A detailed morphological study of two new species of Phthiraptera have been described. One belongs to the genus Heleconomus (Amblycera: Menoponidae), from common cranes, Grus grus (Gruiformes: Gruidae) and the other new species of the genus Chelopistes (Ischnocera: Philopteridae) from common turkey, Meleagris gallopavo (Galliformes: Phasianidae) were recorded from Pakistan. These chewing lice species have been taxonomically enlightened and illustrated with respect to the chaetotaxy and male and female genitalia features. It is a new record of the genus Heleconomus in Pakistan. Both the species have also been compared with their closest allies.

Saima Naz
Syed Anser Rizvi

Detailed Morphology of Two species of Phthiraptera From Pakistan
Amblycera: Menoponidae and Ischnocera: Philopteridae
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Detailed Morphology of Two species of Phthiraptera From Pakistan
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Amblycera: Menoponidae and Ischnocera: Philopteridae
DEDICATED TO
MY PARENTS AND TEACHERS
ACKNOWLEDGEMENTS

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LIST OF ABBREVIATIONS

AL d/v abdomen length by mid-dorsal/mid-ventral side
AWI–AWIX abdomen width of segment I to segment IX respectively
GL genital length
GSL genital sac length
GW genital width
HL head length
MTL metanotal length
MTW metanotal width
PAPW a/p preanal plate width by anterior/posterior ends
PAW preantennal width
PL pronotal length
PML parameres length
POW preocular width
PtL pteronotal length
PtW pteronotal width
PVPL postvulval plate length
PVPW a/p postvulval plate width by anterior/posterior ends
PW pronotal width
SGPL subgenital plate length
SGPW subgenital plate width
TL total length
TW temporal width
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INTRODUCTION

The genus *Heleonomus* Ferris, 1916 is currently represented by 10 species. Although the order Gruiformes includes 12 families, comprising 61 genera and 220 species (Archibald, 2002), only 14 species of the family Gruidae were infested by the genus *Heleonomus* (Price, et al., 2003). Out of 10 species of *Heleonomus*, five species were recorded from the genus *Grus* and five from other genera of the family Gruidae. Price (1970) reviewed and keyed out the genus *Heleonomus* described by Ferris (1916), and also accommodated four new species of the genus. He also reexamed the genus with the current status.

The common crane, *Grus grus* (Linnaeus), is frequently found in the countryside areas of Karachi Region, nearby the aquatic and cultivated areas. It is a ground living bird and can easily be seen in flocks in crops or other shallow fresh water reservoirs (Robert, 1991). The bird is not easy to catch for collection of its lice, because it avoids human presence, although they can be more easily captured in the cultivated fields than the open land areas.

In Pakistan, the fauna of chewing lice is not yet well studied, however Lakshminarayana (1979) compiled a list of chewing lice species found on birds from Pakistan, but he did not mention the genus *Heleonomus* Ferris from Gruids originate in this country.

MATERIALS AND METHODS

Specimens were collected from two towns near Karachi where birds were kept in captivity. A total of 11 birds were examined for their lice. Following the methods of Wundrig (1936) and Ross (1956), pyrethroid was sprayed on the
body of host. The lice shed off the body of bird onto white collecting paper sheet. They were preserved in 85% ethanol-glycerine solution for microscopic examination and genitalia dissection. The chewing lice used in this study were preserved on microscopic slides using a standard method (Palma, 1978) and mounted in Canada-balsam. Line diagrams were made using micro-ocu-locular graticule with a light microscope. Illustrations were drawn on 1cm² graph paper with scales of 0.1mm, 0.05mm and 0.025mm. Collected species have been deposited in the Natural History Museum, University of Karachi (NHMUK), Pakistan.

DESCRIPTION OF HOLOTYPE AND PARATYPES OF *HELEONOMUS ADNANI NAZ, ET AL., 2009* (Figs. 1–15, Tab. 1)

**TYPE HOST:** *Grus grus grus* (Linnaeus) (Aves: Gruiiformes: Gruidae).

**HEAD (Figs. 1–6)**

Colpocephalid type; anterior margin smoothly convex, narrower than preocular region; dorso-lateral and preocular margin bulged; preocular notch present (Fig. 5A), shallow and broad; temples broad, more or less quadrate, gradually tapering posteriorly; occipital margin slightly concave and thick.

Dorsal Head Chaetotaxy (Figs. 1, 3, 5B, 5C)

*Dorsal head setae* (DHS) have been divided into six groups based on their position and attachment.

*Anterior setae* (Fig. 5B), in male, mid-anterior portion of head bears a bunch of 13–15 scattered microsetae; absent in female; four anterior marginal setae, two or three pairs antero-lateral setae present.
Dorsal setae (DHS 14–16) (Figs. 1, 3) present at mid dorsal region of head; setae 14 and 15 closed to each other; seta 16 nearer to mid lateral region; DHS 14 very small, anterior to DHS 15.

Mid dorsal setae (DHS 17–18) (Figs. 1, 3) median setae 17 and 18 small, almost equal; DHS 17 nearer to mid dorsal line; DHS 18 nearer to ocular seta 19 in subocular region.

Preocular setae (DHS 8–11) (Fig. 5C), length: DHS 8: 0.185–0.204; DHS 9: 0.283–0.39; DHS 10: 0.107–0.15; DHS 11: 0.073–0.11; DHS 8 is fine, thinner and shorter than DHS 9; DHS 10 and 11 more or less equal in length or 10 is little longer than 11, both on the corner of the preocular notch; DHS 8, 10 and 11 with microalveoli, DHS 9 with macroalveolus; all setae marginal in position.

Ocular setae (DHS 19–20) (Fig. 5C), length: DHS 19: 0.097–0.126; DHS 20: 0.102–0.156; DHS 19 and 20 present in the ocular region, behind the eyes; fine, subequal; DHS 19 shorter than 20.

Occipital setae (DHS 21–23) (Figs. 1, 3), length: DHS 21: 0.155–0.16; DHS 22: 0.128–0.13; DHS 23: 0.049–0.055; occipital setae 21 and 22 reaching behind the pronotal carina of prothorax; seta 23 relatively very small, up lifted in temporal region; alveoli of DHS 21 and 22 in straight line.

Temporal setae (DHS 24–31) (Figs. 1, 3), length: DHS 24, 25 and 28: 0.02–0.025; DHS 26: 0.357–0.396; DHS 27: 1.05–1.15; DHS 29: 0.85–0.9; DHS 30: 0.20–0.205; DHS 31: 0.2–0.24; temporal setae 24, 25 and 28 very small with peg like alveoli; temporal setae 26, 27 and 29 large, macrosetae with large alveoli, seta 27 very longer than 29, usually reaching behind the abdominal segment IV or V; temporal setae 30 and 31 normal, fine setae, seta 30 subterminal, medio-anterior to seta 29.

Dorsal head sensillae a and b (Figs. 1, 3, 5C) present; sensillae c, d and e absent.
Table 1: Measurements of males and females of *Heleonomus adnani* Naz, et al., 2009.

<table>
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<tr>
<th>Measurement</th>
<th>Male (mm)</th>
<th>Female (mm)</th>
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<td>GL</td>
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<td>(0.140–0.160)</td>
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<td>PVPW a/p 0.312/0.232</td>
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<td>(0.230–0.235)</td>
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<td>PML</td>
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Dorsal Head Carinae and Nodi (Fig. 5A)

At dorsal side of the head, ocular nodi and occipital nodi well developed, darkly pigmented and highly sclerotized; occipital nodi connected with each other by occipital carina; oculo-occipital carinae absent.

Ventral Head Chaetotaxy (Figs. 2, 4, 5D)

Anterior ventral margin with two to three ventral setae; ventro-lateral temporal region bears a small bunch of microsetae at temporal submarginal position, connected with ocular setal comb; ocular setal comb short, comprising five–seven stout setae, anteriorly long and thick; anterior ocular seta present.

Tentorium

The tentorial bridge is thick and little broader at ends, narrow in middle.

Mouth Parts (Fig. 6A–E)

Labrum (Fig. 6A) very reduced, anterior most plate like, narrow, slightly curved, anteriorly convex, thick, membranous layer; bearing small microsetae at its latero-anterior margin, outer setae 1, 4 and 6 short, setae 2, 3 and 5 long; posterior margin almost without setae.

Mandibles (Fig. 6B) hard, highly sclerotized structure, pointed at inner sides; vertically articulated, left mandible overlaps the right mandible, laterally joined with the part of maxillary palpi, ventrally partially covered by labium.

Maxillary palps (Fig. 6C) measures as flagellomere I: 0.029 (0.028–0.03), flagellomere II: 0.028 (0.026–0.030), flagellomere III: 0.025 (0.024–0.026), flagellomere IV: 0.044 (0.042–0.046); elongated, four segmented, segment I and II equal, segment III shortest, segment IV long and narrow; segment I, II and IV with single subterminal seta, segment III with two subterminal setae at ventral side; segment I–III bear single seta at dorsal side; terminal disc
semicircular, bears 18 small microsetae and two to three disc sensillae; postpalpal processes absent.

*Hypopharynx* (Fig. 6D), length: 0.0845 (0.080–0.089); width: 0.037 (0.034–0.04); well developed, sclerotized structure; lingual sclerite developed; hypopharyngeal sclerite well developed; epipharyngeal sclerite highly sclerotized.

*Labium* (Fig. 6E) membranous, broad, unsclerotized structure; anterior margin bears eight pairs of fine, pointed, sharp microsetae with moderate to small alveoli at anterior margin; labial palpi single segmented, measuring 0.0327 (0.0325–0.033), small, rectangular shaped; terminal disc bears five–eight microsetae.

*Postmentum* (Fig. 6E) bears four postmental setae the outer two setae are small and inner two are long, measuring from 0.052–0.081.

*Gular plate* (Fig. 6E) elongated, more or less oval, with slightly straight lateral margins, anteriorly fused with postmentum and posterior margin touching the prosternal plate of prothorax; antero-lateral to postero-lateral margin bears four pairs of gular setae; setae 1 and 2 short, measuring 0.12 (0.11–0.13) and 0.13 (0.12–0.14) respectively; setae 3 and 4 long, measuring 0.17 (0.16–0.18) and 0.145 (0.14–0.15) respectively; all with moderate alveoli.

**Antenna** (Fig. 6F)

Capitat, comprising four segments, elongated, usually concealed inside the antennal groove, exposing only the terminal segment out.

*Basal* 0.028 (0.027–0.029) long; 0.021 (0.019–0.023) wide; small, slightly rectangular or cylindrical with one dorso-anterior microsetae and one ventral sub-terminal setae.

*Pedicel*, length 0.037 (0.036–0.038); width 0.038 (0.036–0.040); broader and longer than basal, roughly trapezoidal shaped; outer ventral margin bulged; bearing four terminal setae on protruded end, all fine, sharp microsetae.
Flagellomere I, length 0.028 (0.026–0.030); width at posterior: 0.005; broader at middle: 0.016; broadest at anterior: 0.03; cup shaped, pedunculated; terminal and latero-terminal margin bear two or three small microsetae; completely sclerotized posteriorly and partially anteriorly, forming a broad terminal disc for the attachment of flagellomere II.

Flagellomere II: length 0.06 (0.05–0.07); width 0.0385 (0.037–0.039) at middle region; thick at periphery, moderately sclerotized, with minute microsetae; terminal disc broad, bearing four–five small thick hyaline setae with large basal sensillae; five–seven fine large microsetae with small alveoli; ventral side bears two sensillae coeloconica; narrow surfacial ridges present.

Antennal Groove (Fig. 5D)

Antennal groove shallow, covering antenna partially; ventral margin sinuated, bearing two microsetae at ventro-anterior margin, one small and one large, measuring 0.027 and 0.101, respectively.

Eyes (Figs. 1, 3, 5C)

Eyes of Heleonomus adnani are nonfunctional, only a small ocular lens present, with two pigmented ommatidia poorly present, covered by ocular nodi, beneath the preocular notch at dorso-lateral margin.

THORAX (Figs. 7–10)

Prothorax (Figs. 7, 8A, 8B)

More or less oval, slightly narrower anteriorly, lateral sides tapering, latero-posterior margin broader than latero-anterior margin.

Chaetotaxy of Pronotum (Fig. 7A) is typical, pronotal seta 1 very long, 0.067 (0.065–0.070); pronotal seta 2 very minute or absent; latero-posterior margin bears eight pairs of pronotal setae; latero-posterior seta 1 and 3 small, robust, seta 2 longer than 1 and 3, setae 4, 6–8 very long, reaching behind
mesothorax, seta 5 very minute, peg like, more or less touching the alveolus of seta 4.

*Postnotum* (Figs. 7A, 8A) weakly sclerotized, medially pigmented, with four anterior mesonotal setae, grouped posterior to pronotum with slightly separated alveoli.

*Prosternal plate* (Fig. 8B) comprising two parts, an anterior transverse plate, weakly sclerotized, slightly curved, bearing one pair of small peg like microsetae on terminal ends; posterior elongated plate, darkly pigmented, oval shaped, with or without lateral pair of setae.

Mesothorax (Figs. 7 B, 8 C, D)

*Mesonotum* (Fig. 7B) very short segment, weakly sclerotized, mesonotum bearing one pair of lateral mesonotal setae.

*Mesosternum* (Fig. 8C) short, weakly sclerotized, elongated and roughly triangular, bearing two anterior mesosternal setae and four–eight irregularly arranged median to posterior setae. Episternum (Fig. 8D) expanded towards ventral side, forming the thick, highly sclerotized mesopleural rib; not fusing in middle; mesosternal plate present between the two mesopleural ribs; five thick normal to macrosetae present at latero-anterior position.

Metathorax (Figs. 7B, 8E)

Large metanotal plate, medially divided, broad and more or less straight posterior margin.

*Chaetotaxy of metanotum* (Fig. 7B) as anterior and mid-anterior setae absent; lateral to latero-posterior setae present, fine lateral setae marginal and submarginal in position, thick, robust and normal; posterior setae long, reaching behind the abdominal segment II.

A pair of *metathoracic spiracles* present at mid-lateral side of metanotum.
Metasternal plate (Fig. 8E) large, trapezoidal plate, with 10–15 long, irregularly arranged metasternal setae; clearly separated from coxae II and III.

Thoracic Legs (Figs. 8D, 9, 10)

Legs are elongated, highly sclerotized, well developed, strong with thick chaetotaxy on tibia; proleg (Fig. 9A) shortest in length, mesoleg (Fig. 9B) median and metaleg (Fig. 9C) longest.

Length: coxa I: 0.184 (0.18–0.188); coxa II: 0.139 (0.138–0.140); coxa III: 0.127 (0.125–0.130); femur I: 4.75 (4.6–4.9); femur II: 6.3 (6.0–6.6); femur III: 8.0 (7.8–8.2); tibia I: 4.65 (4.2–4.8); tibia II: 5.65 (5.3–5.9); tibia III: 7.1 (6.8–7.4); tarsus I: 2.25 (1.9–2.5); tarsus II: 2.85 (2.7–3.0); tarsus III: 3.3 (3.2–3.4).

Coxae (Figs. 8D, 9, 10A–B) rounded to oval, expanded to elongated, ventrally attached with the thoracic segments; coxa I oval, elongated, expanded laterally (Fig. 10A) with particular row of ventro-lateral pattern of chaetotaxy; bearing four–five normal setae; coxae II (Fig. 8D) and III (Fig. 10B) more or less trapezoidal or quadrate with a single long seta on it; separated from meso and metasternal plates; surrounded by pleural ribs.

Trochanter (Figs. 8D, 9, 10A) small in proleg and mesoleg, large in metaleg, connecting coxae with the femur of each leg; setae almost absent or rarely present on trochanter III.

Femur (Figs. 9, 10C) thick, broad, elongated and oval shaped; smallest in proleg: 0.235 (0.230–0.240); median in mesoleg: 0.320 (0.316–0.325); longest in metaleg: 0.375 (0.360–0.390); four–five marginal setae present on femur I–III; femur III (Fig. 10C) bears a thick brush of microsetae on mid-ventral to ventral side in diagonal rows containing 35–40 femoral setae; four ventral and four dorsal anterior marginal setae present.

Tibia (Figs. 9, 10D) elongated, narrower than femur; smallest in proleg and longest in metaleg; length: tibia I: 0.22 (0.21–0.23); tibia II: 0.27 (0.26–
tibia III: 0.345 (0.33–0.36); distal end membranous; articulated with tarsus anteriorly, bearing one–five inner marginal setae, ten–twenty outer marginal setae; a row of thin, hairy, comb like, submarginal microsetae present additionally on ventral mid line to anterior end of each tibia (Fig.10D) with their alveoli in straight line.

Tarsi (Figs. 9, 10D), a small segment, each leg contains a single piece, more or less equal in length; tarsus I: 0.80 (0.79–0.81); tarsus II: 0.145 (0.143–0.146); tarsus III: 0.156 (0.155–0.157); narrow at proximal end and little broader at distal end; one pair of terminal dorsal setae present; anterior end convex, curved with two small cavical surfaces present for the articulation of tarsal claws in each leg (Fig. 10D).

Euplantulae (Figs. 9, 10D) a membranous, curved, leaf like structure, dilated, bearing horizontal lines, present between tibia and tarsi, spread over midproximal region of each tarsus (Fig. 10D).

Tarsal claws (Figs. 9, 10D) are two thick, horny, sharp, pointed, highly sclerotized claws in each leg, with proximal end broad and flat, tapering into pointed, curved distal end, more or less equal in length (Fig. 10D), measuring around 0.06, 0.065 and 0.070 respectively.

ABDOMEN (Figs. 1–4, 11–13, 14A, 15)

Elongated, oval, broadest at middle, tapering towards posterior, posterior end blunt or slightly shortly flat.

Male Abdomen (Figs. 1, 2, 11, 12)

Tergites I–VIII not well developed, less sclerotized; tergite I and II medially divided; tergum III may be divided or only marked by a thin mid line, but not divided; tergite IV–VIII undivided, single plate, equally wide from lateral ends to middle region.
Chaetotaxy as in Fig. 1, tergal setae in double rows; marginal tergal setae normal; tergum I: 12, II: 12–13, III: 12, IV: 13, V: 14, VI: 11, VII: 13, VIII: 12; anterior tergal setae fewer; tergum I: 10, II: 16, III: 12, IV: 12, V: 12, VI: 16, VII: 10, VIII: 2; postspiracular setae outer most; shortest on tergum I, measuring 0.18 long, very long on tergite II–IV, VI and VIII, ranging from 0.63–1.32 long, moderate on tergite V and VII, ranging from 0.42–0.57 long.

Tergites IX–X is known as anogenital region (Figs. 1, 12), terminal segments comprise tergites IX and X, fused tergal plates, rounded, convex posteriorly; pleurites reduced, without membranous gap.

Chaetotaxy of tergites IX and X can be differentiated by one pair of anterior tergal setae and one lateral tergopleural setae; posteriorly tergum X bears two pairs of anterior setae and one pair of subterminal setae; three pairs of long, robust, thick macrosetae with large alveoli, ranging from 1.02–1.26; posterior terminal row of seven–eight setae, relatively short in length, 0.08–0.1.

Sternite I–VIII (Figs. 2, 11A) weakly sclerotized; sternum I present, shortest, semirounded or roughly rectangular; sternite II–VI more or less equal in size; sternite VII and VIII shorter than former ones; evidently separated from pleurites by short membranous gape, containing small pleuro-sternal sclerite between sternite III–VII and their respective pleurites.

Sternal chaetotaxy thin with small microsetae, usually scattered on sternal plates; sternum I bears seven setae; II: 27, III: 25, IV: 26, V: 30, VI: 27, VII: 20, VIII: 18; sternum IV always bears a pair of thick setal brushes containing 150–153 setae (Fig. 11A).

Terminalia (Fig. 12)

Semicircular, rounded, smooth posteriorly and wavy laterally; subgenital plate width at anterior margin: 0.25 (0.24–0.26), at middle concave region: 0.155 (0.15–0.16); length at median line: 0.133 (0.13–0.137); convex posteriorly, more sclerotized than anterior region; anteriorly deeply concave;
medio-anterior piece of the plate slightly separated or may be fused with the posterior concaved piece of subgenital plate; bearing marginal and submarginal setae; two pairs of long, robust macrosetae, measuring from 0.55–0.66 long at outer position and 0.62–0.79 long at inner position; 22 small, fine, normal setae and two median setae present.

Female Abdomen (Figs. 3–4, 13, 14A, 15)

Tergites I–VIII (Fig. 3) not well developed, less sclerotized; tergite I and II medially divided, tergite III–VIII always undivided, complete plates, equally wide from lateral to middle region; tergite IV transversely divided, with narrow lateral ends.

Chaetotaxy on tergites in double rows; marginal tergal setae normal; tergite I: 12, II: 14, III: 15, IV: 15, V: 19, VI: 15, VII: 16, VIII: 12; anterior tergal setae smaller and thinner than marginal setae; tergite I: 12, II: 20, III: 18, IV: 18, V: 19, VI: 14, VII: 20, VIII: 8; postspiracular setae outer most; very long on tergite V and VII–VIII, moderate on tergite VI, short on tergite I–IV.

Tergites IX–X is known as female anogenital region (Figs. 3, 13), fused, forming a single plate, posterior margin straight.

Chaetotaxy of tergite IX and X can be differentiated by two pairs of anterior tergal setae and total seven–eight posterior tergal setae; two pairs of long, thick, robust macrosetae present on mid-lateral position; anterior setae measuring from 0.97–0.99 and posterior setae measuring from 0.91–0.95 long; posterior margin of tergal plate bearing a marginal row of 20–27 microsetae, long in middle, shorter gradually towards lateral side, become shortest at ends.

Sternite I–VII (Figs. 4, 11A) weak; sternum I present, shortest, semi rectangular or rounded; sternite II and VII smaller in width; sternite III–VI wider and more or less equal in size; sternite III and may be IV divided transversely forming adjacent sternal plate.
Sternal chaetotaxy thin on sternite I–III, V–VII, thick on sternum IV only; sternite I: 7, II: 23, III: 21, IV: 25, V: 32, VI: 30, VII: 30; sternum IV always bears a pair of thick setal brushes of microsetae, containing from 150 to 155 setae (Fig. 11A); sternum VII contains lateral setae similar to as lateral marginal setae of subgenital plate.

Terminalia (Figs. 4, 14A, 15)

Female terminalia consists of abdominal segments VIII–X; sternal plates VIII and IX fused, forming a single, subgenital plate; laterally separated from pleurum VIII; sternite X modified into anal and vulval plates.

Subgenital plate (Fig. 15) semicircular large plate, highly sclerotized, antero-medially divided in deep, forming a median ridge, with lateral sides almost parallel inside and divergent outer sides; anteriorly thick, posteriorly membranous and slightly concave; anterior setae absent; lateral marginal and submarginal to latero-posterior setae very thick, nail like, with large alveoli, pointed, sharp, erected and horny hyaline setae, ranging from thirty–thirty two; posterior setae normal and long macrosetae, soft, fine with moderate alveoli, forming a short setae bunch in mid-posterior membranous region and submarginal setae in slight sclerotized region of the plate, ranging from 16–18 setae, measuring 0.0675 (0.0425–0.0925) in mid region and 0.202 (0.162–0.242) at latero-posterior submargin.

Postvulval plate (Fig. 13) as median pair of plates, each with middle deep notch, dividing into two parts; lateral part long, slender and inner part semitriangular, both connected with posterior ends; width at anterior ends (both parts): 0.312 (0.285–0.340), at posterior margin: 0.2325 (0.230–0.235); length in mid line of each plate: 0.15 (0.14–0.16).

Preanal plate (Fig. 14A) at posterior most, single plate, thick, sclerotized, bisinuated, lateral margins wavy, posterior margin slightly concave, anterior margin deeply concave, forming middle region narrow; width at anterior
marginal corners: 0.915 (0.083–0.10), at posterior marginal corners: 0.07 (0.065–0.075); vulval marginal setae fine, normal, dorsal fringe with 20–27 setae, lateral shortest and median longest; ventral fringe with 16 marginal and eight submarginal setae, all short and spinous, except two median submarginal setae and two marginal setae, measuring 0.0925 (0.09–0.95) long.

Abdominal Pleurites (Figs. 2, 4)

Pleural plates well defined at ventral sides, broad, roughly rectangular, clearly separated from sternal plates by a membranous gape; pleural or pleuro–tergal thickening absent; posterior margin of each pleurum with three marginal setae in female and four marginal setae in male; lateral margin with usually two to three short thorny setae; medio-anterior with five–seven scattered fine microsetae.

Sterno-pleural sclerites (Figs. 2, 4, 11A) present in the membranous gap between pleurite and sternite, thick, highly sclerotized piece, which separate the pleural and sternal plates.

Abdominal Spiracles (Figs. 1, 3)

Abdominal spiracles always dorsal, open at tergal plates at most lateral position in both male and female.

Male Genitalia (Fig. 14 B–C)

Very complex, structurally complicated, typical in genus, reaching behind up to the abdominal segment III–IV.

Basal apodeme very elongated, slender, anteriorly narrow into curved tip, gradually broadened posteriorly, bifurcately broader at middle near mesomeral plate, articulated posteriorly with parameres.
Parameres (Fig. 14C) are lateral most structures, highly sclerotized, usually darkly pigmented; anteriorly slightly curved and convex, posteriorly deeply curved inside outwards.

Mesomeral plate is complex, medially divided into a pair of lateral tubular sclerites, fused with the endomeral plate.

Endomeral plate: the posterior most, less sclerotized, broad structure, fused with mesomeral sclerites and middle piece of penis; posteriorly slightly concave.

Genital sac is delicate, with scattered, minute spinous sclerites; genital sclerites contain two tubular, small sclerites with anterior end swollen.

Penis is the copulatory structure, tubular, elongated, anteriorly rounded, posteriorly bifurcated, present between mesomeral sclerites.

MATERIAL EXAMINED

Holotype: 1 male, on Grus grus (Linnaeus), niche: wing feathers, Karachi, Pakistan; 08-I-2006; leg. Saima Naz; lodged at Natural History Museum, of University of Karachi, Pakistan.

Paratypes: 5 males and 8 females, on Grus grus (Linnaeus), niche: wing and tail feathers, Karachi, Pakistan; 08-I-2006; leg. Saima Naz and Adnan Khan, lodged at Natural History Museum, of University of Karachi, Pakistan.

ETYMOLOGY

This species is named for Adnan Khan (University of Karachi) in recognition of his aid in the collection of lice used in this study.

DISCUSSIONS

The present species of the genus Heleonomus belongs to the “macilentus–group” of the genus (Price, 1970; Naz, et al., 2009). It closely resembles to H. macilentus (Nitzsch) in all the generic characters of the group, but it can be
differentiated by the other species of the group by having numbers, arrangement of tergal, sternal and pleural setae, which is variable among species. It also clearly varies in having transverse division of sternal plates III and IV in females; tergal plate III complete, only IV is divided in the present species, while both plates are divided in *H. macilentus* (Nitzsch). Beside these, subgenital plate slightly concave posteriorly, with narrow anterior sub-parallel margins, 28 lateral spiniform setae are in the present species, whereas more concave posteriorly with broad, less deeper, subparallel margin, 33 fine, spiniform setae on lateral to mid-posterior margin in *H. macilentus* (Nitzsch); postvulval plate variable; preanal plate smooth, broad posteriorly and less concave anteriorly in *H. macilentus* (Nitzsch), but medially biconcave and broad laterally in the female of the present species of *Heleonomus* (Hopkins & Clay, 1952; Price, 1970).

Male genitalia variable in endomeral plate, mesomeral plate and genital lobes broad, more complex in the present species; male subgenital plate deeply concave anteriorly and broadly convex posteriorly, medially separated from the middle lobe of the plate in the present species, whereas fused, forming deep, subparallel margins of the male subgenital plate in *H. macilentus* (Nitzsch).

REFERENCES

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CHAPTER 2

THE MORPHOLOGY OF *CHELOPISTES KARACHIENSIS* NAZ AND RIZVI, 2012 (PHTHIRAPTERA: ISCHNOCERA: PHILOPTERIDAE)

INTRODUCTION

Thirty four species of the genus *Chelopistes* Kéler are found worldwide. They parasitize the avian order Galliformes, which includes 15 species in the family Cracidae and 19 species in the family Phasianidae (Price, et al., 2003). *Chelopistes* are usually large and they are usually found in the base of quills close to the skin on the back and belly feathers and under the wings, (Eichler, 1969). They are found on the host family Cracidae in the Neotropical region (Emerson, 1960, 1962), and on the host family Phasianidae throughout the world but primarily in the Palearctic and Oriental regions (Clay, 1941; Kéler, 1957; Emerson, 1962). In Sikkim, India in the Indo-Pak region, only one species, *Chelopistes lervicola* (Clay), has been recorded (Qureshi, 1957; Lakshminarayana, 1979). The genus *Chelopistes* has been observed in Karachi, Pakistan on common turkey fowl, *Meleagris gallopavo* L., a type host *Ch. meleagridis* (L.) (Naz, et al., 2003).

Turkey fowls have been domesticated in North America and Mexico for many decades. They were introduced to Europe and Asia in sixteenth century (Rands, 2002), but have not been commonly domesticated in Indo-Pak region. In this region, the domestic fowl, *Gallus gallus* L., has been more successfully bred (Robert, 1991).

During the present study the turkey fowl were kept in captivity in two local towns near Karachi because they are not kept as pets in the region. The new insect species is described in detail with special reference to their morphology and genitalia. The chaetotaxy, terminalia, and male genitalia are
also compared with the previously reported species from the region, *Chelopistes meleagridis* (Naz, et al., 2003).

MATERIAL AND METHODS

A total of 5 birds were examined, 2 birds of which were parasitized with *Ch. meleagridis* (few adults and mostly nymphs) and 3 of which were parasitized with the new species of *Chelopistes* (8 adult males, 13 adult females, and 15 nymphs). Following the methods of Wundrig (1936) and Ross (1956), pyrethroid was sprayed on the body of host. The lice shed off the body of bird onto white collecting paper sheet. They were preserved in 85% ethanol-glycerine solution for microscopic examination and genitalia dissection (Naz, et al., 2003).

The chewing lice used in this study were preserved on microscopic slides using a standard method (Palma 1978) and mounted in Canada-balsam. Illustrations were drawn on 1cm2 graph paper with scales of 0.1mm, 0.05mm and 0.025mm. Collected species have been deposited in the Natural History Museum, University of Karachi (NHMUK), Pakistan. All measurements were taken in millimeters (mm).

DESCRIPTION OF HOLOTYPE AND PARATYPES OF *CHELOPISTES KARACHIENSIS* NAZ AND RIZVI, 2012

(Figs. 16–25, Tab. 2 and 3)

TYPE HOST: *Meleagris gallopavo* Linnaeus.

HEAD (Figs. 16–20)

Preantennal Region

*Anterior Marginal Carina* (Figs. 16–18): Anterior margin broadly convex; hyaline margin absent; marginal carina moderately thickened in middle and thinner at lateral sides, complete band along the head margins, poorly
indented posteriorly; premarginal carina poorly developed; laterally forming pointed ends at the base of preantennal nodi.

Table 2: Measurements of males and females of *Chelopistes karachiensis* Naz and Rizvi, 2012.

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
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<tbody>
<tr>
<td>HL</td>
<td>0.738 (0.725–0.751)</td>
<td>0.676 (0.603–0.750)</td>
</tr>
<tr>
<td>PAW</td>
<td>0.741 (0.730–0.752)</td>
<td>0.661 (0.650–0.672)</td>
</tr>
<tr>
<td>TW</td>
<td>1.026 (0.922–1.13)</td>
<td>0.882 (0.822–0.942)</td>
</tr>
<tr>
<td>PL</td>
<td>0.330 (0.30–0.36)</td>
<td>0.250</td>
</tr>
<tr>
<td>PW</td>
<td>0.540 (0.480–0.60)</td>
<td>0.554 (0.493–0.615)</td>
</tr>
<tr>
<td>PtL</td>
<td>0.560 (0.550–0.570)</td>
<td>0.516 (0.510–0.523)</td>
</tr>
<tr>
<td>PtW</td>
<td>1.107 (0.965–1.250)</td>
<td>0.922 (0.820–1.025)</td>
</tr>
<tr>
<td>AL d/v</td>
<td>1.85/1.81 (1.80–1.90)/ (1.80–1.820)</td>
<td>1.65/1.740 (1.62–1.68)/ (1.72–1.76)</td>
</tr>
<tr>
<td>GL</td>
<td>0.510 (0.460–0.56)</td>
<td>0.516</td>
</tr>
<tr>
<td>GW</td>
<td>0.050 (0.0430–0.057)</td>
<td></td>
</tr>
<tr>
<td>PML</td>
<td>0.155 (0.150–0.160)</td>
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</table>

*Preantennal Nodus (Figs. 16–18):* Premarginal carina laterally becomes thickened, forming preantennal nodus, just anterior to the antennal sockets; dorsally short and blunt, ventrally continuous with ventral carina.

*Ventral Carina (Fig. 18A):* Ventral carina is a thickened, complete band around oral lobe or pulvinus.
Conus (Figs. 16–18): Very short, reduced and blunt, turned posteriorly towards antennal socket, setae present, inner normal setae and outer very short microsetae at inner corner of premarginal carina (Fig. 18A).

Mouth Parts (Figs. 18A, 19A–C)

Pulvinus (Figs. 18A and 19A): A large membranous lobe like structure, that covers the ventro-anterior of head; complete lobe; surrounded by ventral carina; anteriorly touching ventral carina and latero-posteriorly supported by tormae.

Torma (Fig. 19A): Small irregular to triangular shaped sclerite, present at latero-posterior sides of the pulvinus and latero-anterior ends of labrum; supporting the pulvinus and labrum.

Labrum (Fig. 19A): Very reduced, anterior most, slit like, narrow, slightly curved, anteriorly convex, thick, membranous layer; bearing small microsetae at its anterior margin along the length, outer setae slightly larger than gradually short inner setae.

Mandibles (Fig. 19A): Hard, highly sclerotized structure, pointed at inner sides; horizontally articulated; right mandible overlaps the left mandible; laterally jointed with the part of ventral carina; ventrally partially covered by labium.

Maxillae: Maxillae and maxillary palpi are absent in Chelopistes karachiensis.

Labium (Fig. 19B): Membranous, broad, unsclerotized structure; covering the part of mandibles and the whole sitophore beneath it; anterior margin bears five–eight pairs of fine, pointed, sharp microsetae with moderate to small alveoli; labial palpi single segmented, measuring 0.0435 (0.04–0.047); terminal disc bears five–six microsetae.
Hypopharynx (Fig. 19C): Length: 0.071 (0.07–0.072); width: 0.0915 (0.091–0.092); well developed, sclerotized structure; hypopharyngeal sclerite well developed, connected with a pair of salivary cups at lateral sides.

Antennal Region

Antenna (Figs. 16–18 and 20A–B): Filiform, comprising five segments, fully exposed, ventrally articulated.

Table 3: Measurements of Antennal segments of Chelopistes karachiensis Naz and Rizvi, 2012.

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
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<tbody>
<tr>
<td>Scape</td>
<td>0.240</td>
<td>0.097</td>
</tr>
<tr>
<td></td>
<td>(0.211–0.27)</td>
<td>(0.084–0.11)</td>
</tr>
<tr>
<td>Pedicel</td>
<td>0.105</td>
<td>0.075</td>
</tr>
<tr>
<td></td>
<td>(0.10–0.11)</td>
<td>(0.070–0.08)</td>
</tr>
<tr>
<td>Flagellomere I</td>
<td>0.075</td>
<td>0.066</td>
</tr>
<tr>
<td></td>
<td>(0.07–0.08)</td>
<td>(0.06–0.072)</td>
</tr>
<tr>
<td>Flagellomere II</td>
<td>0.055</td>
<td>0.066</td>
</tr>
<tr>
<td></td>
<td>(0.05–0.060)</td>
<td>(0.055–0.077)</td>
</tr>
<tr>
<td>Flagellomere III</td>
<td>0.095</td>
<td>0.078</td>
</tr>
<tr>
<td></td>
<td>(0.090–0.10)</td>
<td>(0.076–0.080)</td>
</tr>
</tbody>
</table>

Scape is elongated in male, with lateral sclerotized extension, bearing a median fine seta. In female it is short, almost equal to the pedicel.

Pedicel is longer than narrow in both male and female; roughly rectangular; outer ventral margin bears one or two fine setae.

Flagellomere I is longer than broad; rectangular shaped. Flagellomere II is slightly longer than broad, rectangular shaped, with one subterminal short seta and two sensillae coeloconica. Flagellomere III with terminal disc short and
narrow, bearing four–five small setae with basal sensillae; two subterminal sensillae coeloconica present.

*Antennal Socket (Fig. 20A):* Antennal socket shallow, highly lateral in position; clavi is developed, present behind the antenna.

Postantennal Region

*Eyes* are nonfunctional, only a small ocular lens present at very lateral sides, with a pigmented weak post ocular nodus; bearing a large ocular macrosetae on the lens, reaching behind the terminal end of temple; a small postocular seta behind the lens present.

*Gular Region (Fig. 18A–B)* is very short and weakly sclerotized; gular plate is absent.

*Temporal Region (Figs. 16–18):* Temples very large and expanded, pointed, posteriorly projecting behind the posterior margin of head; marginal temporal carina complete; marginal temporal setae six in male with setae 1, 2, 3 and 5 short and microsetae, seta 4 very long macroseta and dominant, seta 6 medially large and fine seta; marginal temporal setae five in female, with marginal temporal setae 1, 2, 4 and 5 very small microsetae and seta 3 very large macroseta and dominant; post temporal setae present.

*Occipital Region (Figs. 16–18):* Posterior head margin bears thick sclerotized occipital carina, connecting two occipital nodi, expanded posteriorly to articulate with prothorax.

THORAX (Figs. 16, 17 and 21)

Prothorax

*Pronotum (Figs. 16, 17 and 21A)* more or less trapezoidal, with lateral sides diverged towards posteriorly, posterior margin straight to convex. One pair of small, anterior pronotal setae present; one pair of long macrosetae
present at postero-lateral ends of pronotum, along the lateral sides of pteronotum.

*Rhombic sclerite (Fig. 21A)* is a small cup shaped thick, sclerotized structure present at anterior margin of prothorax, connecting with extensions of occipital nodi, articulating head and thorax.

*Prosternal plate* is absent in *Chelopistes karachiensis* Naz and Rizvi, 2012.

Pterothorax (Figs. 16, 17 and 21A)

Mesothorax and metathorax completely fused, forming pterothorax of trapezoidal to triangular shaped; lateral margins thick, divergent; posterior margins tapering towards posterior with median pointed margin.

Two pairs of large lateral pteronotal macrosetae and two pairs of latero-posterior marginal macrosetae present; a short thorn-like seta present at lateral sides; trichoid seta is absent. One pair of mesothoracic spiracles present at pleuro-sternal position.

*Mesopleural Ribs (Figs. 21A):* Ventrally meso-pleurites extended medially towards inner side, forming meso-pleural ribs, with their developing end towards abdomen.

*Proepimeron (Figs. 21A)* is developed, extended towards abdomen; separated from each other, not fused medially.

*Meso-metasternal plate (Figs. 21A)* is large, roughly triangular with lateral sides concave, forming anterior part narrower than posterior broad and flat part; bearing five pairs of long, fine and normal meso-metasternal setae, arranged at lateral periphery.
Thoracic Appendages (Figs. 21B i–iii)

Elongated, stumpy, sclerotized, well developed, strong with thick chaetotaxy on femur and tibia; proleg (Fig. 21B i) shortest in length, mesoleg (Fig. 21B ii) median and metaleg (Fig. 21B iii) longest.

**Length:** coxa I 0.210 (0.200–0.220); coxa II 0.212 (0.210–0.214); coxa III 0.231 (0.23–0.232); femur I 0.262 (0.260–0.264); femur II 0.325 (0.320–0.330); femur III 0.412 (0.41–0.415); tibia I 0.287 (0.270–0.304); tibia II 0.310 (0.290–0.310); tibia III 0.450 (0.44–0.46); tarsus I 0.037 (0.035–0.039); tarsus II 0.065 (0.060–0.070); tarsus III 0.081 (0.08–0.082).

*Coxae* rounded to oval, expanded to elongated, ventrally attached with the thoracic segments; coxa I oval, expanded laterally with scars chaetotaxy; coxa II and coxa III more or less oval to roughly quadrate with a short subterminal seta; separated from meso-metasternal plate; surrounded by pleural ribs.

*Trochanter* small and flattened, triangular shaped, connecting coxae with the femur of each leg; setae almost absent or rarely present.

*Femur* thick, broad, elongated and oval shaped; smallest in proleg, median in mesoleg, longest in metaleg; four–five marginal setae present on femur I–III.

*Tibia* elongated, narrower than femur; smallest in proleg and longest in metaleg; distal end membranous, bearing a tuft of thick hyaline setae and four–five thick marginal setae; articulated with tarsus anteriorly.

*Tarsi* are smallest segment, each leg contains a single segment; broad at proximal end; one pair of terminal dorsal setae present; anterior end convex, curved with two small cavical surfaces present for the articulation of tarsal claws in each leg.

*Tarsal claws* thick, horny, sharp, pointed, highly sclerotized, two claws on each leg, with proximal end broad and flat, tapering into pointed, curved distal end, more or less equal in length.
ABDOMEN (Figs. 16, 17, 22–24A)

Oval, tapering to pointed posteriorly, broadest at middle, posterior end narrow and pliers shaped.

Male Abdomen (Figs. 16 and 22)

Male Pre-genital Segments I–VII: Tergites and pleurites fused, forming tergopleurites, divided medially and separated by wide gap; membranous and less sclerotized median region; abdominal segment I fused anteriorly with pterothorax and posteriorly with segment II; pleurites are developed into highly thick sclerotized pleural ribs with developed pleural knots; sternal plates complete but very weakly sclerotized, continuous with pleural ribs.

Chaetotaxy (Figs. 16 and 22): Tergal medial setae double on segment I and single rows on segments II–VII; tergal medial setae on segment I: 4, II: 4, III: 4, IV: 6, V: 8, VI: 8, VII: 2; submedian setae not evident; one intermediate setae present on segments III–VII; sternal setae absent on segment I and II, on segment III: 8–10, IV: 8–10, V: 8, VI: 4, VII: 2; all setae long fine normal setae.

Male Anogenital Segments VIII–X (Figs. 16, 22 and 23A–B): Terminal segments comprise anogenital segments VIII–X, paratergite VIII developed, sclerotized, separated from the median ridge; tergites IX and X small and triangular in shape; tergal plates X and XI actually fused and considered as single tergal plate of segment X; subgenital plate very developed, uniquely formed; sternite VIII and IX fused forming stylus (Fig. 23B), bearing numerous microsetae on its terminal end, measuring 0.590 (0.560–0.620); genital opening ventral and on segment X; sternite VIII bears one pair of fine normal setae and two pairs of lateral tergopleural setae; sternite IX contains six–eight minute central setae at lateral sides of stylus; segment XI is modified into two parallel pointed parts of pliers shape, bearing two lateral setae (Fig. 23A).
Female Abdomen (Figs. 17 and 24)

*Female Pre-genital Segments I–VIII*: Tergopleurites divided medially and separated by wide gap; membranous and less sclerotized median region; abdominal segment I fused anteriorly with pterothorax and posteriorly with segment II; pleurites are developed into highly thick sclerotized pleural ribs with developed pleural knots; sternal plates complete but very weakly sclerotized, continuous with pleural ribs.

*Chaetotaxy*: Tergal medial setae single rows on segments III–VII; tergal medial setae on segment III: 8, IV: 8, V: 8, VI: 8, VII: 4, VIII: absent; submedian setae not evident; one intermediate setae present on segments III–VII; sternal setae absent on segment II, on segment III: 4, IV: 10, V: 10, VI: 8, VII: 0–2, VIII: 0–2; submedian sternal setae present on sternite III: 4 pairs, IV: 7 pairs, V: 5 pairs, VI: 4 pairs; all setae short to long fine normal setae.

*Female Anogenital Segments IX–XI* (Figs. 17, 24 and 25A): Terminal segments comprise anogenital segments IX–XI; tergites IX–XI fused, forming two small and triangular tergal plates; genital opening dorsal between segments VII and VIII; tergite IX–X and sternite IX–X without setae; segment XI is modified into two parallel pointed parts of pliers shape, bearing two subterminal and four terminal microsetae; (Fig. 25A); subgenital plate (Fig. 25B) very developed, short, fly-winged shaped, ventro-posterior margin bears a minute fringe of terminal microsetae; vulval margin broad and slightly oval shaped.

Abdominal Spiracles

Abdominal spiracles always dorsal, open on tergopleurites III–VIII.

Male Genitalia (Figs. 25C i–ii)

Complex and unique, typical in genus, reaching behind up to the abdominal segment VIII.
Basal apodeme elongated, spatula like, slender proximally and broader distally, thickly membranous, weakly sclerotized, articulated posteriorly with paramere bag.

Parameres cone shaped, tapering towards posteriorly with blunt end, developed into a bag like structure, in which the aedeagus is enclosed.

Aedeagus complex is central highly modified mesomeral plate forms the aedeagus complex; endomeral plate undeveloped; medially covered in a membranous fold of basal apodeme, connected with penis.

Penis, copulatory structure, tubular, very short and highly sclerotized, posteriorly curved into claw-shape, anteriorly connected with mesomeral sclerites.

MATERIAL EXAMINED

Holotype: 1 male, on Meleagris gallopavo L., niche: back feathers, Karachi, Pakistan; 09-IX-2005; coll. Naz, S. deposited at Natural History Museum, University of Karachi, Pakistan.

Paratype: 8 males, 13 females, on 3 birds Meleagris gallopavo L., niche: back and under wings, Karachi, Pakistan; 09-IX-2005; coll. Naz, S. deposited at Natural History Museum, University of Karachi, Pakistan.

ETYMOLOGY

The present species is named for Karachi where it has been collected by the authors.

DISCUSSION

Chelopistes karachiensis Naz and Rizvi, 2012 is closely related to Ch. meleagridis (L.) and is similar in characters of head, antennae and antennal articulation, occipital margins and temporal margins of the head, pterothoracic lateral margins, shape of abdomen, and tergal and pleural sclerotization (Kéler,
However, they differ in male and female terminalia in male genitalia armature. The size of both sexes of *Ch. karachiensis* is smaller in almost all dimensions (TW not >1.13 and PW not >0.60 for *Ch. karachiensis* vs. TW at least 1.40 and PW at least 0.70 for *Ch. meleagridis*).

Female terminal segments are slightly curved inwardly; female subgenital plate is broader, expanded laterally (Fig. 25B) with 37 submarginal setae at inner posterior margin; stylus is shorter (0.56–0.62 vs. 0.68), broader anteriorly and slightly broad posteriorly but narrow at middle (Fig. 23B); in male genitalia, the basal apodeme is expanded laterally, with immediately narrow struts; parameral bag is roughly spatulate and pseudopenis is longer and transversely upward (Fig. 25C).

In *Ch. meleagridis* (Naz, et al., 2003), the cephalic, thoracic and abdominal chaetae are thicker and setae longer; female terminal segment is quadrate and bilobed; female subgenital plate is bilobed and less expanded (Fig. 6, p: 34 in Naz, et al., 2003), with 30–32 microsetae on inner posterior margin; male stylus is longer and gradually tapering towards posterior; basal apodeme is smoothly rounded anteriorly, posteriorly tapering struts; parameral bag is oval; pseudopenis is shorter and usually resting downwards (Figs. 9, p: 34 in Naz, et al., 2003).

REFERENCES


SUMMARY

A detailed morphological study of two new species of Phthiraptera have been described. One belongs to the genus *Heleonomus* (Amblycera: Menoponidae), from common cranes, *Grus grus* (Gruiformes: Gruidae) and the other new species of the genus *Chelopistes* (Ischnocera: Philopteridae) from common turkey, *Meleagris gallopavo* (Galliformes: Phasianidae) were recorded from Pakistan. These chewing lice species have been taxonomically enlightened and illustrated with respect to the chaetotaxy and male and female genitalia features. It is a new record of the genus *Heleonomus* in Pakistan. Both the species have also been compared with their closest allies.
Fig. 1
Fig. 3
Fig. 8
PLATES OF FIGURES OF *CHELOPISTES KARACHIENSIS* NAZ AND RIZVI, 2012.

Fig. 16
Fig. 21
Fig. 23