depth 0.032 mm. Hypopharynx (Fig. 5F) lateral and apical margins smooth. Maxilla (Fig. 5G) 8 lateral teeth (0.003 mm broad) and 26 ventral teeth, a dental depth of 0.076 mm. Mandible (Fig. 5H), narrow (0.012 mm broad) 4 strongly recurved teeth per 0.004 mm, a dental depth=0.056 mm. Cibarium (Fig. 5I) 0.067 (0.06-0.076) mm broad, with 14-16 rather broad pointed teeth arranged on an convex arch (comprising 5-6 small narrower central teeth and 8-9 relatively larger lateral teeth on each side), ventral plate with a median notch of varying shape (0.014 mm deep and 0.017 mm broad), chitinous arch not well developed, pigment patch ill-developed with an anterior process or pigment patch absent. Pharynx (Fig. 5J) 0.14 (0.13-0.152) mm long, 2.765-3.04 times hind width, fore width 0.031 (0.031-0.032) mm, posterior width 1.516-1.562 times fore width, pharyngeal bulb width 0.047 (0.044-0.05) mm, basal width, 0.034 (0.032-0.036) mm. The anterior edge of armature forms an almost straight line whereas posterior armature is composed of transverse ridges with a few spicules, the side walls of the pharyngeal bulb have 4-5 lateral spicules pointing anteriorly, height of pharyngeal armature 0.03 mm and is 0.214x length of pharynx. Spermatheca (Fig. K) 0.065 (0.060-0.068) mm long, elliptical, or more or less oval, fore width of spermathecal capsule 0.017 (0.014-0.02) mm, maximum central width 0.042 (0.04-0.044) mm, basal width 0.023 (0.020-0.026) mm, ducts (Fig. 5L) 0.14 mm long and 0.016 mm broad, ducts with a common opening into genital atrium (Fig. 5M) which is 0.05 mm broad and genital furca (Fig. 5N) 0.08 mm long.

**Male:** 48 specimens were examined (Fig. 6). Eye 0.19 (0.17-0.21) mm long, 0.542x length of head, 0.148 (0.13-0.16) mm broad, 0.195 (0.165-0.22) mm, distance between eyes. Head 0.35 (0.32-0.38) mm long, 0.399 (0.38-0.41) mm broad. Wing (Fig. 6A) 1.29 (1.19-1.4) mm (1.19-1.4) mm long, 0.288 (0.26-0.31) mm broad,  $\alpha=0.15$  (0.11-0.18) mm long,  $\beta=0.25$  (0.24-0.264) mm,  $\delta=0.05$  (0.04-0.064) mm, in a single specimen from Kahan a shortest negative  $\delta$  -0.016 mm is observed whereas in another specimen from Chaman,  $\delta$  is measured to be zero,  $\gamma=0.219$  (0.19-0.24) mm long,  $\pi=0.088$  (0.08-0.096) mm, whereas in one specimen from Sibi a largest  $\pi$  is measured to be 0.127 mm long, alar index=0.6 (0.458-0.681). Proboscis 0.18 (0.17-0.19) mm long. Palps (Fig. 6B) 0.635 (0.62-0.65) mm long, with relative length 1:2.55:3.88:4.33:8.66 and a commonest formula 1,2,3,4,5, but also 1,2,3-4,5. P3 has 8-12 Newstead's sensilla at middle third of segment, other palpal segments have none. A3 (Fig. 6C) 0.16 (0.14-0.18) mm long, 0.124x length of wing, 0.888x length of proboscis, 1.142x length of labrum, 0.963x length of A4+5, ascoid on A3=0.018 (0.016-0.02) mm long



Table 1: Comparison of taxonomic characters (in mm) of *Sergentomyia babu babu* Annandale (1910)

♀ Taxonomic characters	Balochistan (Present study)	Lahore and Rawalpindi (Lewis, 1967)	Afghanistan (Artemiev, 1978)	Southern India (Ilango <i>et al.</i> , 1994)	Ceylon and Mauritius (Kirk and Lewis, 1951)
Wing length	1.43 (1.36-1.50)	1.64 (1.49-1.87)	-	1.5	1.4-1.6
breadth	0.35 (0.32 - 0.34)	0.37 (0.31-0.45)	-	-	0.34-0.42
Alar index	0.615 - 0.75	0.7	-	0.7	0.5-0.62
A3 length	0.178 (0.16-0.19) long	0.18 (0.17-0.21)	-	0.14	0.10-0.14
A3/Labrum	1.078	0.8-0.9xlength of labrum	1.0-1.17	-	0.9 - 0.10
A3/A4+5	1.059	1.0 (0.9-1.0)xlength. of A4+5	-	-	-
A3/Wing	0.124	-	-	0.09 x length of wing	A3=A4+5
Labrum length	0.165 (0.16-0.17)	0.16 (0.14-0.17)	-	0.16	0.13-0.15
Maxilla	Maxilla bearing 28 ventral and 9 lateral teeth, a dental depth 0.08	-	-	Maxilla with 30 ventral and 12 lateral teeth, dental depth =0.07	-
Ascoïd formula	2/3-15	-	-	2/315	-
Ascoïd 4/A4	0.329	0.3	-	0.4	0.4
A4+5	0.168 (0.14 - 0.19)	0.18 (0.16-0.20)	-	-	-
Palpal ratio	10 :22:40 : 42: 82.	-	-	10:12:17:17:19:27	-
Cibarium	30-32 sharply pointed almost equal sized teeth and a notch width 0.01	About 30 nearly equal pointed teeth	About 26-32 uniform pointed teeth	25 teeth, notch width 20 µm	36-40 equally pointed teeth on a row of concave posteriorly

Table 1: (continued)

♂ <i>S. babu babu</i> Taxonomic characters	Balochistan (Present study)	Lahore and Rawalpindi (Lewis, 1967)	Afghanistan (Artemiev, 1978)	Southern India (Ilango <i>et al.</i> , 1994)	Ceylon and Mauritius (Kirk and Lewis, 1951)
Wing length	1.359 (1.237-1.60)	1.33 (1.30-1.39)	-	1.4	1.27 - 1.53
breadth	0.29 (0.24-0.344)	0.27 (0.24-0.32)	-	-	0.34
Alar index	0.64 (0.535-0.714)	0.7 (0.4-0.9)	-	0.68	0.25-0.6
A3 length	0.165 (0.14-0.19)	0.16 (0.14-0.17)	0.164-200 µm	0.15	0.12-0.13
A3/wing	0.121	almost same length . . as of labrum	1.17-1.48	0.11	-
A3/Labrum	1.269	-	-	1.1	-
A3/A4+5	0.910	shorter than A4 + 5	-	-	-
Labrum length	0.13 (0.12-0.14) long 0.121xlength of wing	0.15 (0.14-0.16) long	-	0.14 mm, long 0.1	0.14-0.17
Ascoïd formula	1/3-15	-	-	1/3-15	1/3-15
Ascoïd 4/A4	0.211	0.2	-	0.2	0.2
A4+5	0.168 (0.14 - 0.19)	-	-	-	-
Palpal ratio	10:21:33:35:77	-	-	10 :9 :15 : 15: 38	10:12:13
Cibarium	16-18 hardly visible minute teeth, inconspicuous, additional row of smaller teeth at their bases.	Cibarial teeth often scarcely visible, about 10 in the center are pointed and 5 on each side are often ill-defined	20-22 hardly visible pointed teeth, additional row of smaller teeth at their bases.	Cibarium with 15 groups of teeth, each consisting of 3 or 4 teeth	With 2 rows of poorly developed denticles, variable and rather difficult to count, approximately 17 in each row
Coxite length	0.19-0.204 long	-	0.224-0.246 µm long	-	0.18-0.21
Style length	0.09-0.1, Seta at 0.711 of the style	Seta at 0.65 of the style	108-120 µm long	-	Seta at 0.7 of the style
Paramere	Beaked	-	Hooked with rather thick end.	Beaked	-
Aedeagus	Straight with rounded and almost blunt colorless end.	Tapering to a rounded colorless tip	Straight	Aedeagus narrow with blunt tip.	-
Genital filament/Pump	2.55, filament with transverse striations.	2.2, genital filament with transverse striations.	2.19-3.04, genital filament with transverse striations.	1.2	-

and is 0.112x length of segment, ascoïd situated at 0.699 of the segment. A4 (Fig. 6D, lower) 0.083 (0.07-0.098) mm long, ascoïd on A4=0.018 (0.016-0.02) mm long, 0.204-0.228x length of segment, ascoïd situated at 0.333 of the segment. Antennal segments III and IV have a single prominent papilla. It is usually by the side of the ascoïd but is occasionally anterior to it. The positions of the papilla on the segments are: AIII, 0.906 and AIV, 0.809. A5 (Fig. 6D, upper) 0.083 (0.07-0.095) mm long, ascoïd on A5=0.018 (0.016-0.02) mm long and 0.210-0.228 x length of segment, ascoïd situated at 0.291 of the segment. There

are one ascoïd on segments III to XV. Labrum (Fig. 6E) 0.14 (0.13-0.15) mm long, with 2 median apical sensilla, long and stout placed at a distance with one another, adorals compact and thinner, sensilla depth 0.04 mm. Hypopharynx (Fig. 6F) with 6 central and 11 lateral teeth strongly undulating. Maxilla (Fig. 6G) narrow, lateral and apical margins appear smooth or with very weak teeth, a dental depth of 0.028 mm. Cibarium (Fig. 6H) 0.049 (0.043-0.055) mm broad, about 16 minute hardly visible teeth arranged on a convex row, anterior to teeth there are 6-8 dot like embedded denticles present, cibarial ventral plate

Table 2: Comparison of taxonomic characters (in mm) of *Sergentomyia palestinensis* Adler and Theodor (1927)

♀ Taxonomic characters	Balochistan (Present study)	Jericho (Adler and Theodor, 1927 :64)	Dead sea and Baghdad (Theodor, 1947:96)	Azarbaijan (Perfiliev,1968:327)
Wing length	1.25 - 1.28	-	1.6-1.8	1.6-1.8 mm
breadth	0.30 - 0.32	-	0.4-0.45	0.4-0.5 mm
Alar index	0.5 - 0.55	-	0.5-0.6	-
A3 length	0.13-0.14 mm	-	-	0.17-0.19 mm
A3<A4+5	A3<A4+5	-	A3<A4+5	A3<A4+5
Ascoide 4/A4	0.20-0.22xlength of segment	-	-	¼ the length of segment
Palp formula	1,2,3,4,5	-	1,2,3-4,5	1,2,3-4,5
Cibarium	15-18 parallel long teeth, large pigmented area with short anterior process	About 20 teeth parallel and pointed standing of a straight line, pigmented area heart shaped and the apex anterior.	-	16-20teeth, pigmented area broad, more or less triangular or bifid also.
Pharynx	Widest part is 2.25 - 2.27 times the anterior part, anterior armature consisting of large teeth.	Widest part is twice as wide as the anterior part, teeth are very numerous and strongly marked. A posterior margin of toothed area is slightly indented.	-	Lamp-glass shaped, armature well developed, the spines well marked, amature occupies the whole posterior part of the pharynx, its anterior margin extends into the wide part of the pharynx, spines of the armature pointed, the points directed anteriorly.
Spermatheca	Almost rounded.	Almost spherical length to breadth 4:3.	-	Spermatheca with globular capsule and short, narrow ducts.

Table 2: (continued)

♂ <i>S. palestinensis</i> Taxonomic characters	Balochistan (Present study)	Jericho (Theodor, 1947 :96)	Azarbaijan (Perfiliev, 1968 : 326)
Wing length	1.12-1.20 mm	1.4	1.4-1.7 mm
breadth	0.24-0.32	0.26	0.26-0.32 mm
Alar index	0.4-0.657	0.4	-
A3 length	0.12-0.16 mm, A3<A4+5	-	0.18-0.19 mm, A3<A4+5
Palp formula	1,2,3-4,5	1,2,3-4,5	1,2,3-4,5
Cibarium	12 - 13 uniform teeth on a straight line, pigmented area weakly marked.	12-13 teeth, with moderate points, pigmented area very faint	12 teeth, uniform, short, pointed, on a line slightly convex anteriorly or straight, pigmented area weakly marked, triangular, with rounded corners.
Pharynx	1.33-1.38 times as wide posteriorly as anteriorly. Armature little developed.	Twice as wide posteriorly as anteriorly. Armature consisting of several rows of irregular blunt and well marked teeth.	Narrow, slightly widened at the posterior half, armature little developed, consisting of irregular rows of minute, indistinct and weakly marked denticles.
Coxite length	0.20-0.22 mm	-	0.20 mm
Style length	0.09-0.10 mm, style is about half the length of coxite, 4 spines : 2 apical, 2 sub apical, ventral seta at 0.8 of the anterior end style.	Half the length of coxite, 4 spines: 2 terminal, 2 sub terminal	0.09, terminal spines consisting of 2 apical and 2 sub-apical spines, ventral seta short, closer to the apex,
Paramere	With hooked end.	With hooked tip	Hooked,
Aedeagus	Narrow.	Slender, tapering to a blunt rounded point	Narrow with light blunt tip.
Surstyle length	0.17 mm, 0.7- 0.85xlength of coxite.	As long as coxite.	0.18 mm, shorter than coxite
Genital tubes/genital pump	3.0-3.5	-	Genital tubes almost 4 times as long as genital pump.

forms a deep angle shaped onvex arch, apex of the arch sharply curved not showing a deep notch, but its hind ends markedly concave, chitinous arch ill defined or in some specimens absent, pigment patch also absent. Pharynx (Fig. 6I) lamp glass shaped, 0.125 (0.12-0.13) mm long, 2.826-3.157 times hind width, posterior width 1.533-1.583 times fore width, 0.027 (0.024-0.03) mm fore-width, 0.042 (0.038-0.046) mm pharyngeal bulb width, 0.028 (0.024-0.032) mm basal width. The anterior edge of armature forms an almost straight line whereas most of the armature occupies the pharyngeal bulb where teeth is in the form of weak transverse faint ridges, height of armature 0.022 (0.020-0.024) m and is 0.183-0.184 times

pharyngeal length, inner side walls of pharyngeal ulb bear 7-9 short and long ridges pointing anteriorly. Coxite (Fig. 6J) 0.22- 0-23 mm long, 0.065 (0.06-0.07) mm broad, coxite length/ breadth length/breadth=3.28-3.66, coxite/style=2.3-2.44, coxite/labrum=1.53-1.69, coxite/A3=1.27-1.57. Style (Fig. 6K) 0.09 (0.08- 0.10) mm long, 0.028 (0.027- 0.29) mm broad, a ventral seta 0.04 mm long situated at 0.75 (0.70-0.80) of the length of the style, style with 2 terminal and 2 sub terminal spines (Fig. 6L). Paramere (Fig. 6M) 0.14 (0.13-0.15) mm long, the basal and middle part of the paramere extend downwards 0.038 (0.036-0.04) mm with a ventral tubercle 0.016 (0.012-0.018) mm broad, bearing 3 short spinules, body of paramere bears 9-12 long bristles,

Table 3: Comparison of taxonomic characters (in mm) of *Sergentomyia (Parratomyia) baghdadis* Adler and Theodor (1929)

♀ Taxonomic characters	Balochistan (Present study)	Rawalpindi, Peshawar and other parts of Pakistan (Lewis, 1967)	Afghanistan (Artemiev, 1978 : 29)	Baghdad (Adler and Theodor, 1929 : 284)
Wing length	1.45 (1.25 - 1.66) mm.	1.62 (1.51 - 1.72) mm	-	
breadth	0.36 (0.34 - 0.38) mm	0.35 (0.32 - 0.338) mm	-	
Alar index	0.578 (0.529 - 0.633)	0.6 (0.3 - 0.8)	-	0.50-0.75
Palpal formula	1,2,3,4,5.	1,2,3,4,5.	-	1,2(3-4),5
Labrum length		0.15 (0.14-0.17) mm	-	
A3 length	0.17 (0.15-0.19) mm	0.16 (0.15 -0.17) mm	-	
A3/A4+5	0.952	A3 is of same length as A4+5	-	
A3/Labrum	A3 almost equal to length of labrum	1.0-1.11	-	A3=A4+5
Cibarium	14-16 teeth (8-9 larger lateral, 5-6 smaller median)	About 18 teeth (4 small median and 7 large lateral ones.) ill defined.	About 16 - 20 teeth (4-5 central smaller than lateral ones.	A row of about 16-18 rather broad pointed teeth standing on an arc concave posteriorly.
Chitinous arch	Ill defined.			The teeth in middle are narrower than the side ones.
Pigment patch	ill developed and usually hidden	Broad.		Posteriorly it is about twice as wide anteriorly.
Pharynx	Posteriorly, 1.51-1.56 times as wide as anteriorly.	Pharynx with faint transverse ridges.	-	

Table 3: (continued)

♂ <i>S. baghdadis</i> Taxonomic characters	Balochistan (Present study)	Rawalpindi, Peshawar and other parts of Pakistan (Lewis, 1967).	Afghanistan (Artemiev, 1978 : 29)	Baghdad (Adler and Theodor, 1929:282)
Wing Length	1.29 (1.19 - 1.4) mm	1.51 (1.39 - 1.64) mm	-	
Breadth	0.288 (0.26 - 0.31) mm	0.32 (0.28 - 0.36) mm	-	
Alar index	0.458-0.681		-	1.0-0.26
Ascoid 4/A4	0.204-0.228)	0.2	-	-
Labrum Length	0.14 (0.13-0.15) mm	0.15 (0.14-0.16) mm	-	
A3 Length	0.16 (0.14-0.18) mm	0.17 (0.14-0.19) mm	-	
A3/A4+5	0.963x A4+5.	A3 slightly shorter than A4+5	-	
A3/Labrum	1.142	1.1 (1.0-1.2)	-	
Genital filament/Pump	2.5-2.545	2.5	-	
Cibarium	About 16 minute teeth.		14-16 teeth	-
Chitinous arch	Ill defined	Ill defined.		
Pigment patch	Absent	Absent		
Paramere	Gradually narrowing anteriorly and bends laterally like a bird's head	-	-	Tapering to an almost rounded blunt tip.
Aedeagus	Tapering to an almost rounded blunt tip.	With colorless rounded tip.	-	Intermediate appendages sharply pointed ventrally

gradually narrowing towards anterior and finally bends laterally like a bird's head. Aedeagus (Fig. 6N) 0.105 (0.10-0.11) mm long, straight, darkly pigmented, tapering to an almost rounded blunt and colorless tip 0.008 (0.008 -0.009) mm long. Genital pump (Fig. 6O) 0.095 (0.08-0.11) mm long, genital filament (Fig. 6P) 0.24 (0.20-0.28) mm long, with no transverse striations, 1.09x length of coxite, F/P=2.5-2.545. Surstyle 0.169 (0.15-0.18) mm long, 0.768x length of coxite.

**Distribution:** Balochistan: New Record, Present survey: Bela, Chaman, Dashte Kuddan, Dera Allah Yar, Dhadar, Duki, Kahan, Kohlu, Khuzdar, Nal, Panjgour, Sibi, Turbat, Usta Muhammad, Wadh. These localities are important foci of cutaneous leishmaniasis (CL). Sandflies were collected from indoors and outdoors using mouth aspirators and sticky traps. Dera Bugti<sup>[38]</sup>, Sangsila<sup>[17]</sup>.

Keys for the identification of Pakistanese *S. babu babu*, *S. palestinensis* and *S. Baghdadis* Cibarium with 1 or more rows of teeth, pigment patch usually present, hairs on the hind ends of abdominal tergites 2-6 recumbent, sockets much smaller than 1 except in a few

species which have a few erect hairs. Dististyle with 4 large spines and an accessory ventral seta.....  
 .....Genus *Sergentomyia* A comb like cibarial armature, lamp glass-shaped pharynx and elliptical capsular spermatheca.....  
 Subgenus *Parratomyia* Cibarium with a convex row of 30-32 almost equal sized teeth (27 lateral conspicuous teeth with a slightly broader base and five central narrower teeth), ventral plate angular darkly pigmented having 2-3 protrusions and with a deep median notch of variable shape, A3=0.16-0.19 mm long 1.....  
 ♀ *S. babu babu* Cibarium with about 14-16 rather broadly pointed teeth (comprising about 5-6 small narrower central teeth and 8-9 relatively larger teeth on each side) arranged on a convex arch, A3=0.14-0.16 mm long.....  
 ♀ *S. baghdadis* Cibarium with 15-18 parallel arrow like teeth with moderately long points, each with a nodular thickening near its center, a second row of about 19-21 punctiform denticles at the bases of long ones, A3=0.13-0.14 mm long.....  
 ♀ *S. palestinensis*

Cibarial teeth 16-18 (about 10 in the center are pointed and five on each side are often ill-defined), arranged on a convex row, additional row of smaller dot like teeth at their bases, A3=0.14-0.19 mm long, genital filament about 2.2-2.50 times pump length..... ♂ *S. babu babu*.  
 Cibarium with 12-13 short, uniform, parallel teeth arranged on a straight line, irregular row of short punctiform denticles at the bases of teeth, A3=0.12-0.16 mm long, genital filament about 3.0-3.5 times pump length..... ♂ *S. palestinensis*  
 Cibarial teeth 16 hardly visible, arranged on a convex row, additional row of 6-8 smaller dot like teeth at their bases, cibarial ventral plate forms a deep angle shaped convex arch, apex of the arch sharply curved not showing a deep notch, A3=0.14-0.18 mm, genital filaments about 2.5 times pump length..... ♂ *S. baghdadis*

### DISCUSSION

Results of the present study are compared with the published data of these species from other territories (Table1-3).

*S. babu babu* (Table1) ♀ specimens of Balochistan Province are found differ with the published data of this species from Lahore and Rawalpindi specimens<sup>[5]</sup>, Southern India<sup>[39]</sup>, Ceylon-Mauritius<sup>[40]</sup>. The present specimens are showing a relatively shorter wing, alar index and ascoid 4/A4 as compared with the published data of this species from northern Pakistan, southern India and Ceylon and Mauritius. It was also found to differ in numbers of cibarial teeth (Balochistan specimens=30-32 teeth, northern Pakistan=30, southern India=25, Ceylon and Mauritius=36-40 teeth). However, specimens from Balochistan are observed resembling in characters like A3, labrum and ascoid formula with the published data of this species from northern Pakistan and southern India. Similarly, ♂ forms of this fly from Balochistan were also found to differ having a relatively shorter labrum, as compared with the form of northern Pakistan, Ceylon-Mauritius, also having a shorter A3 as compared with the form of Afghanistan and northern Pakistan and in fewer number of cibarial teeth (16-18) than the Afghanistan form (20-22 teeth). However, Balochistan specimens do show a closer resemblance in number of cibarial teeth, with the specimens from northern Pakistan, southern India and Ceylon and Mauritius and also in ascoid formula, Ascoid 4/A4, aedeagus and paramere.

*S. palestinensis* (Table 2) ♀ form of Pakistani flies are found to differ from Azarbaijan specimens<sup>[37]</sup> in characters like, a relatively shorter A3 and fewer cibarial teeth (Pakistan=15-18, Azarbaijan=16-20). However, Pakistani specimens were observed to be closely resembling in characters viz., A3 < A4+5, shorter ascoids, presence of

punctiform denticles at the base of teeth, larger triangular pigmented area with conical apex, morphology of pharynx with well developed armature and structure of spermatheca. Balochistan specimens were also found to resemble with type specimens from Jericho<sup>[6]</sup> in the morphology of cibarium, pharynx and spermatheca (almost spherical, length to breadth 4:3) but have fewer cibarial teeth (Pakistan=15-18, Jericho=20). Similarly, ♂ form of Pakistani flies were found to differ from Azarbaijan specimens in characters like shorter A3, but it was found to agree with it in A3 < A4 + 5, shorter ascoids, morphology of cibarium, number of cibarial teeth (Pakistan=12-13, Azarbaijan=about 12), weakly marked pigmented area, pharynx and its weak armature and male terminalia specially coxite, style, paramere, aedeagus and filament/ pump ratio. There are no published reports incriminating *S. palestinensis*, which is thought to be a probable vector of reptilian leishmaniasis<sup>[16]</sup> and presumably plays no part in transmitting *Leishmania*. *S. baghdadis* (Table 3) A relatively larger ascoid 4/ A4, a comparatively shorter wing length, breadth, A3, A3<A4+5, are observed in ♂ specimens of *S. baghdadis* from Balochistan as compared with the published data of *S. baghdadis* from Lahore and Rawalpindi, Pakistan<sup>[5]</sup>. However, ill-defined chitinous arch, absence of pigment patch, aedeagus and genital filament/ pump were found same and well coincides with the published data of this species from Lahore and Rawalpindi<sup>[5]</sup>. Similarly, palpal formula, number and kind of cibarial teeth, morphology of cibarium, chitinous arch, pigment patch and pharynx in ♀ specimen from Balochistan also coincides with these taxonomic characters of specimens of this species from Punjab<sup>[5]</sup>. A relatively larger A3 and shorter wing length, alar index, A3<A4+5 in ♀ *S. baghdadis* from Balochistan are observed as compared with the specimens of this species from Punjab<sup>[5]</sup>. Morphology of pharynx and cibarium including number and shape of cibarial teeth of ♂ and ♀ *S. baghdadis* from Balochistan were observed similar to those from Afghanistan<sup>[16]</sup>. Similarly, alar index, A3=A4+5, palpal formula and morphology of paramere and aedeagus of ♂ fly and morphology of cibarium and pharynx of ♀ *S. baghdadis* from Balochistan are found in full accord with the published data of this species from Baghdad reported by Adler and Theodor<sup>[13]</sup>.

The results of the present study show that *S. babu babu* is an uncommon species (165/2013, 8.2%) and has a nearly localized distribution in Balochistan. There are no published reports incriminating *S. babu babu*, which is thought to be thermophilic, hydrophilic and a possible vector of reptilian leishmaniasis<sup>[16]</sup> and plays no part in transmitting *Leishmania* to man. *S. palestinensis* is a Middle Eastern species and previously it was localized in

Peshawar only<sup>[5]</sup>. Only one ♂ fly has been recorded from Pakistan prior to the present study. The results of the present study show that it is a rare species (10/2013, 0.5 %) and has a discontinuous distribution in Balochistan. The overall distribution shows that this species prefers hot and semi arid regions. There are no published reports incriminating *S. palestinensis*, which is thought to be a probable vector of reptilian leishmaniasis<sup>[16]</sup> and presumably plays no part in transmitting *Leishmania*. *S. baghdadis* is mainly an Indian species which has probably spread along the Persian Gulf north to Baghdad where it was first found. The results of the present study show that *S. baghdadis* is an uncommon species (145/2013, 7.2 %) and it has a wide and nearly continuous distribution and occurs in a wide variety of climatic regions. There are no published reports incriminating *S. baghdadis*, which is thought to be thermophilic, hydrophilic and a possible vector of reptilian leishmaniasis<sup>[16]</sup> and presumably plays no part in transmitting *Leishmania* to man.

#### ACKNOWLEDGEMENTS

The author wishes to thank Professors Drs R. Killick-Kendrick, David J. Bradley, R.W. Ashford, R.P. Lane and David A. Evans for their encouragement and valuable guidance. My sincerest thanks are due to respected Joanna Kapusta (BMNH), Linda Huddleston (BMNH), Prof. Dr. J.P. Dedet (France), Dr. Farrukh Muddaber (WHO) and Prof. Dr. V.N. Neronov (Russia) for providing me literature on sandflies.

#### REFERENCES

1. Ammandale, N., 1910. The Indian species of Papatasi fly (*Phlebotomus*). Rec. Indian Mus., 4: 35-52 .
2. Ammandale, N., 1911. Further notes on Indian *Phlebotomus*. Rec. Indian Mus., 4: 319-320.
3. Sinton, J.A., 1932. Notes on some Indian species of the genus *Phlebotomus*. Part XXX. Diagnostic table for the females of the species recorded from India. Indian J. Med. Res., 20: 55-74.
4. Sinton, J.A., 1933. *Ibidem* XXXV. Diagnostic table for males of the species recorded from India. Indian J. Med. Res., 21: 417- 428.
5. Lewis, D.J., 1967. The Phlebotomine sandflies of west Pakistan (*Diptera, Psychodidae*). Bull. Brit. Mus. Nat. Hist. (Ent.), 19: 1-57.
6. Adler, S. and O. Theodor, 1927. On a collection of *Phlebotomus* sp. of *minutus* group. Ann. Trop. Med. Parasit., 21: 61-68.
7. Theodor, O., 1947. On some sandflies (*Phlebotomus*) of the *sergenti* group in Palestine. Bull. Ent. Res., 38: 91-98.
8. Pringle, G., 1953. The sandflies (*Phlebotominae*) of Iraq. Bull. Ent. Res., 43: 707-734.
9. Perfiliev, P.P., 1960. *Phlebotomus minutus* Rondani and the species of the group *minutus* (*Sergentomyia*) in the Crimea and Caucasus. Medskaya Parazit., 29: 40-48.
10. Mesghali, A., 1961. *Phlebotominae* (*Diptera*) of Iran. Acta Medica Iranica, 1: 20-73.
11. Lewis, D.J., A. Mesghali and B. Dijanbakhsh, 1961. Observations on Phlebotomine sandflies in Iran. Bull. Wld. Hlth. Org., 25: 203-208.
12. Theodor, O. and A. Mesghali, 1964. On the *Phlebotominae* of Iran. J. Med. Ent., 1: 285-300.
13. Adler, S. and O. Theodor, 1929. The distribution of Sandflies and leishmaniasis in Palestine, Syria and Mesopotamia. Ann. Trop. Med. Parasit., 23: 269-306.
14. Mesghali, A., 1965. *Phlebotominae* (*Diptera*) of Iran. III. Studies on sandflies in the areas of Bandar Abbas and Jasks (littoral areas of Hormoz strait and sea of Oman). Bull. Soc. Path. Exot., 58: 259-275.
15. Nadim, A. and E. Javadian, 1976. Key for species identification of sandflies (*Phlebotominae, Diptera*) of Iran. Iranian J. Publ. Hlth., 5: 33-44.
16. Artemiev, M.M., 1978. Sandflies (*Diptera: Psychodidae, Phlebotominae*) of Afghanistan. pp: iv + 87, Kabul.
17. Aslamkhan, K., 1996. Biodiversity of sandflies (*Phlebotominae*) of Pakistan. M.Sc. Thesis, Department of Zoology, Government College, Lahore, Punjab Univ., pp: 144.
18. Kakarsulemankhel, J.K., 2001. The Fauna of the Phlebotomine sandflies (*Diptera, Psychodidae*) of Balochistan, Pakistan and the disease cutaneous leishmaniasis. Ph.D. Thesis. Department of Zoology, University of Balochistan, Quetta, pp: 389.
19. Johnson, P.T., E. McConnel and M. Hertig, 1963. Natural Infections of leptomnoid flagellates in Panamanian *Phlebotomus* sandflies. Exp. Parasitol., 14: 107-121.
20. Killick-Kendrick, R., 1983. Investigation of Phlebotomine sandflies-vector of leishmaniasis. In Proceedings of the Indo-UK workshop on leishmaniasis. Dec. 6-10, 1982, Patna, India, pp: 72-83.
21. Killick-Kendrick, R., Y. Tang, M. Killick-Kendrick, R. N. Johnson, P.M. Ngumbi, D.K. Sang and P.G. Lawyer, 1994. Phlebotomine sandflies of Kenya (*Diptera, Psychodidae*) III. The identification and distribution of species of the subgenus *Larrousius*. Ann. Trop. Med. Parasit., 88: 183-196.

22. Lawyer, P.G., Y.B. Mebrahtu, P.M. Ngumbi, P. Mwanyumba, J. Mbugua, G. Kilu, G. Kipkoech, D. Nzovu and C.O. Anjilli, 1991. *Phlebotomus guggisbergi* (Diptera, Psychodidae) a vector of *Leishmania tropica* in Kenya. Am. J. Trop. Med. Hyg., 44: 290-298.
23. Lewis, D.J., 1973. *Phlebotomidae* and *Psychodidae*. In : Insects and other arthropods of Medical importance. (Ed. Smith K.G.V.). Bull. Brit. Mus. Nat. Hist., London, pp: 159-179.
24. Lewis, D.J., 1978. The Phlebotomine sandflies (*Diptera, Psychodidae*) of the Oriental Region. Bull. Brit. Mus. Nat. Hist. (Ent.), 37: 213-343.
25. Lewis, D.J., 1982. A taxonomic review of the genus *Phlebotomus* (*Diptera, Psychodidae*). Bull. Brit. Mus. Nat. Hist. (Ent.), 45: 121-209.
26. Sinton, J.A., 1927. Notes on some Indian species of the genus *Phlebotomus* XVIII. Further records of the geographical distribution. Indian J. Med. Res., 14: 941-945.
27. Sinton, J.A., 1928a. *Ibidem*. XXXII. *Phlebotomus clydei* n. sp. Indian J. Med. Res., 20 16: 179-186.
28. Sinton, J.A., 1928b. The synonymy of the Asiatic species of *Phlebotomus*. Indian J. Med. Res., 16: 297-324.
29. Theodor, O., 1938. On sandflies (*Phlebotomus*) from Ceylon, Siam and Malay. Indian J. Med. Res., 26: 261-267.
30. Parrot, L., 1940. Notes sur less Phlebotomes XXXIV. Les epines geniculees des Phlebotomes. Arch. Inst. Pasteur Alger., 18: 307-320.
31. Mitra, R.D. and D.N. Roy, 1952. Notes on Sandflies. Part II. *Phlebotomus thepari* n. sp. Indian Med. Gaz., 87: 188-193.
32. Quate, L.W., 1962. *Psychodidae* at the Zoological Survey of India. Proc. Hawai Ent. Soc., 18: 158.
33. Artemiev, M.M., 1976. Sandflies (*Diptera, Psychodidae, Phlebotominae*) of eastern Afghanistan. Communication IV. Genus *Sergentomyia*, subgenus *Parrotomyia* (in Russian, with short English summary). Medskaya Parazit., 45: 422-429.
34. Adler, S. and O. Theodor, 1926. On the *minutus* group of the genus *Phlebotomus* in Palstine. Bull. ent. Res., 16: 399-405.
35. Lewis, D.J., 1957. Some *Phlebotominae* from Iran. Ann. Mag. Nat. Hist., 12: 689- 694.
36. Theodor, O., 1958. *Psychodidae-Phlebotominae*. Fliegen Palaearkt. Reg., 9: 1-55.
37. Perfiliev, P.P., 1968. *Phlebotomidae*. Translation of Perfiliev, 1966. Israel Program of Scientific Translation, Jerusalem.
38. Aslamkhan, M. and S. Rafiq, 1980. Studies on cutaneous leishmaniasis and sandflies of Balochistan. Ann. Rept. Uni. Md. Sch. Med. ICMR., 315-324.
39. Ilango, K., V. Dhanda, R. Srinivasan, A.B. Sadanand and R.P. Lane, 1994. Phlebotomine sandflies (*Ditera, Psychodidae*) of Tamil Nadu and Pondicherry, Southern India, in relation to visceral leishmaniasis. Ann. Trop. Med. Parasit., 88: 413-431.
40. Kirk, R. and D. J. Lewis, 1951. *Phlebotominae* of the Ethiopian Region. Trans. R. Ent. Soc. London, 102: 383-510.