



First Record of Genus *Goniodes* Nitzsch, 1818 (Phthiraptera: Ischnocera: Philopteridae) on Peafowl (Galliformes: Phasianidae) from Pakistan

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Authors' contributions

This work was carried out in collaboration between both authors. Author SN designed the study, performed the experimental work, wrote the protocol, and wrote the first draft of the manuscript. Author SAR managed the analyses of the study and improved the draft in final form. Both authors read and approved the final manuscript.

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ABSTRACT

Aims: To examine and explore chewing lice (Phthiraptera) species found in Peafowls in Pakistan. To find out more species and compare these species with previously known species of chewing lice found on Peafowls.

Study Design: The genus *Goniodes* Nitzsch, 1818 is specifically found on gallinaceous hosts all over the world, represented by 100 species. It is very clearly identifiable for its circumfasciate head and somehow angulated temples of the head, antennae always heteromorphic; thorax and abdomen also very peculiar in its morphology, the abdominal segment I always larger and expanded laterally. Parasitological investigation of Peafowls was undertaken to find out the chewing lice infestation in Sindh, Pakistan.

Place and Duration of Study: Department of Zoology, University of Sindh, Jamshoro, Sindh, Pakistan. Between 2016 and 2017.

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Methodology: Peafowl, *Pavo cristatus* L. 1758 was examined during the present study for chewing lice collection; chewing lice were processed for the permanent mount through the standard method and were studied under high magnification microscope for illustration and identification.

Results: During the examination of chewing lice, the genus *Goniodes* was recovered from *Pavo cristatus* for the first time from Sindh province, Pakistan. Out of 18 peafowls, seven were infested, contained 28 specimens of two species, *G. dissimilis* Denny 1842 and *G. meinertzhageni* Clay 1940 were isolated from Thatta, Karachi, Jamshoro, Hyderabad and Mirpur Khas districts of Sindh. Both species *G. dissimilis* and *G. meinertzhageni* were recorded first time from Pakistan, hence put on new record at country level for Indian Peafowl. A key for the identification of all *Goniodes* species found on the peafowl has also been presented along with their detailed morphological descriptions and morphometric features.

Conclusion: Two species of chewing lice of the genus *Goniodes* were collected and identified and were compared with each other to clarify their morpho-taxonomical characteristics in both species.

Keywords: *Goniodes*; new records; Pakistan; *Pavo cristatus*; Sindh.

1. INTRODUCTION

The genus *Goniodes* Nitzsch 1818 [1] is a particular genus of birds of order Galliformes all over the world. There are around 100 species of the genus have been reported from different gallinaceous birds like fowls, partridges, pheasants and guinea fowls [2,3,4].

The Indian Peafowl, *Pavo cristatus* L. has been studied for its chewing lice infestation in different regions of the world [5,6,7,8,9,10,11] and harbors 12 species of chewing lice on it [3,12].

In Pakistan, there is no significant information available about the chewing lice or other ectoparasites of Peafowls, however, this bird is very ornamental and economically valuable, hence a little work is done on protozoan infection [13]. From Pakistan, there was a single report of Peafowl chewing lice only from Karachi [14], but not any species of genus *Goniodes* is yet being described from the region. However, during a present survey of captive Peafowls in different regions of Sindh, it has been reported first time the constant existence of the two species of *Goniodes* on this bird and hence described in detail with their comparative morphology. It was also observed that the most common peafowl body louse, *Goniodes pavonis* (L. 1758) [15] was not reported from the region, other than Karachi, Pakistan.

2. MATERIALS AND METHODS

The captive peafowls were examined for their chewing lice during the present survey at different local parks and public zoos where peafowls were available also at some bird keepers at their house gardens. Total of 18 peafowls was examined at districts Thatta,

Karachi, Jamshoro, Hyderabad and Mirpur Khas, Sindh, Pakistan. Chewing lice were sorted for the identification of genus *Goniodes*.

The specimens were left in 10% solution of Potassium Hydroxide for overnight; neutralized with 10% acetic acid and then washed with distilled water. Dehydration was taken out by using 20% ethanol to ascending grads up to absolute and cleared and fixed in clove oil and xylol respectively; finally, the specimens were mounted in Canada balsam on microscopic slides with clearly set at dorsal and ventral habitus on each slide. After keeping them warm in the oven at 50°C for 3 days, drawings were made to illustrate the specimens using micro-ocular graticule and measurements were taken by an ocular micrometer (Table 1); photographs were shot by Nikon digital microscopic camera for the details of the morphology of lice specimens.

All specimens in mounted slides as well as preserved in 70% ethanol in vials are lodged in Museum Collection of Advanced Parasitology Research Lab (APRL), Department of Zoology, University of Sindh, Jamshoro, Sindh, Pakistan.

3. RESULTS

Presently, seven infested peafowls provided 28 specimens of two species of genus *Goniodes* Nitzsch 1818 [1], including 11 adults of *G. dissimilis* Denny 1842 [16] (Figs. 1-7) and 17 adults of *G. meinertzhageni* Clay 1940 [2] (Figs. 8-13). Nymphs were also isolated but not included in this study. An identification key to species of genus *Goniodes* found generally and specifically on Indian peafowl, *Pavo cristatus* has been given (Table 2).

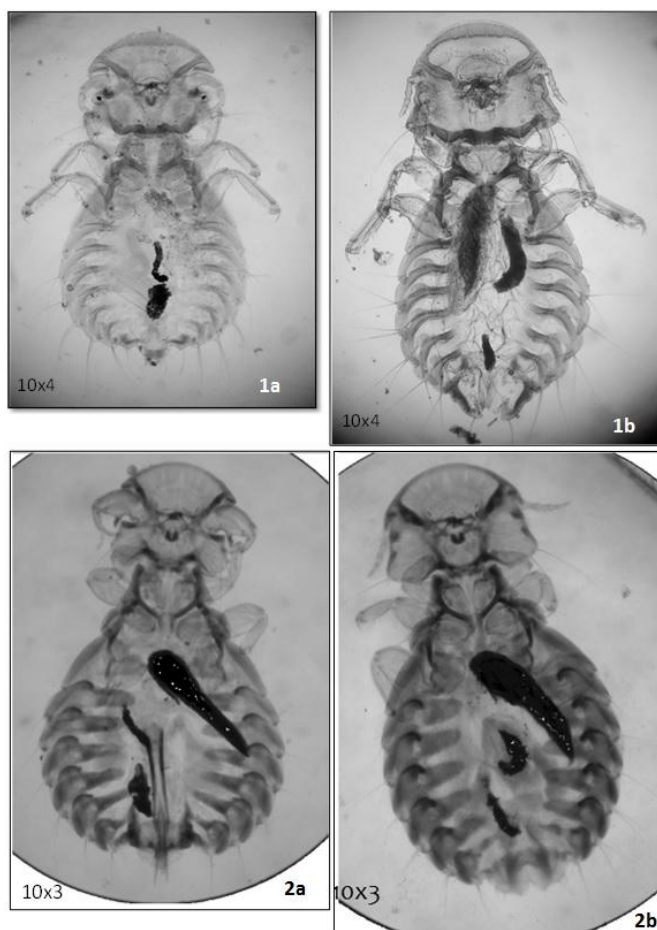
Table 1. Measurements of different body parts of the two species of genus *Goniodes* (mm)

Body parts	<i>G. dissimilis</i>		<i>G. meinertzhageni</i>	
	♂	♀	♂	♀
Total Body Length	2.176 (2.150-2.203)*	2.931 (2.930-2.933)	3.552 (3.470-3.575)	3.696 (3.692-3.70)
Head Length	0.696 (0.685-0.708)	0.799 (0.798-0.80)	0.871 (0.870-0.872)	0.910 (0.90-0.920)
Preantennal Width	0.826 (0.820-0.832)	0.949 (0.948-0.950)	1.027 (1.025-1.029)	1.196 (1.185-1.207)
Temporal Width	0.781 (0.770-0.793)	1.096 (1.092-1.10)	1.053 (1.01-1.096)	1.30 (1.00-1.50)
Pronotal Length	0.198 (0.175-0.221)	0.208 (0.206-0.210)	0.468 (0.458-0.478)	0.468 (0.466-0.470)
Pronotal Width	0.472 (0.468-0.477)	0.559 (0.557-0.561)	0.845 (0.840-0.850)	0.832 (0.812-0.852)
Pteronotal Length	0.649 (0.299-0.350)	0.364 (0.362-0.366)	0.538 (0.513-0.563)	0.548 (0.540-0.556)
Pteronotal Width	0.687 (0.672-0.702)	0.806 (0.802-0.808)	1.170 (1.15-1.19)	1.183 (1.161-1.176)
Abdominal Length	0.962 (0.950-0.975)	1.560 (1.550-1.570)	1.664 (1.660-1.668)	1.846 (1.840-1.848)
Genital Length	0.874 (0.865-0.884)	-	1.382 (1.36-1.404)	-
Genital Width	0.07 (0.065-0.075)	-	0.098 (0.091-0.105)	-

*range of the size for male: n=3 and female: n=4

Table 2. Key to the species of genus *Goniodes* Nitzsch, found parasitizing peafowl

1.	Anterior margin of head broadly convex; anterior marginal carina thick; conus of male head large and pointed; clavi membranous; antennal scape without posterior process; flagellomere I with short lateral extension; marginal temporal carina thick; prothorax short and narrow; meso-metasternal setae absent; lateral plates in male segment IX present; female genital organs without genital sclerite; female ventral terminalia with dense chaetotaxy and spinous process at lateral sides; parameres elongated, tapering to slightly angular head angular.....	<i>G. dissimilis</i> Denny
-	Anterior margin of head smoothly rounded; anterior marginal carina thin; conus of male head short and blunt; antennal scape with posterior process; flagellomere I with long lateral extension; marginal temporal carina thin; prothorax longer and broad; meso-metasternal setae present; lateral plates in male segment IX absent; female genital organs with bifid genital sclerite.....	2
2.	Preantennal nodus thick and long; clavi thick, prolonged posteriorly; posterior process on scape short; female genital organs with membranous bifid sclerite; female ventral terminalia with thick lateral bunches of setae; vulva dorsal in position with lateral marginal setae; vulval plate slightly concave posteriorly; basal apodeme short and broad with thick struts; telomere well developed; parameres broad and wing shaped.....	<i>G. pavonis</i> (Linnaeus)
-	Preantennal nodus thin and short; clavi short, not pointed posteriorly; posterior process on scape large; female genital organs with thin bifid sclerites; female ventral terminalia with thick lateral striated marks; vulva terminal in position with posterior marginal setae; vulval plate deeply concave and bilobed, with fine row of terminal setae; telomere weakly developed; parameres tapering to pointed.....	<i>G. meinertzhageni</i> Clay



Figs. 1-2: Species of *Goniodes* of Pea cock, 1: *G. dissimilis* a: male, b: female; 2: *G. meinertzhageni* a: male, b: female

3.1 *Goniodes dissimilis* Denny 1842 (Figs. 1, 2-7)

Type Host: *Gallus gallus* (L.) (Galliformes: Phasianidae).

Material Examined: 05 ♂, 06 ♀, on *Pavo cristatus* Linnaeus, niche: down wing feathers, Karachi, Thatta, Hyderabad, Pakistan; 04-viii-2010, 24-vii-2011; leg. Naz, S.; lodged at APRL, Department of Zoology, University of Sindh, Jamshoro and author's collection.

Status: First record from *Pavo cristatus* in Sindh region.

Description

Preantennal Region: Circumfasciate; rounded, broad anteriorly; hyaline margin absent; marginal carina complete band along the margins of head;

internal margin with large nodus; pre-marginal carina continuous with post marginal carina; dorsal carina absent; ventral carina complete band around pulvinus; transverse carina absent; marginal carinal nodus present; preantennal nodus large, blunt; conus pointed, smaller than scape in male and equal in female; medial dorsal groove present in male; anteclypeus reduced; dorsal anterior plate absent, ventral anterior plate absent; dorsal preantennal suture absent; pulvinus large, complete lobed, fused with pulvinal band, separated from torma; trabecula absent.

Antennal Region: Antennae heteromorphic; scape of male elongated, broad, without lateral process or clavus; pedicel and flagellomeres unfused, articulation subterminal; flagellomere I curved, with a large lateral extension, strongly chitinised; antennal socket deep.

Postantennal Region: Gular plate absent; margins of temples angular, blunt, not posterior to head margin; marginal temporal carina thick, marginal temporal setae five, setae 2 and 3 dominant, setae 1, 4 and 5 subordinate; post-temporal setae present; postocular setae normal, macrosetae, behind the lens; ocular setae normal, macrosetae, on the lens; postocular nodus well developed.

Prothorax: Anterior setae present; rhombic sclerite between head and prothorax present, large cup-like; posterolateral setae one pair, arrangement 1+1.

Pterothorax: Lateral margins divergent; posterior margin convex, V-shaped, embedded into abdominal segment II; pteronotum divided; posterior to lateral setae four pairs, arranged as 2,2+2,2; trichoid setae absent; thorn like setae present; mesothoracic spiracles ventrolateral, with small atrium; meso-metasternal plate absent, second sternal plate absent, meso-metasternal setae absent; mesofurcal pit absent; proepimeron expanded, unfused, developed towards posterior; mesothoracic and metathoracic legs sternocoxal in articulation.

Abdomen: Large, expanded, oblong, with lateral margins very convex, darkly pigmented tergopleurites.

Pregenital Segments: Tergite I fused with tergite II; tergite II divided; median to submedian setae on tergites II: 2 pairs, III: 3 pairs, IV-V: 4 pairs, VI-VII: 3 pairs, VIII: 6 pairs; intermediate tergal setae present; trichoid setae on VIII present; median to submedian sternal setae in single row; abdominal sclerotization limited to tergopleurites, separated medially by wide gape; pleural ribs enlarged, expanded with large pleural knots; abdominal spiracles six pairs with small atria; sternal plates absent or weakly sclerotised.

Male Terminalia: Dorsal abdominal plate on terminal segment divided into anterior fused tergites IX and X; tergite XI narrow; ventral chaetotaxy characteristic; a thickened pointed, protruded process on ventral of sternite VIII present.

Female Terminalia: Subgenital plate developed, sclerotized, V-shaped, armed with pediculated sharp spines (Fig. 6a), arranged as 5+5 in oblique line along the margin of vulva; vulval opening in between segment X and XI; cluster of sharply pointed micro setae present at

pleurosternal position; behind these microsetae a pair of pointed sclerotized hyaline thorn like process present (Fig. 6a pointed with red arrow).

Male Genitalia: Complex, elongated, reaching behind up to the abdominal segment III or IV; parameres (Fig. 7a, b pointed) tapering, pointedly curved, well developed; basal apodeme flat, narrow, elongated; mesosomal plate developed; endomere fused with paramere; penis short, fixed within mesosomal plate.

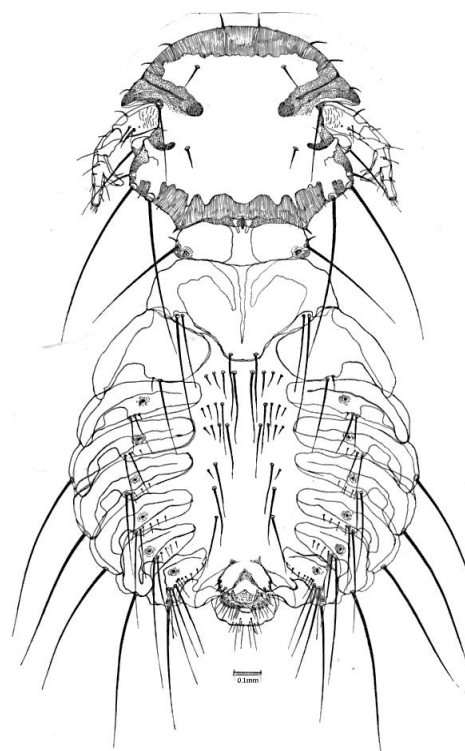


Fig. 3. *Goniodes dissimilis*, Male dorsum

3.2 *Goniodes meinertzhageni* Clay 1940 (Figs. 2, 8-13)

Type Host: *Pavo cristatus* L. (Galliformes: Phasianidae).

Material examined: 7♂, 10♀, on *Pavo cristatus* L., niche: marginal covert and alula feathers of wings, Karachi, Mirpur Khas and Hyderabad, Pakistan; 14-xii-2011, 05-v-2012; leg. Naz, S.; lodged at APRL, Department of Zoology, University of Sindh, Jamshoro and author's collection.

Status: New record from Pakistan.

Description:

Preantennal Region: Anterior head margin broad, convex; hyaline margin absent; marginal carina complete, thin, along the head margin; pre-marginal carina continuous with post marginal carina; dorsal carina absent; ventral carina complete, around pulvinal cavity; transverse carina absent; marginal carinal nodus absent; preantennal nodus large, blunt; medial dorsal groove in male present; dorsal anterior and ventral plates absent; dorsal preantennal suture absent, separated from torma; conus blunt, smaller than scape in male, equal to the scape in female; trabecula absent; torma present.

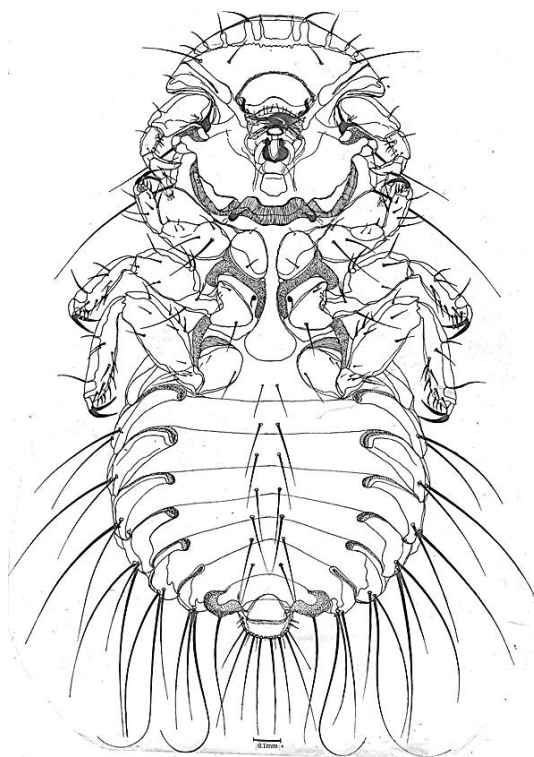


Fig. 4. *Goniodes dissimilis*, Male ventrum

Antennal Region: Antennae heteromorphic; scape elongated with the lateral process; clavi short, not pointed posteriorly; pedicel and flagellomere unfused; articulation subterminal; flagellomere I with the large process, slightly curved; antennal socket slightly deep.

Postantennal Region: Gular plate absent; margin of temples angular, quadrate, less than posterior margin of head; marginal temporal carina complete in temporal region; marginal temporal setae five, setae 1 and 3 dominant; post-temporal setae present; postocular setae

normal, microsetae, behind the lens; ocular setae thorn-like, microsetae, on the lens; postocular nodus well developed, deeply pigmented.

Prothorax: Anterior setae absent; rhombic sclerite between the head and prothorax cup-like; one pair of posterolateral setae present, arrangement 1+1.

Pterothorax: Lateral margins divergent; posterior margin convex, V-shaped; posterolateral marginal setae five pairs, arranged as 2,2,1+1,2,2; pteronotum undivided; trichoid seta present; thorn like seta present; mesothoracic spiracles ventro-lateral with small atrium; proepimeron expanded, unfused, developed posteriorly towards abdomen, sclerite between proepimeron present; meso-metasternal plate absent or unsclerotized; second sternal plate absent; meso-metasternal setae two pairs, arrangement 1,1+1,1; mesofurcal pit absent; mesothoracic and metathoracic legs sternocoxal in articulation; posterior of pterothorax fused with abdominal segment II.

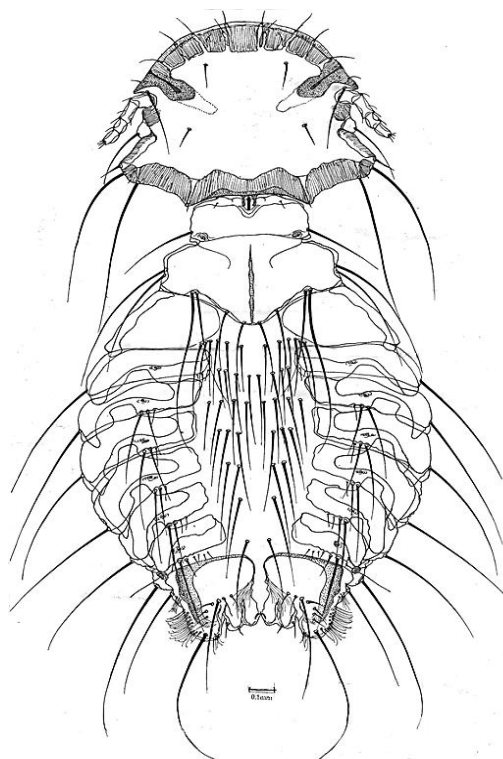


Fig. 5. *Goniodes dissimilis*, Female dorsum in details

Abdomen: Very large, wide, oval to rounded; tergopleurites thick with developed pleural knots.

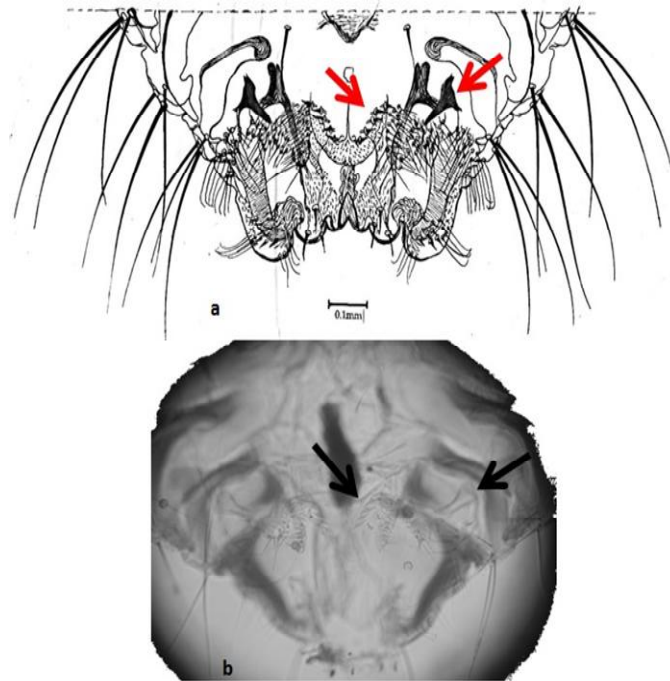


Fig. 6. *Goniodes dissimilis*, a. Female terminalia in details, b. Photograph showing the main features of female terminalia

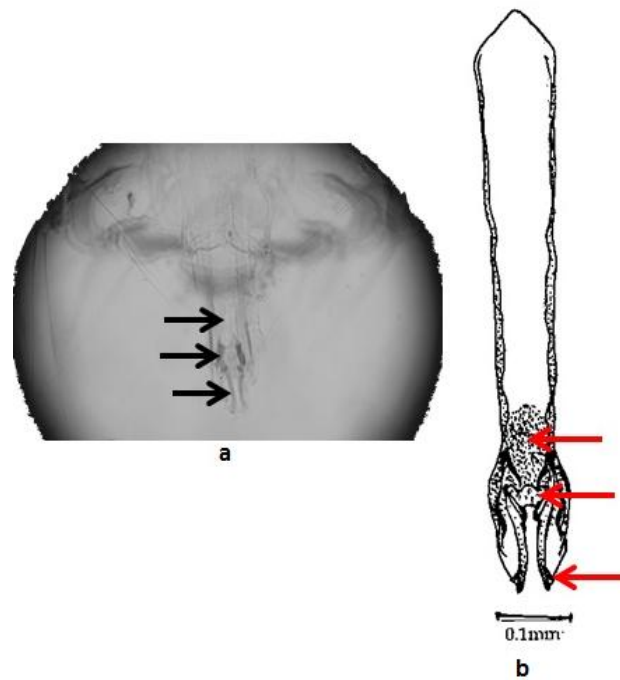


Fig. 7. *Goniodes dissimilis* a. Male terminalia in photograph showing genitalia, b. Male genitalia armature

Pregenital Segments: Abdominal segment II segment III; medial tergal division present; smaller and deeply embedded into abdominal tergites II and III unfused; setae on tergite II

absent; submedian to median setae on tergites III-VI two pairs in single row; lateral setae on tergites III-VII two-three pairs; intermediate tergal setae present; abdominal spiracles six pairs with large atrium; tergal and pleural abdominal plates fused to form tergopleurites, thickly sclerotised, separated by wide gape; cuticular sculpture on posterior abdominal segments present; pleural abdominal ribs enlarged, expanded with pleural knobs; sternal abdominal plates absent or weakly

sclerotized; trichoid setae on segment VIII present.

Male Terminalia: Tergites IX and X fused to form a single tergal plate; tergal sclerotisation reduced to pleurite; a sclerotic structure with oblique lines is present in roughly triangular shape, in association with genital plate; subgenital sclerite deeply concave present with the blunt end.

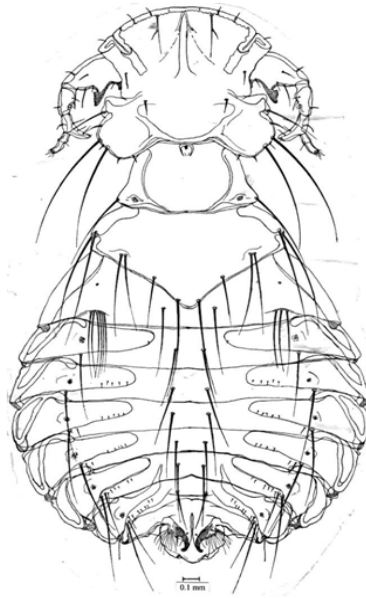


Fig. 8. *Goniodes meinertzhageni* Male dorsum

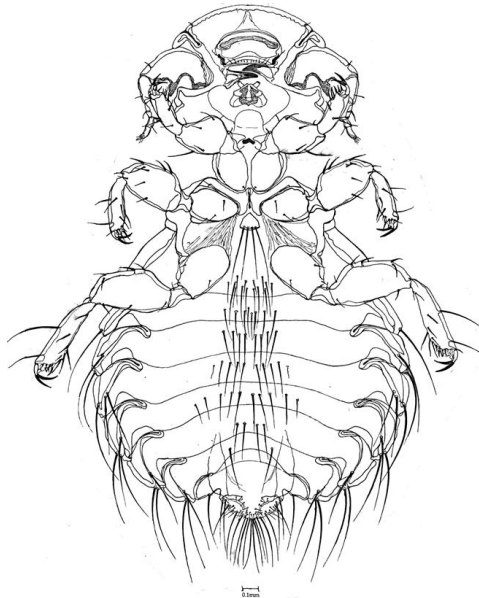
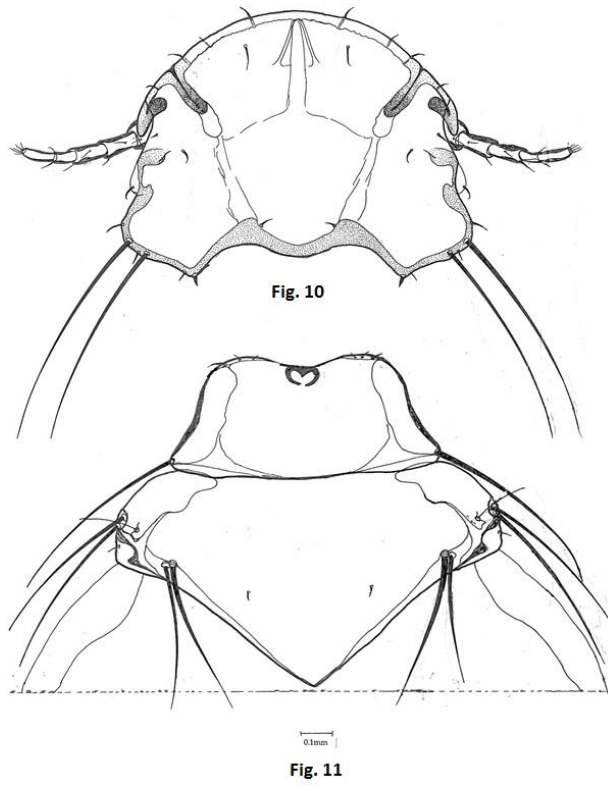


Fig. 9. *Goniodes meinertzhageni* Male ventrum



Figs. 10-11. *Goniodes meinertzhageni* 10. Female head; 11. Female thorax

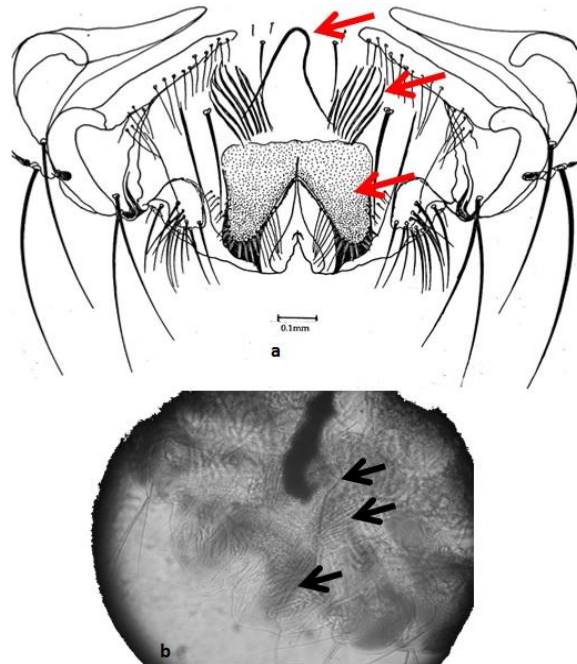


Fig. 12. *Goniodes meinertzhageni* a. Female terminalia illustrated in details b. Photograph showing the main features

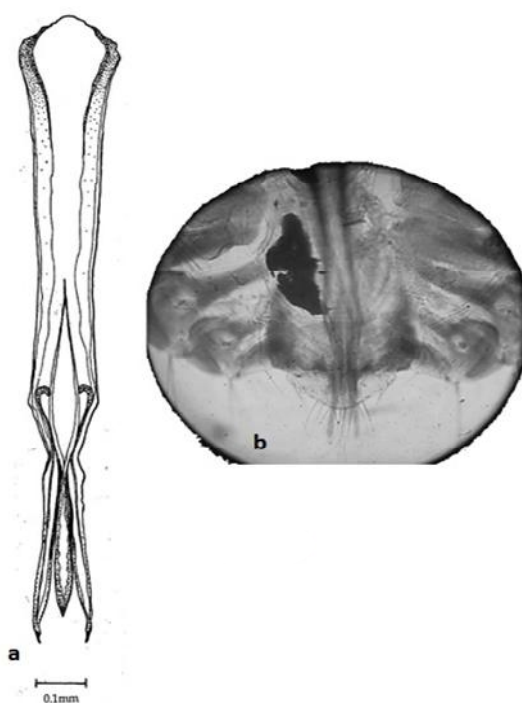


Fig. 13. *Goniodes meinertzhageni* a. Male genitalia illustrated b. Male terminalia showing genitalia

Female Terminalia: Subgenital plate deeply bilobed; vulval margin deeply concave, with minute spinous setae at inner to posterior margins (Fig. 12a); a genital region with a thickened striated sclerotic plate (Fig. 12a, b pointed with red arrow), just above the vulval aperture.

Male Genitalia: Narrow, elongated, exceeds up to segment IV; parameres narrow, equally thickened, elongated; penis tapering posteriorly, smaller than parameres in length; endomere reduced; basal apodeme elongated, narrow, flat (Fig. 13a, b).

4. DISCUSSION

About 100 species of genus *Goniodes* are known worldwide and found parasitised on different host birds of order galliformes. This genus, however, was finely described in the very clear manner by Clay [2] with its species group level. However many of species have been described separately by various lice specialist in a different region of the world [6,10,11,17,18,19,20,21,22, 23].

Previously this genus has been reported from Pakistan on domestic fowls and chickens,

peafowls [14,24] for the two under discussion species. However, *G. dissimilis* was recovered from domestic fowls and *G. meinertzhageni* was reported from peafowl but was not described in Naz et al. [14]. The first species was however reported from Saudi Arabia on peafowls [10] but it is reported from the same host for the first time from Pakistan. Besides these two species found on peafowls, *G. pavonis* (L. 1758) [15] is the type species and has been reported from different regions including Pakistan [3,11,25].

The two species of genus *Goniodes*, found on peafowls in present study are sharing common generic features however these can have a variety of differences in general body shape, body dimensions and chaetotaxy, however both can easily be differentiated by head anterior marginal carina; temporal margin; abdominal plates; male and female terminalia and male genitalia, as shown in Figs. 1-13. The comparative morphometric values are also given in Table 1; on the basis of which a taxonomic key for the three species of genus *Goniodes* found on peafowl, *Pavo cristatus* has been formulated (Table 2).

In the present study, the presence of chicken poultry louse on Peafowls indicated the

evolutionary relationship of both the species of genus *Goniodes*. As Peafowl and domestic fowl belong to the same family (Phasianidae) with conspicuous features [26,27] may also share their parasites in variety. The phylogeny of fowls along with their parasitic diversity may reveal that both Peafowl and domestic fowls are closely related [28,29,30,31,32].

It was also observed that the host bird was kept in where the chewing lice were recovered, were not sharing their place with domestic fowls with them, hence it is obvious to say that they have no sharing their habitats and their parasites too; the successful breed of *G. dissimilis* is natural and evidently found on Peafowls in Sindh, Pakistan.

5. CONCLUSION

The present work deals with the comparative identification of the two species of chewing lice of the genus *Goniodes* that were recovered from Indian peafowl, *Pavo cristatus* L. with the new records for the chewing lice species and new locality records for the host bird, peafowl from Sindh, Pakistan. The two species of the genus *Goniodes* were collected and identified and were compared with each other to clarify their morpho-taxonomical characteristics in both species.

ETHICAL APPROVAL

It is not applicable.

CONSENT

It is not applicable.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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