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Taxonomic Morphology of *Sergentomyia (Neophlebotomus) hodgsoni hodgsoni* Sinton (1933) (Diptera, Psychodidae) from Pakistan

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Abstract: During entomological surveys conducted in the whole of Balochistan Province, *Sergentomyia* (*Neophlebotomus*) *hodgsoni hodgsoni* Sinton (1933) was collected (N=20) from three localities. These localities appear to be the new record of this species in the existing literature to date. This is, to the author's knowledge, the first record of this species from Balochistan. Morphology of taxonomic characters not reported and measured previously are also described in the present study. Comparative analysis of Balochistan specimen with the published data of this species from other territories is also given. Differential diagnosis of this species with its other closest allies and a taxonomic note discussing briefly its position in the subgenus *Neophlebotomus* is also furnished.

Key words: *Sergentomyia hodgsoni hodgsoni,* sandfly, taxonomic characters

INTRODUCTION

Among the sandflies collected from Landikotal, Jandola and Peshawar area of NWFP (now in Pakistan) in 1932 by Col. Hodgson and Maj. C.F. Anthonisz, a new species was identified, described and named as *Phlebotomus hodgsoni* by Sinton[1]. In the same year, a new species *Phlebotomus pawlowskyi* was described from Karakala in Trurkemenistan by Perfiliev[2] and was later recorded from Tashkent (Uzbakistan) and from Armenia by Perfiliev[3]. The same was recorded as *Sergentomyia hodgsoni* from Iraq by Pringle[4] and a single specimen from Mehriz near Yazd by Lewis[5]. Theodor[6] pointed out that *S. pawlowskyi* closely resembles *S. hodgsoni* Sinton[1]. Theodor and Mesghali[7] considered both species *(S. hodgsoni, S. pawlowskyi)* as valid on the ground of number of teeth in the cibarium of the ♀ (40-50 in *S. pawlowskyi* and 50-60 in *S. hodgsoni*, *S. pawlowskyi* has 3-4 rows of small punctiform denticles in the cibarium, whereas there is only a single row of 4 such teeth in *S. hodgsoni*). Punctiform denticles were not mentioned in the original description of *S. hodgsoni*. Lewis[8] while describing *S. hodgsoni* from Rawalpindi and Peshawar areas of Pakistan gave it a status nova and treated it as *Sergentomyia (Rondanomyia) pawlowskyi hodgsoni* Sinton. stat. nov., but the number of punctiform denticles was not mentioned. Artemiev[9] while describing sandflies from Afghanistan treated *S. hodgsoni hodgsoni* Sinton (♀ with 42-58 cibarial teeth and 0-8 punctiform denticles) and *S. hodgsoni pawlowskyi* Perfiliev[2] (♀ with 1-35 punctiform denticles and more numerous cibarial teeth, up to 70) as two different species. Lewis[8] did not supply measurements of cibarium, pharynx, proboscis, hypopharyx, mandibles, ♂ terminalia, spermatheca and ducts of *S. hodgsoni hodgsoni* and also did not sketch wing, antennal segments, palps, hypopharynx, mandible, genital atrium and furca. Artemiev[9] also did not furnish these characters.

To fill this gap of knowledge, an extensive taxonomic study for the species identification of sandflies was carried out in the whole of the Balochistan Province during 1996-2001 and collected 2013 sandflies comprising of genera *Phlebotomus, Sergentomyia* and *Grassomyia*[10]. In view of the insufficient descriptions of Artemiev, Lewis, Sinton, Theodor, Theodor and Mesghali (*loc. cit.*), *Sergentomyia* (*Neophlebotomus*) *hodgsoni hodgsoni* Sinton[1] was redescribe in detailed. Taxonomic morphology not measured and not figured by earlier workers are described, measured and illustrated in the present paper.

MATERIALS AND METHODS

For collection, processing, preservation, dissection, mounting of the specimens and observation of external and anatomic parts of the sandflies, the conventional techniques especially those used by Johnson *et al.*[11], Killick-Kendrick[12], Killick Kendrick *et al.*[13], Lawyer *et al.*[14] and Lewis[15] were followed. For the

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species identification of sandflies, keys furnished by Artemiev[9], Lewis[8,16], Perfiliev[2], Sinton[1] were consulted. Measurements are in millimeter (mm). 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 (Neophlebotomus) hodgsoni hodgsoni* Sinton[1]:**

Phlebotomus hodgsoni Sinton[1] Indian J. Med. Res., 20: 874[17], Indian J. Med. Res., 21: 226[18]. Indian J. Med. Res., 21: 419. Lewis[8]: 37.

Sergentomyia hodgsoni (Sinton) Theodor[19], Bull. Ent. Res., 39.

Sergentomyia (Rondanomyia) hodgsoni (Sinton)[7], J. Med. Ent., 1: 296.

Sergentomyia (Rondanomyia) pawlowskyi hodgsoni (Sinton) Lewis[8], Bull. Brit. Mus. Nat. Hist (Ent.)., 19: 37.

Sergentomyia (Rondanomyia) hodgsoni hodgsoni, Artemiev,[20], Medskaya Parazit., 45:39, Artemiev[9]: 31.

Sergentomyia (Neoplebotomus) hodgsoni hodgsoni (Sinton), Lewis[16], Bull. Brit. Mus. Nat. Hist (Ent.), 37: 277.

Female: Three specimens were examined (Fig.1). Wing (Fig. 1A) narrow, 1.20 mm long, 0.38-0.40 mm broad, 3.0-3.15 times as long as broad, α= 0.16-0.176 mm long, β=0.3-0.32 mm long, δ=0.02-0.04, one specimen had a negative δ, γ=0.28-0.336 mm, π =0.064-0.08 mm, alar index=0.53-0.55. Palp (Fig. 1B), 0.622 mm long, palpal ratio 1 : 4.01 : 6.63 : 5.18 : 11.54, palpal formula 1, 2, 4, 3, 5, Newstead's sensillae number about 16-20 on basal third of segment 3. Proboscis 0.2 mm long. Antennal segment III (Fig. 1C) 0.136-0.14 mm long, 0.68-0.7x length of proboscis, 0.85-0.87x length of labrum, 0.823-0.871x length of AIV and AV together, ascoid on A3 0.036 mm long, 0.257-0.264x length of segment. A4 (Fig. 1D, lower) 0.08-0.09 mm long, ascoid on A4=0.036 mm long, ascoid 4/A4=0.4-0.45. A5 (Fig. 1D, upper) 0.076-0.08 mm long, asoicd on A5= 0.035 mm long and ascoid 5/A5=0.43-0.46. Antennal segments III and IV have a sigle prominent papilla (Fig. 1C-1D). On AIII it is usually at the mid length of ascoid and on AIV it was near the tip of the ascoid. The positions of the ascoids on segments are: AIII, 0.73, AIV, 0.37 and AV, 0.39. There are two ascoids on segements III to XV. Labrum (Fig. 1E) 0.16 mm long, with about 6 apical sensilla and sensilla depth 0.036 mm. Hypopharynx (Fig. 1F) with weak indentations and dental depth 0.024 mm. Mandible (Fig. 1G) narrow, about 0.012 mm

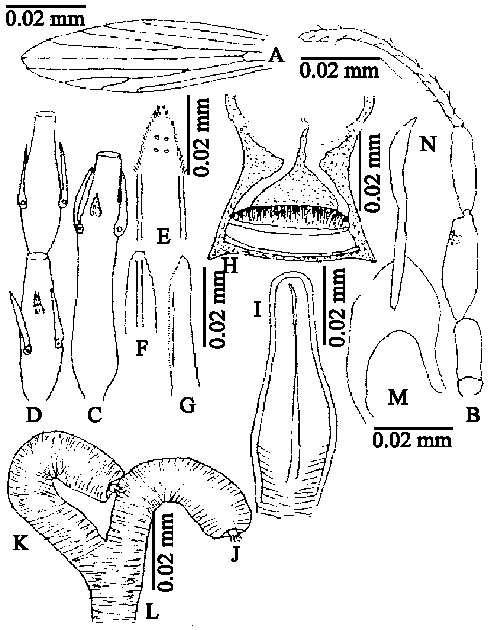

Fig. 1: Camera Lucida drawing of *Sergentomyia (Neophlebotomus) hodgsoni hodgsoni* Sinton (♀) from Balochistan showing: wing (A), palp (B), the third (C), fourth (D, lower) and fifth (D, upper), antennal segments, labrum (E), hypopharynx (F), mandible (G), cibarium (H), pharynx (I), spermatheca (J), individual spermathecal duct (K), common duct (L), genital atrium (M) and furca (N)

broad, a dental depth of 0.056 mm and 6 small re-curved teeth per 0.008 mm. Cibarium (Fig. 1H) 0.058- 0.06 mm broad with a armature consisting of a single and an almost straight row of teeth (0.056 mm long) about 45-49 in number (each tooth 0.009-0.01 mm long) (8 teeth per 0.01 mm) and a line of about 10-15 punctiform denticles at bases of teeth, these anterior denticles are difficult to count as pigment patch was very dark and denticles are not always in definite rows, a triangular dark pigment patch (0.04-0.046 mm long and 0.026-0.03 mm broad) with a pale forward extension, chitinous arch ill defined and in front of it at each side of cibarium, there is a large inward extension. Pharynx (Fig. 1I) 0.15-0.16 mm long, not much dilated posteriorly, length about 3.75-4.0 times greatest breadth (0.04 mm) which is about 1.66-1.82 times the width of narrow anterior portion (0.022-0.024 mm), armature 0.032-0.04 mm height, which is about 0.21-0.25x length of pharynx, armature comprising of several fine, short and transverse lines occupying the posterior portion of pharynx. Spermatheca (Fig. 1J) body broad, about 0.032 mm long and 0.028 mm broad, no collar but with a distinct anterior knob at the apex, individual duct (Fig. 1K) just behind the main body of spermathecal capsule, short

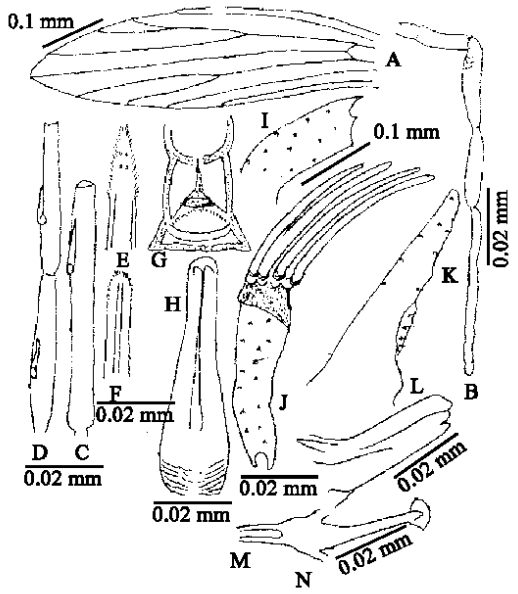

Fig. 2: Camera Lucida drawing of *Sergentomyia (Neophlebotomus) hodgsoni hodgsoni* Sinton (♂) from Balochistan showing: wing (A), palp (B), the third (C), fourth (D, lower) and fifth (D, upper), antennal segments, labrum (E), hypopharynx (F), cibarium (G), pharynx (H), coxite (I), style (J), paramere (K), aedeagus (L), genital filament (M), genital pump (N)

(0.056 mm long) and comparatively less broader (0.02 mm) with some irregular striations but faint, a common duct (Fig. 1L) about 0.096 mm long and 0.056 mm broad, genital atrium (Fig. 1M) 0.032 mm broad and furca (Fig. 1N) 0.088 mm long.

Male: Seven specimens were examined (Fig. 2). Head 0.24-0.28 mm long, 0.21-0.25 mm broad, eye 0.10-0.128 mm long, 0.056-0.08 mm broad, 0.064-0.010 mm distance between eyes. Wing (Fig. 2A) narrow 1.0-1.12 mm long, 0.20-0.24 mm broad, α=0.064-0.096 mm long, β=0.116-0.20 mm long, 2 specimens have a zero δ whereas 3 specimens have a negative δ, δ= -0.04 mm, γ=0.24 mm long, π=0.04- 0.08 mm, alar index= 0.48-0.55. Palp (Fig. 2B) 0.426 mm long, palpal formula 1, 2, 4, 3, 5 and ratio 1: 2.6: 4.5 : 4.0 : 9.2. Proboscis 0.14 mm long. Antennal segment III (Fig. 2C) short, 0.11-0.12 mm long, 1.0-1.1x length of labrum, 0.785-0.857x length of proboscis, 1.30-1.5 xlength of AIV and AV together, ascoids on A3=0.018-0.02 mm long, 0.163-0.166x length of segment. AIV (Fig. 2D, lower) 0.076-0.08 mm long, ascoid on A4=0.016 mm long, ascoid 4/A4=0.2-0.21. AV (Fig. 2D, upper) 0.08 mm long, ascoid on AV=0.016 mm long, ascoids 5/A5=0.2. The positions of the ascoids on the segments are: AIII, 0.66, AIV, 0.28 and AV, 0.30. There is one ascoid on segments III to XV. Labrum (Fig. 2E) 0.10-0.12 mm long with two relatively long apical sensillae and sensillae depth 0.028 mm. Hypopharynx (Fig. 2F) with weak indentations, apical margin broad and dental depth 0.024 mm. Cibarium (Fig. 2G) 0.024-0.026 mm broad with about 25-28 small teeth on a almost straight line and in front of these, are a few denticles, chitinous arch ill developed, pigment plate 0.01-0.02 mm broad, short and triangular but pale. Pharynx (Fig. 2H) 0.12 (0.11-0.14) mm long, not much dilated posteriorly, length about 3 times (3.0-3.42) of greatest breadth, which is about 1.75-1.81 of the width of narrow anterior portion, pharyngeal armature 0.026-0.03 mm height, which was about 0.216-0.25 the length of pharynx, armature was in the form of faint transverse lines at posterior portion of the pharynx. Coxite (Fig. 2I) 0.19-0.20 mm long, 0.056-0.064 mm broad, coxite length/breadth=3.12-3.39, coxite/style=2.50-2.71, coxite/labrum=1.66-1.9, coxite/A3=1.66-1.72. Style (Fig. 2J) 0.07-0.08 mm long, 0.02 mm broad, less than half as long as coxite, terminal spines of style consisting of 2 apical and 2 sub-apical spines which were almost as long as the style or longer (0.096-0.11 mm long) and a ventral seta situated closer to the apex of style (0.825-0.875 of the style), tips of the spines are usually spatulate. Parmere (Fig. 2K) 0.10-0.12 mm long, base of paramere 0.034-0.04 mm broad, ventral tubercle less obvious which bears 4-5 short hairs, these hairs does not form a large tuft, paramere gradually narrowing just behind the tubercle up to a blunt ending with many bristles. Aedeagus (Fig. 2L) relatively short (0.078-0.08 mm long) and thick (0.008 -0.01 mm broad) with pointed blunt tip and a sub apical tubercle at (0.853 of aedeagus) near blunt tip. Genital filament (Fig. 2M) 0.28-0.32 mm long, without striations, genital pump (Fig. 2N) 0.08 mm long, with filament to pump of 3.5-4.0. Surstyle about 0.14 mm long, 0.7-0.736x length of coxite.

Distribution: Balochistan. Present survey, New Record: Bela, Kahan, Nanasaheb ziarat. These localities are important foci of cutaneous leishmaniasis. Sandflies were collected from human residences through sticky traps.

DISCUSSION

The morphology and measurements of various taxonomic characters of *S. hodgsoni hodgsoni* Sinton[1] from Balochistan show considerable differences when compared with the published data of this species from other territories (Table 1). ♀ specimens from Balochistan are found tallying fairly well with the published data of specimens of this fly from NWFP, Punjab and northern areas[1,8] in characters like presence of negative δ,

Table 1: Comparison of taxonomic characters (mm) of *Sergentomyia (Neophlebotomus) hodgsoni hodgsoni* Sinton[1] from Balochistan and the published data of this species and its related species from other territories

♀ Taxonomic characters	Balochistan (Present study)	*Phlebotomus hodgsoni*[1] from Jandola, Landikotal, NWFP (Pakistan)[1]	Rawalpindi, Saidpur, Taxilla (Pakistan)[8]	*S. r. Hodgsoni pawlowskyi*[2]. From Central and Northern Afghanistan[9] (µm)
Wing Length/ Breadth	3.0-3.15	4.2	4.23	-
Alar index	0.53-0.55	0.4-1.0	0.7 (0.4-1.0)	
♂	1 specimen had a negative ♂	1 specimen had a - ♂		
Palpal formula	1, 2, 4, 3, 5	1, 2, 4, 3, 5	1, 2, 3, 4, 5	-
Newstead's sensilla	Newstead's sensillae number about 16-20 on basal third of segment 3.	Newstead's sensillae number about 40 on basal thir of segment 3.	-	-
A3 Length	0.136-0.14	0.12-0.147	0.14 (0.12-0.15)	108-160 µm long
A3/A4+5	A3<A4+5	A3<A4+5	A3<A4+5	
A3/labrum	0.85-0.87		0.8 (0.7-0.8)	0.7-0.86
Ascoid 4/A4	0.42-0.45		0.45	0.39-0.58
Ascoid formula	2/3-15.	2/3-15		
Cibarium	About 45-49 teeth	About 60 teeth	About 40-60 teeth, a line of punctiform teeth and 4 additional punctiform teeth	About 42-58 teeth
Punctiform denticles	About 10-15,			About 0-8 denticles.
Pigment patch	Triangular, with forward extension.	Triangular, with forward extension (in drawings)	Pigment patch broad with forward extension.	Pigment patch broad with long anterior process.
Chitinous arch	Ill defined		Scarcely visible	
Large inward extension.	Each side of cibarium with large inward extension in front of chitinous arch.		Each side of cibarium with large inward extension in front of chitinous arch.	
Pharynx	Not much dilated posteriorly, length about 3.75-4.0 times greatest breadth which is about 1.66-1.82 times the width of anterior narrow position.	Not much dilated posteriorly, length about 3 times greatest breadth, which is about twice the width of anterior narrow portion.	-	-
Armature	Several transverse lines at posterior end.	Several rows of fine short teeth.	Several rows of transverse lines at posterior end.	Several transverse lines at base of pharynx.
Spermatheca	Capsule long and broad, 1.14 times as long as broad with transverse striations, individual ducts short and comparatively less broader with striations and uniting into a common duct.	Pipe shaped, shows transverse striations, individual duct short and uniting with a common duct	Spermatheca tubular, with transverse striations, individual duct broad which finally joining a broad common duct.	Spermatheca very large with irregular striations, ducts of spermatheca striated.

Table 1 : (continued)

♂ Taxonomic characters	Balochistan (Present study)	*Phlebotomus hodgsoni*[1] from Jandola, Landikotal, NWFP (Pakistan)[1]	Rawalpindi, Saidpur, Taxilla (Pakistan)[8]	*S. r. Hodgsoni pawlowskyi*[2]. From Central and Northern Afghanistan[9] (µm)
Wing Length/ Breadth	4.66-5.0	4.2	4.2	-
Alar index	0.48-0.55	0.50-0.65		
A3 Length	0.11-0.12	0.144-0.15	0.14-0.15	116-176
A3/A4+5	A3<A4+5	A3<A4+5		
A3/labrum	1.0-1.1		0.9-1.1	0.84-1.05
Ascoid4/A4	0.20-0.21	-	0.3	0.25-0.38
Cibarium punctiform denticles	About 25-28 small teeth, in front of these a few punctiform denticles.	About 50 small teeth	About 32 teeth, a few denticles also	About 17-46 teeth
Pigment patch	Short, triangular or round	Oval pigmented area	Broad	Triangular or broad
Chitinous arch	Ill defined	-	Almost invisible	
Pharynx	Pharynx with posterior weak transverse lines.	Teeth more poorly developed.	With posterior lines	-
Coxite	0.19-0.20 long	-	-	0.204-0.252
Style	0.07-0.08 long, each spine almost as long as style.	Each spine almost as long as style.		0.092-0.128
Paramere	With broad base, hooked end, ventral tubercle with short hairs.	Short ventral lobe with short stout spine	With beaked end with ventral tubercle	With broad base and hairy ventral tubercle.
Aedeagus	Thick, 0.75-0.8 times as long as broad.	Tapering to a blunt end.	Tapering to a blunt end.	Thick, tapering to a blunt end.
Filament /Pump	3.5-4.0	-	3.6	2.7-3.7

Newstead's sensilla on segment 3, palpal formula (1, 2, 4, 3, 5), ascoid formula (2/3-15) A3<A4+5, A3/labrum, ascoid 4/A4, morphology of pharynx and spermatheca. Ballochistan forms are also observed tallying fairly well in characters like A3/labrum (0.85-0.87) with published data of this species from Afghanistan[9]. However, Balochistan forms are found slightly differing in A3 (0.136-0.14 mm long) whereas Sinton[1] and Lewis[8] reported A3=0.12-0.15 mm long and in fewer number of cibarial teeth (45-49), whereas Sinton[1] and Lewis[8] reported 60 and 40-60 teeth, respectively. Balochistan forms were observed showing an almost resemblance with Afghanistan specimens[9] in characters like A3/labrum and a broad triangular pigment patch with anterior process, but also show variation characters like a shorter A3 (0.136-0.14 mm), shorter ascoid 4/A4 (0.42-0.45), fewer number of cibarial teeth. Similarly, ♂ flies of Balochistan are found in full accord with Afghanistan forms[9] in characters like A3/labrum, paramere with broad base and with hairy ventral tubercle and aedeagus thick, tapering to a blunt end but also show difference in characters like shorter A3 (0.11-0.12 mm), shorter ascoid 4/A4 (0.20-0.215), with fewer number of cibarial teeth (25-28), shorter coxite (0.19-0.20) and a shorter style (0.07-0.08 mm). However, Balochistan forms have relatively a shorter A3 (0.11-0.12 mm) and fewer number of cibarial teeth as compared with NWFP Punjab and northern areas specimens reported by Sinton[1] and Lewis[8]. Aedeagus of Balochistan forms are observed having a sub apical tubercle (at 0.85 of the length of aedeagus) near blunt tip.

Differential diagnosis: So far, no species of the sub genus *Neophlebotomus* except *S. hodgsoni hodgsoni* have been described from Pakistan, but from Afghanistan in addition to this, another species *S. hodgsoni pawlowskyi* Perfiliev, was described by Artemiev[9,20]. The morphology of the characters like cibarium and spermatheca differentiates *S. hodgsoni hodgsoni* from *S. hodgsoni pawlowskyi*. In addition:

a) ♀ *S. hodgsoni pawlowskyi* Perfiliev[1] has a relatively shorter A3 (0.108-0.144 mm), shorter A3/labrum (0.59-0.77), cibarial teeth (till 70) and punctiform denticles (1-35) more numerous. In addition, spermathecal ducts not striated and relatively narrower than the breadth of spermathecal capsule. Similarly, ♂ of this species has a shorter A3 (0.104-0.144 mm), shorter A3/labrum (0.73-1.0) and a shorter ascoid 4/A4 (0.25-0.29).

Taxonomic note: Lewis[9] placed *S. hodgsoni* Sinton[1] in the subgenus *Neophlebotomus*. Sinton[1] described cibarium of female with 42-68 teeth and paramere of male with a spinose process. Sinton[1] also suggested that this species occurs in central Asia to western India. Sinton, further described a subspecies *S. n. hodgsoni hodgsoni* with female cibarium having 50-60 teeth and the paramere of male bearing a ventral spinose process and suggested its distribution in India and Pakistan. Artemiev[9] placed *S. hodgsoni hodgsoni* in the subgenus *Rondonomyia*. Lewis[16] stated that the members of the sub genus *Neophlebotomus* have a longer antenna 3, longer than A44+5 and often 1.25-2.00 times length of labrum which placed *S. hodgsoni hodgsoni* Sinton in this sub genus. Lewis[16] reported ♀ with 50-60 cibarial teeth and paramere with spinose process at base of the neck. While reporting *S. p. hodgsoni* from NWFP Punjab and northern areas of Pakistan, Lewis[8] observed variation in measurement of these taxonomic characters. Variation in these and other systematic characters of this species collected from Balochistan during present study have been carefully noted in which A3 of ♀ is observed relatively shorter (0.136-0.14 mm long) and cibarium with fewer cibarial teeth (45-49). The present study, however, indicated that the morphological variations not only present among the individuals of a species from one country to the other but it also exists even among the members of a species of various geographical regions of the same country. Therefore, the taxonomic study of the fauna of insect of different geographical regions of a country is of significance.

The results of the present study show that *S. n. hodgsoni hodgsoni* is a rare species (20/2013,1.25%) and has a discontinuous distribution in Pakistan. There are no published reports incriminating *S. hodgsoni hodgsoni,* which is thought to be thermophilic, rather xerophilous, prefer to suck blood of birds and reptiles[9] and presumably plays no part in transmitting *Leishmania* to man.

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