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The genus *Neopsittaconirmus* (Psocodea: Ischnocera: Philopteridae) from parrots of Pakistan, and evaluation of its distribution on captive parrots (Psittaciformes) around the world

Saima Naz [a,*], Oldřich Sychra [b,*], Syed Anser Rizvi [c], Ali Murtaza Dharejo [a]

[a] Advanced Parasitology Research Laboratory (APRL), Department of Zoology, Faculty of Natural Sciences, University of Sindh, Jamshoro 76080, Sindh, Pakistan
[b] Department of Biology and Wildlife Diseases, Faculty of Veterinary Hygiene and Ecology, University of Veterinary Sciences, Brno, Czech Republic
[c] Department of Zoology, University of Karachi, Karachi 75270, Sindh, Pakistan

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ABSTRACT

The genus *Neopsittaconirmus* Conci, 1942 is a host-specific genus, found on both wild and captive parrots and love birds (order Psittaciformes). Two species of this genus: *N. lybartota* (Ansari, 1947) and *N. chandabani* (Ansari, 1947) have been previously reported from the Punjab province, Pakistan. We recorded *N. lybartota* from *Psittacula eupatria nipalensis* ($n = 2$), *Psittacula krameri borealis* ($n = 13$), and captive *Psittacula krameri krameri* ($n = 4$) with the mean intensity of 2.0 ± 1, 2.13 ± 0.35 and 2.25 ± 0.47, respectively; the prevalence of louse infestation was 62% in *P. krameri borealis* and 100% in *P. krameri krameri* and *P. eupatria nipalensis*. From this material, we redescribed its morphological variations in taxonomic features. Records on *P. eupatria nipalensis* and *P. krameri krameri* represent new host associations for this species of louse. We also present a new record of *Neopsittaconirmus vendulae* from a captive cockatiel, *Nymphicus hollandicua* ($n = 3$) in Pakistan, with mean intensity of 2.6 ± 0.66. Intraspecific variability of this species is described in detail, with special reference to the male and female terminalia, and male genitalia. We aimed to update and extend the fauna of chewing lice infesting birds of Pakistan. Previous records of *Neopsittaconirmus* on captive parrots around the world are summarized and discussed. Despite long-standing systematic veterinary care, some *Neopsittaconirmus* have cosmopolitan distribution and they are able to survive and successfully reproduce in captivity with their hosts, and even colonize novel hosts.

1. Introduction

The genus *Neopsittaconirmus* Conci, 1942 is host-specific, infesting both wild and captive birds of the order Psittaciformes, found infesting both New and Old World parrots. The genus is represented by 34 species, parasitizing parrots of various types (Price et al., 2003; Price and Johnson, 2007; Sychra, 2006; Sychra and Palma, 2008). Some of these species have remarkable morphological variations in the size and shape of the male genitalia, female vulval margin, chaetotaxy, structure of antennae, and sexual dimorphism. As a consequence, many synonyms of present valid species have been shown to occur. Specimens of particular species in this genus, collected from different individuals of the same host species, usually show a series of variations in their characteristics, that may sometimes confuse their identification to species level. Therefore, we recommend researchers always use the available morphometric revisions and keys when identifying lice of this genus (i. e., Guimarães, 1974; Sychra, 2005, 2006; Sychra and Palma, 2008).

Neopsittaconirmus spp. usually occur on the nape, back and wings (primaries and secondaries); however, during larger infestations, they can be found on the whole body (Beck and Pantchev, 2006; Sychra, 2005). Eggs are typically found on the head. Saxena et al. (2009) studied the reproductive cycle of *Neopsittaconirmus elbeli* Guimarães, 1974 and found that mean life expectancy of males and females was 11 (2–21) and 16 (3–27) days, respectively. Females laid an average of 9 eggs in their lifetime, i.e., an average of 0.6 eggs per day. The incubation period was 4–6 days and duration of nymphal development was 14–21 days (Saxena et al., 2009).

There are four species of parrots occurring in Pakistan: Alexandrine Parakeet, *Psittacula eupatria nipalensis* (Hodgson), Rose-ringed Parakeet, *Psittacula krameri borealis* (Neumann), Slaty-headed Parakeet, *Psittacula*

* Corresponding authors.
E-mail addresses: syma.naz@usindh.edu.pk (S. Naz), sychrao@vfu.cz (O. Sychra).

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himalayana (Lesson) and Plum-headed Parakeet, *Psittacula cyanocephala* (Linnaeus) (Lepage, 2023). Three species of *Neopsittaconirmus* are known from those hosts (Table 1), but only two of them have been recorded from wild parrots from Pakistan: *Neopsittaconirmus chandabani* (Ansari, 1947) on *P. eupatria nipalensis* and *Neopsittaconirmus lybartota* (Ansari, 1947) on *P. krameri borealis*, both collected in the upper Punjab province (Ansari, 1947; Lakshminarayana, 1979). Recently *N. lybartota* has been reported infesting *P. krameri* in Sindh province (Naz et al., 2016).

Psittacula krameri is one of the most numerous and popular parrots in captivity around the world (Pruett-Jones, 2021). Despite its wide distribution, data about the occurrence of ectoparasites on this host are scarce and incomplete for both wild and captive birds (Ansari, 1947; Mori et al., 2015; Sychra, 2006).

Similarly, another common parrot in aviaries throughout the World is the Cockatiel, *Nymphicus hollandicus* (Kerr). It harbours *Neopsittaconirmus vendulae* Sychra, 2006, that was described on the basis of lice collected on captive birds in the Czech Republic, Germany and Australia (Sychra, 2006).

Our objectives are 1) to present new records of lice from wild and captive parrots in Pakistan, 2) to discuss the intraspecific variability of *N. lybartota* and *N. vendulae*, and 3) to summarize and discuss previous records of *Neopsittaconirmus* infesting psittaciphorms in captivity around the World.

2. Material and methods

Fresh specimens of chewing lice were collected from 17 live *P. krameri* (13 wild *P. k. borealis* and four captive *P. k. krameri*) by visual examination, holding the bird in one hand and picking the lice, one by one, with the help of a brush (size 00), dipped in 90% ethanol; in some cases, fine sharp forceps were also used to detach lice from feather barbules, mainly from flanks, wing and tail feathers. Specimens were collected in some lower parts of the Sindh province including Karachi, Hyderabad and Jamshoro. Other specimens from two *P. eupatria nipalensis* were provided by senior retired Professor Dr. A.M. Dharejo, who collected them from wild parrots from some upper areas of the province, including Sukkar and Larkana. Lice from *N. hollandicus* were collected from three captive birds in Hyderabad. Fresh specimens were processed for permanent slide mounting in Canada balsam following methods described by Palma (1978).

Specimens on permanent slides were examined under a light microscope (Olympus CH20), where illustrations of morphological characters of each species were drawn with the help of an Olympus drawing tube attachment at the magnification of 100×, 400× and 1000× for various structures. Line drawings were then scanned and converted to a picture file (JPEG format) where these were finalized using the software (Autodesk Sketchbook 6.0.5) and saved on the personal computer in JPEG and TIFF format. Prevalence and mean intensity of louse infestations in parrots were calculated to understand the parasite burden of chewing lice on Pakistani parrots.

Measurements were taken using an ocular micrometer, in millimeters (Tables 2 and 3); abbreviations for the dimensions are AHWn: anterior head width at anterior nodi, AL: abdominal length, ASII: antennal segment II length, ASIII+IV: antennal segments III and IV length, AWVI: abdominal width at segment VI, GL: male genitalia length at mid-line, GW: male genitalia width at the proximal end of paramere, HL: head length at mid-line, INWi: inter-nodal width at the inner side, INWo: inter-nodal width at the outer side, PALl: pre-antennal length at the left side, PALr: pre-antennal length at the right side, PAW: pre-antennal width of head, PL: prothorax length at mid-line, PtL: pterothorax length at mid-line, PtW: pterothorax width, PW: prothorax width, SGPL: subgenital plate length at mid-line, SGPW: subgenital plate width at maximum wide, TL: total length, TW: temporal width (Fig. 1). The morphological characters from Guimarães (1974), Smith (2001) and Sychra (2006) for the identification of species were followed. Species of birds were identified following Clements et al. (2021), Grimmett et al. (2008), Peters (1937) and Robert (1991).

All examined specimens are deposited at the Advanced Parasitology Research Laboratory, Department of Zoology, University of Sindh, Jamshoro, Sindh, Pakistan (APRLMP). We also collected the data and the photos of type specimens of *N. chandabani* and *N. lybartota* from the database of Natural History Museum London, United Kingdom for their reference and confirmation.

In addition, we summarized all available records of *Neopsittaconirmus* spp. infesting captive parrots around the World. For this summary, we used available published and also unpublished records (Table 4).

Table 1
List of parrots of genus *Psittacula* harboring chewing lice species of the genus *Neopsittaconirmus* around the world.

	Host species	Louse species reported	Distribution	References
1	*P. alexanderi fasciata* (Müller)	*N. palaeornis* Guimarães*	Thailand, Myanmar	Guimarães, 1974
2	*P. cyanocephala* (L.)	*N. lybartota* (Ansari)	No location	Price et al., 2003
3	*P. derbiana* (Fraser)	*N. palaeornis* (Eichler)	China	Eichler, 1943; Sychra and Palma, 2008
4	*P. eupatria nipalensis* (Hodgson)	*N. chandabani* (Ansari)	Pakistan	Ansari, 1947
		N. lybartota (Ansari)	Pakistan	this paper
		N. meinertzhageni Guimarães	Nepal	Guimarães, 1974
5	*P. eupatria siamensis* (Kloss)	*N. elbeli* Guimarães	Thailand	Guimarães, 1974
6	*P. finschii* (Hume)	*N. palaeornis* Guimarães*	Thailand	Guimarães, 1974
7	*P. krameri borealis* (Neumann)	*N. lybartota* (Ansari)	Pakistan, India, Czech Republic[C], Italy[I]	Ansari, 1947; this paper; Guimarães, 1974; Sychra, 2006; Mori et al., 2015
8	*P. krameri krameri* (Scopoli)	*N. lybartota* (Ansari)	Pakistan[C]	this paper

* reported under a junior synonym *N. lybartota difficilis* (see Sychra and Palma, 2008); [C] = captive birds; [I] = introduced feral birds.

3. Results

Seventeen *P. krameri* (13 *P. k. borealis* and four *P. k. krameri*), two *P. e. nipalensis* and three *N. hollandicus* were examined, out of which eight *P. k. borealis* (with 62% prevalence), and all *P. k. krameri, P. e. nipalensis* and *N. hollandicus* were infested 100% with lice. The mean intensity of lice on each host species was calculated as 2.13 ± 0.35, 2.25 ± 0.47, 2.0 ± 1 and 2.6 ± 0.66, respectively. There were 30 specimens of *N. lybartota* collected from all three species of genus *Psittacula* (see Material examined section below) with the burden of 2.14 on each bird, whereas, eight *N. vendulae* were collected from three birds with the burden of 2.66 per bird. Since the three *N. hollandicus* were kept together in a cage and there were no other parrots kept with them by the keeper, we consider that they were most likely or at least one of them was already infested before they came to the bird keeper and share their lice to other birds in the same cage.

The specimens collected from *P. krameri* and *P. eupatria nipalensis* belong to the genus *Neopsittaconirmus*, which was previously reported from Faisalabad (formerly Lyallpur) in the genus *Psittaconirmus*. We identified all specimens as *N. lybartota*, with some morphological and morphometric variations (Tables 2 and 3). Specimens collected from *N. hollandicus* were identified as *N. vendulae*. They are here described in detail, with reference to the male and female terminalia and male

Table 2
Measurements and material data of *Neopsittaconirmus lybartota* collected in the present study compared with previous reports.

Morphometric parameters	Present specimen 1		Present specimen 2		Ansari's specimen		Guimarães's specimen	
Gender	♂ (n = 2)	♀ (n = 2)	♂ (*n* = 5)	♀ (*n* = 6)	♂	♀*	♂	♀
TL	1.46 ± 0.008	1.88 ± 0.095	1.48 ± 0.04	1.72 ± 0.03	1.293	1.645	1.59	1.98
HL	0.42 ± 0.008	0.44 ± 0.0081	0.405 ± 0.006	0.43 ± 0.003	0.4	0.44	0.42	0.45
AHWn	0.17 ± 0.002	0.17 ± 0.0041	0.16 ± 0.003	0.16 ± 0.006	–	–	–	–
INWo	0.11 ± 0.003	0.141 ± 0.016	0.103 ± 0.003	0.11 ± 0.001	–	–	–	–
INWi	0.071 ± 0.0007	0.077 ± 0.006	0.061 ± 0.005	0.06 ± 0.002	–	–	–	–
PAW	0.25 ± 0.0016	0.26 ± 0.016	0.25 ± 0.004	0.26 ± 0.001	–	–	–	–
HW/TW	0.284 ± 0.0093	0.316 ± 0.025	0.27 ± 0.003	0.3 ± 0.003	0.28	0.293	0.32	0.34
PALl	0.143 ± 0.0015	0.164 ± 0.002	0.14 ± 0.004	0.154 ± 0.002	–	–	–	–
PALr	0.146 ± 0.0003	0.16 ± 0.002	0.15 ± 0.002	0.152 ± 0.0014	–	–	–	–
PL	0.11 ± 0.0022	0.12 ± 0.008	0.107 ± 0.009	0.122 ± 0.03	0.093	0.093	0.11	0.12
PW	0.203 ± 0.001	0.23 ± 0.02	0.204 ± 0.007	0.18 ± 0.029	0.173	0.213	0.23	0.25
PtL	0.211 ± 0.013	0.2 ± 0.005	0.19 ± 0.004	0.18 ± 0.008	0.20	0.226	0.19	0.20
PtW	0.271 ± 0.005	0.34 ± 0.046	0.28 ± 0.013	0.38 ± 0.007	0.293	0.306	0.34	0.38
AL	0.79 ± 0.0095	1.12 ± 0.06	0.81 ± 0.025	0.99 ± 0.018	0.60	0.886	0.86	1.2
AWVI	0.314 ± 0.0045	0.4 ± 0.03	0.31 ± 0.009	0.36 ± 0.019	0.28	0.33	0.36	0.44
GL/SGPL	0.234 ± 0.0014	0.214 ± 0.002	0.26 ± 0.01	0.207 ± 0.002	–	–	–	–
GW/SGPW	0.11 ± 0.002	0.207 ± 0.005	0.112 ± 0.003	0.118 ± 0.004	–	–	–	–
Date of collection	15-xii-1985		1-ix-1985; 21-vii-2002		6-x-1931		4-ii-1952	
Material/ Type material	APRLMP649, APRLMP650, APRLMP667		APRLMP671–672, APRLMP675–679		NHML010679307, NHML010679308*, NHML010679309		NHMUK010679310 (Meinertzhagen collection 19.911)	
Host	*Psittacula eupatria nipalensis*		*Psittacula krameri*		*Psittacula krameri borealis*		*Psittacula krameri borealis*	
Locality	Upper Sindh (Larkana, Sukkar)		Lower Sindh (Karachi, Hyderabad)		Faisalabad, Punjab		Assam, India	
Reference	–		–		Ansari, 1947		Guimarães, 1974	

* Holotype.

Table 3
Measurements and material of *Neopsittaconirmus vendulae* collected in the present study compared with previous reports.

Morphometric parameters	Present specimens		Sychra's specimens		Larramendy's specimens	
Gender	♂ (n = 3)	♀ (n = 3)	♂	♀	♂	♀
TL	1.72 ± 0.026	1.95 ± 0.009	1.47–1.69	1.74–2.05	1.61–1.76	1.76–2.10
HL	0.44 ± 0.006	0.44 ± 0.029	0.37–0.42	0.41–0.46	0.38–0.41	0.40–0.44
AHWn	0.14 ± 0.005	0.14 ± 0.007	–	–	–	–
INWo	0.127 ± 0.001	0.128 ± 0.0015	–	–	–	–
INWi	0.072 ± 0.001	0.077 ± 0.001	–	–	–	–
PAW	0.29 ± 0.006	0.29 ± 0.004	–	–	–	–
HW/TW	0.31 ± 0.001	0.32 ± 0.0054	0.25–0.29	0.30–0.34	0.27–0.30	0.30–0.35
PALl	0.018 ± 0.002	0.187 ± 0.004	–	–	–	–
PALr	0.181 ± 0.0009	0.187 ± 0.004	–	–	–	–
PL	0.161 ± 0.004	0.13 ± 0.031	0.08–0.12	0.09–0.14	0.10–0.12	0.10–0.13
PW	0.22 ± 0.003	0.22 ± 0.003	0.19–0.21	0.20–0.23	0.17–0.21	0.20–0.24
PtL	0.2 ± 0.009	0.21 ± 0.023	0.18–0.20	0.20–0.24	0.18–0.21	0.20–0.24
PtW	0.303 ± 0.005	0.32 ± 0.0065	0.25–0.31	0.26–0.36	0.27–0.35	0.30–0.38
AL	1.01 ± 0.019	1.17 ± 0.018	0.85–1.0	1.03–1.28	0.92–1.02	1.00–1.30
AW	(VI) 0.32 ± 0.0027	(VI) 0.34 ± 0.005	(V) 0.27–0.34	(V) 0.33–0.42	0.30–0.37	0.34–0.40
GL/SGPL	0.23 ± 0.0085	0.23 ± 0.003	–	–	–	–
GW/SGPW	0.082 ± 0.0005	0.21 ± 0.006	–	–	–	–
Date of collection	23-ii-2014		1965; 1966; 1971; 20-vii-2001; 17-ix-2003		2007–2013	
Material/ Type material	APRLMP-660, APRLMP-661, APRLMP-662		NHML-B.M. 1969–101 (holotype) NHML-B.M. 1971–509 (paratype) Other material in Moravian Museum, Brno		–	
Host	*Nymphicus hollandicus*		*Nymphicus hollandicus*		–	
Locality	Hyderabad, Sindh, Pakistan		The Czech Republic		Cuba	
Reference	–		Sychra, 2006		Larramendy et al., 2017	

genitalia that is peculiar in this genus.

Neopsittaconirmus Conci, 1942
(Phthiraptera: Ischnocera: Philopteridae)
Psittacicola Guimarães, 1942: 80.
Pflegeriella Eichler, 1943: 114.
Neopsittaconirmus Conci, 1942: 37.
Type species: *Neopsittaconirmus borgliolii* Conci, 1942.

Neopsittaconirmus chandabani **(**Ansari, 1947**)**
Fig. 2
Psittaconirmus chandabani Ansari, 1947: 273.
Neopsittaconirmus chandabani Hopkins and Clay, 1952: 237.
N. chandabani Guimarães, 1974: 155.
N. chandabani Price et al., 2003: 200.
N. chandabani Naz et al., 2020: 435.

Type host: Alexandrine parrot, *Psittacula eupatria nipalensis* (Hodgson) [Psittaciformes: Psittaculidae].

Remarks: This species was first reported and described by Ansari (1947) from Faisalabad (formerly Lyallpur), Punjab, where *P. eupatria nipalensis* are mostly found in Pakistan. The range of this parrot also includes some parts of District Ghotki and Sukkar on the northern border of Sindh province (Robert, 1991; Zoological Society of Pakistan (ZSP) Report, 2011). Differences in chaetotaxy and male genitalia clearly separate this species from *N. lybartota* of its type host (Guimarães, 1974). The specimens of the species collected by Ansari and Meinertzhagen are deposited in the NHML, UK (Fig. 2) (Natural History Museum, 2014a). This species was initially collected by Ansari in 1931 and identified as

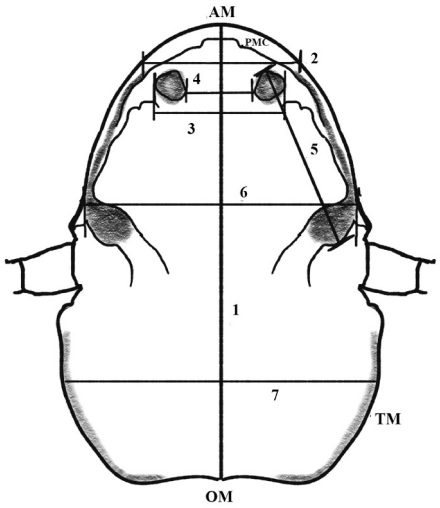

Fig. 1. Head of a *Neopsittaconirmus* species to show the dimensions of the head measured. 1: Head length (HL); 2: Anterior head width at anterior nodus (AHWn); 3: Inter-nodal width at outside (INWo); 4: Inter-nodal width at inner side (INWi); 5: Pre-antennal length (PAL); 6: Pre-antennal width (PAW); 7: Temporal width (TW); AM: Anterior margin; OM: Occipital margin; PMC: Pre-marginal carina; TM: Temporal margin.

Psittaconirmus chandabani. Later, Meinertzhagen collected this species from the type host, *P. eupatria nipalensis* from Peshawar, Pakistan in 1937 (Meinertzhagen collection no. 9425–26 in BMNH), that Guimarães (1974) compared with type specimens designated by Ansari (1947). Ansari's description of this species is not clearly illustrated, so Guimarães (1974) redescribed it with reference to the male specimen. Moreover, no additional specimens of this species have been collected from the same host, neither from Pakistan nor any other part of the world.

The morphometry of *N. chandabani* according to Ansari (1947): female holotype- TL: 1.918; HL: 0.493; HW: 0.366; PL: 0.133; PW: 0.226; PtL: 0.226; PtW: 0.35; AL: 1.06; AW: 0.466. Male paratype- TL: 1.425; HL: 0.426; HW: 0.333; PL: 0.106; PW: 0.20; PtL: 0.226; PtW: 0.306; AL: 0.68; AW: 0.373.

The morphometry of *N. chandabani* according to Guimarães (1974): female- TL: 2.08; HL: 0.49; HW: 0.38; PL: 0.13; PW: 0.25; PtL: 0.20; PtW: 0.40; AL: 1.26; AW: 0.49. Male- TL: 1.75; HL: 0.45; HW: 0.36; PL: 0.12; PW: 0.24; PtL: 0.2; PtW: 0.37; AL: 0.98; AW: 0.42.

Neopsittaconirmus lybartota (Ansari, 1947)

Figs. 3–10; Table 2

Psittaconirmus lybartota Ansari, 1947: 275.

Neopsittaconirmus lybartota Hopkins and Clay, 1952: 238.

N. lybartota lybartota Guimarães, 1974: 139.

N. lybartota Price et al., 2003: 200.

N. lybartota lybartota Naz et al., 2020: 436.

Type host: Rose-ringed parakeet, *Psittacula krameri borealis* (Neumann) [Psittaciformes: Psittaculidae].

Material examined: 6♂, 11♀ [APRLMP649–650; 667; 671–672; 675–679]; ex *Psittacula krameri borealis* (Neumann), 15-xii-1985, 17-xii-1985, 4-viii-2005; 4-viii-2014; Hyderabad, Karachi, Larkana; 5♂, 4♀; ex *Psittacula krameri krameri* (Scopoli) – in captivity, 21-vii-2002; Karachi; 2♂, 2♀; ex *Psittacula eupatria nipalensis* (Hodgson); 1-ix-1985; Sukkar; leg. A.M. Dharejo, S. Naz; deposited at APRLMP.

Diagnosis: Body long, narrow, light yellow to light brown with lateral dark brown to black pleural plates. Head circumfasciate, longer than wide, premarginal carina thin, hyaline margin present with irregular line in some specimens; one pair of characteristic dark anterior nodi in the premarginal region are present, with extended hyaline region towards the preantennal nodi (Fig. 3a); one pair of post anterior nodal setae; 3 pairs of lateral marginal and 1 pair of lateral submarginal dorsal head setae; 4 pairs of anterior to lateral ventral submarginal setae and a pair of ventral median setae; preantennal seta short, all setae fine and small (Fig. 3b); conus short; antennal carina extended from preantennal carina to eyes; antennae long, filiform, sexually dimorphic (Fig. 4a and b), segment I broad, segment II slender and shorter than the combined length of segments III and IV in all specimens from both hosts, *P. krameri* (ASII 0.087 ± 0.0018, ASIII+IV 0.09 ± 0.0027 in male; ASII 0.066 ± 0.0018, ASIII+IV 0.079 ± 0.0006 in female) and *P. eupatria* (ASII 0.086 ± 0.003, ASIII+IV 0.091 ± 0.0003 in male; ASII 0.065 ± 0.0029, ASIII+IV 0.08 ± 0.005 in female); segment III without any process; gular plate short, weakly sclerotized and roughly diamond-shaped; temples widely rounded with thin temporal carina and short temporal marginal setae, with seta 3 dominant; ocular seta short and inside the lenses; post ocular seta and post occipital seta very short; occipital margin slightly concave to more or less straight.

Pterothorax is more or less equally wide and long with slight variations in size and position of attachment of latero-posterior setae. Other features can be seen in Ansari (1947).

Abdomen long, narrow in both sexes, with complete tergites (Fig. 5); tergites I–VII bearing one pair of short tergo-median setae; tergite IV and V with very long tergo-lateral setae; tergite VIII is always semicircular (Fig. 6a–d) and fringed with a bunch of tergo-lateral setae. There is variation in the number and size of these setae, which can be 5 to 7; these setae in all males from *P. krameri krameri* almost same length (Fig. 6a–b), whereas the male from *P. krameri borealis* has gradually shorter to long setae from median to lateral sides (Fig. 6c) and *P. eupatria nipalensis* has one seta longer than others (Fig. 6d); 3–4 very short tergo-median, small microsetae present in unequal or irregular arrangement, attached behind the sclerotized margin of tergite VIII; genital opening dorsal; sternites VII–X fused, subgenital plate partially divided into three lobes; ventral terminal and subterminal setae also vary in number and size of setae in different specimens of *N. lybartota* (Fig. 7a–d).

The female abdomen oblong, with long tergo-lateral setae on tergites IV and V in specimens from *P. krameri borealis* and *P. krameri krameri*, and on tergites IV–VI on specimens from *P. eupatria nipalensis* (Fig. 5b); female dorsal terminalia simple (Fig. 8a–b); subgenital plate of ventral terminalia a characteristic tripartite shape (Fig. 8c–d); vulval margin mostly narrow, V-shaped, armed with 3–4 thick spinous setae with strong alveolar base and few short fine setae at the lateral margin; middle section of subgenital plate bears a small number of scattered fine lateral setae, relatively longer than posterior marginal setae; number and arrangement of setae vary in females from the two different hosts.

Armature of male genitalia peculiar to the genus, as described by Guimarães (1974); however, variations in the aedeagus complex and pineal structure were observed in the species from various hosts (Fig. 9a–e). Basal apodeme covers 3/4 the length of the genitalia, lateral struts narrow and sclerotization may vary in species from host to host; aedeagus complex calyculated; penis long, tubular; pineal complex laterally extended, wing-shaped, armed with 3 microsetae. In the genitalia of specimens from *P. krameri krameri,* penis is thick and slightly curved; pineal complex darkly pigmented, extended backwards to the endomeral plate; parameres more curved and short posteriorly (Fig. 9a–b), whereas in specimens from *P. krameri borealis* (Fig. 9c) and *P. eupatria nipalensis*, the penis is straight, slightly narrower; pineal complex lightly pigmented, extended back to the parameres; endomeral plate wide, octagonal-shaped, clearly visible on the dorsal side (Fig. 9d–e); parameres curved outside posteriorly to slightly straight ends.

Remarks: The specimens studied by Guimarães (1974) were borrowed from the collection of Meinertzhagen at Natural History Museum London (Fig. 10), and were already marked with the specific name. However, Guimarães updated them to the subspecies level. Guimarães (1974) compared his specimens with the description of the same species by Ansari (1947) and found a several differences; however, the only confirmation of the species was based on the similar host species, *P. krameri borealis,* from which Meinertzhagen collected the specimens of *N. lybartota* (Fig. 10) (Natural History Museum, 2014b).

Table 4
Summary of records of *Neopsittaconirmus* lice on captive parrots around the world with note to their prevalence and intensity.

Lice / host	Prevalence P/E (%)	Mean intensity	Location, year of collection	Origin and status of hosts	Reference
Neopsittaconirmus lybartota					
Psittacula krameri	50/104 (48%)	14.4	Italy, 2015–2016	live birds from Rescue centre	Ancillotto et al., 2018
Psittacula krameri borealis	1/3 (33%)	19	Czechia, 2002	dead bird from a pet shop	Sychra, 2006; this paper[1]
<< " " " >>	8/13 (62%)	2.13 ± 0.35	Pakistan, 1985, 2002, 2014	live birds from wild habitats	Naz et al., 2016; this paper
Psittacula krameri krameri	4/4	2.25 ± 0.48	Pakistan, 2002	live birds in captivity at a private park	this paper**
Psittacula eupatria nipalensis	2/2	2.0 ± 1	Pakistan, 1985	dead wild birds	this paper**
Neopsittaconirmus vendulae					
Nymphicus hollandicus	3/3	2.66 ± 0.66	Pakistan, 2014	live bird from a private keeper	this paper
<< " " " >>	1/4 (25%)	2	Czechia, 2003	dead bird form a pet shop	Sychra, 2006
<< " " " >>	2/?	2.5	Germany, 2001	live birds from a private keeper	Sychra, 2006
<< " " " >>*	4/?	not mentioned	Poland, 2015	live birds from 2 to 3 private keepers and a commercial breeding	Karocka, 2022
<< " " " >>	39/215 (18%)	not mentioned	Cuba, 2007–2013	dead birds	Larramendy et al., 2017
<< " " " >>*	1/21 (5%)	not mentioned	Brazil	Live birds from 3 different private keepers	Neiva and Martins, 2021
Melopsittacus undulatus	1/?	2	Germany, 2001	live bird from private keeper	Sychra, 2006
<< " " " >>	6/160 (4%)	not mentioned	Cuba, 2007–2013	dead birds	Larramendy et al., 2017
Agapornis roseicollis	5/86 (6%)	not mentioned	Cuba, 2007–2013	dead birds	Larramendy et al., 2017
Agapornis fisheri	1/6 (17%)	up to 3 ex.	Cuba, 2007–2013	dead birds	Larramendy et al., 2017
Neopsittaconirmus gracilis					
Melopsittacus undulatus	4/10 (40%)	2.8	Czechia, 2001	private keeper (live birds in good condition)	This paper
<< " " " >>	2/26 (8%)	1 & 118	Czechia, 2001, 2002	3 pet shops (one live and one dead bird)	This paper
<< " " " >>	1/?	"several"	Czechia, 2008	live bird from private keeper	J. Novák, pers. Comm.
<< " " " >>*	1/?	6	Germany, 1998	live bird from private keeper	Beck, 1999
<< " " " >>	3/?	not mentioned	Germany	Live birds from 3 different private keepers	Mey, 2004 (pers. comm.)
<< " " " >>	2/?	massive infestation	Germany, 1998	live birds from private keeper	Beck, 2017
<< " " " >>*	not mentioned	not mentioned	Poland, 2015	not mentioned	Karocka, 2022
<< " " " >>	1/?	not mentioned	Egypt, 2018	not mentioned	E. S. Adly, pers. comm.
<< " " " >>*	not mentioned	not mentioned	USA	not mentioned	Mullen and Durden, 2002; (Durden, pers. comm.)
<< " " " >>	1/?	6	Peru	not mentioned	Gomez–Puerta and Lujan–Vega, 2018
Agapornis personatus	1/?	at least 3	Brazil, 2005	not mentioned	M. P. Valim, pers. comm.
<< " " " >>	1/14 (7%)	up to 3 ex.	Cuba, 2007–2013	dead birds	Larramendy et al., 2017
Agapornis roseicollis	1/86 (1%)	up to 3 ex.	Cuba, 2007–2013	dead birds	Larramendy et al., 2017
Nymphicus hollandicus	1/215 (0.5%)	up to 10 ex.	Cuba, 2007–2013	dead birds	Larramendy et al., 2017
<< " " " >>*	1/1	high infestation (6 ex. collected)	Brazil, 2020	Live bird form the commercial breeding	Gois et al., 2022

P/E = parasitized/examined parrots; * = determined as *Neopsittaconirmus* sp.; ** = new host association; [1] = Sychra (2006) mentioned unpublished record of this association, here we added details of this finding.

a **b**

Fig. 2. The type specimen of *Neopsittaconirmus chandabani* (Ansari, 1947): A. Photograph of the Holotype female and Allotype male collected by Ansari in NHML; B. Photograph of the specimen collected by Meinertzhagen in NHML. The photo was taken from the NHML collection data portal.

In specimens we have examined, the anterior head margin is narrowly rounded with a thin hyaline margin; tergo-lateral setae are found on the tergites IV and V (Fig. 5a) as in the specimen shown in Guimarães (1974); however, only one female, collected from *P. eupatria nipalensis*, has tergo-lateral setae on tergites IV to VI (Fig. 5b) as shown in Ansari's specimen (Ansari, 1947: 275: Fig. 7a). Armature of the male genitalia varies in the aedeagus complex. The penial complex also varies in shape and size that is closely similar to the aedeagus of *N. lybartota difficilis* (= currently *N. palaeornis*) as described in Guimarães (1974) and Sychra and Palma (2008).

This is the first record of *N. lybartota* from *P. eupatria nipalensis* and *P. krameri krameri* which are new host associations of this species. Our

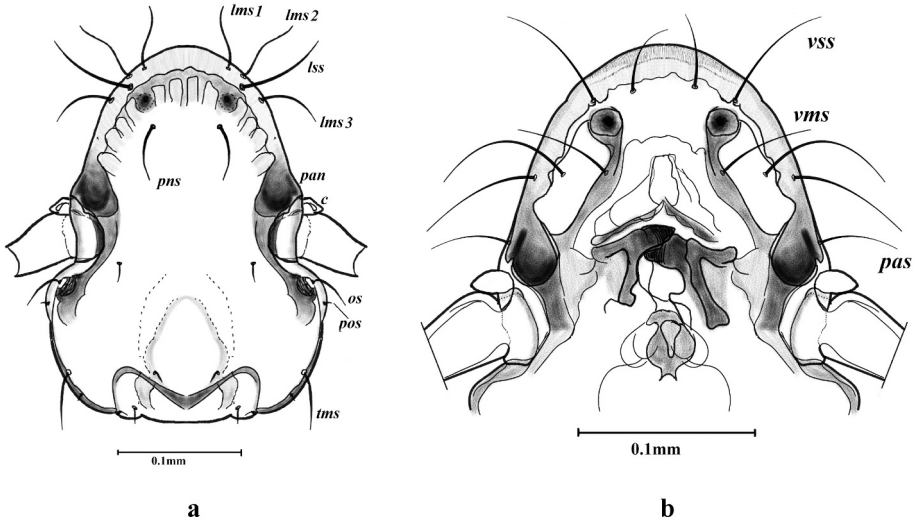

Fig. 3. *Neopsittaconirmus lybartota* (Ansari, 1947). A. Head in dorsal view; B. Anterior portion of head in ventral view. *c:* Conus; *lms1–3:* Lateral marginal setae 1–3; *lss:* Lateral submarginal setae; *os:* Ocular setae; *pas:* Pre-antennal setae; *pns:* Post-nodal setae; *pos:* Post-ocular setae; *tms:* Temporal marginal setae; *vms:* Ventral marginal setae; *vss:* Ventral submarginal setae.

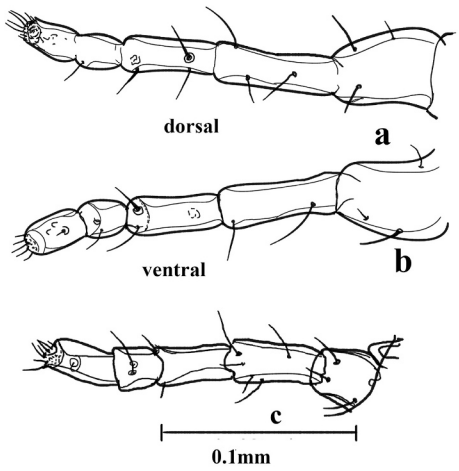

Fig. 4. *Neopsittaconirmus lybartota* (Ansari, 1947). A. Male antennae in dorsal view; B. Male antenna in ventral view; C. Female antenna.

record of *N. lybartota* infesting *P. eupatria nipalensis* from the province of Sindh is in addition to Ansari (1947), reported *N. chandabani* infesting this host from Punjab province.

Neopsittaconirmus vendulae Sychra, 2006

Figs. 11–20; Table 3

Neopsittaconirmus vendulae Sychra, 2006.

Type host: *Nymphicus hollandicus* (Kerr) [Psittaciformes: Cacatuidae].

Material examined: 4♂; 4♀ [APRLMP660–662]; ex. *Nymphicus hollandicus* (Kerr) – in captivity; 23-ii-2014; leg. S. Naz; Hyderabad, Sindh, Pakistan; deposited at APRLMP.

Description: Body long, narrow, brown and darkly pigmented, a little longer than *N. lybartota* and shorter than *N. chandabani* (Fig. 11a and b). Head circumfasciate, narrowly rounded anteriorly, longer than wide (Fig. 12a), premarginal carina thin, very weak hyaline margin, if present; anterior nodi dark and strongly sclerotized in the preantennal region connected with ventral carina, extended towards the preantennal nodi; ventral carina broken medially, restricted along the premarginal carina (Fig. 12b); only one pair of submarginal latero-anterior setae; one pair of median dorsal setae at post anterior nodal region; two pairs of anterior to lateral ventral marginal and three pairs submarginal setae;

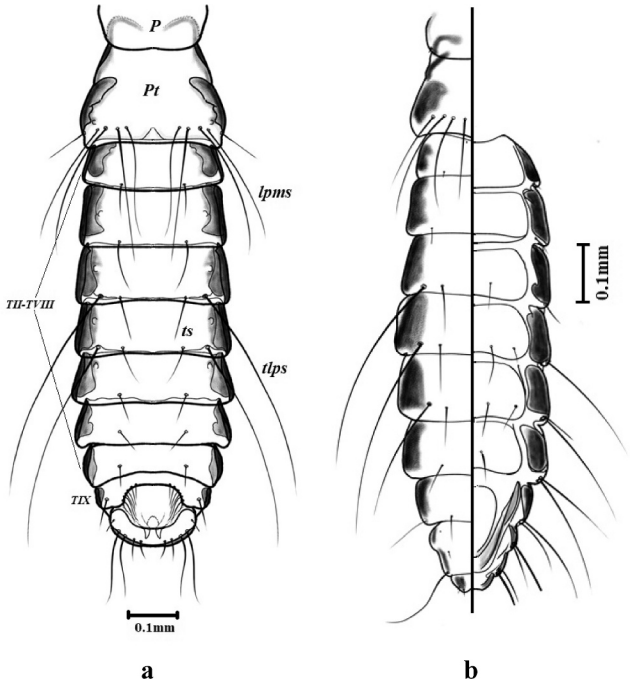

Fig. 5. *Neopsittaconirmus lybartota* (Ansari, 1947). A. Male abdomen in dorsal view; B. Female abdomen in dorsal and ventral views (ex *Psittacula eupatria nipalensis*). *lpms:* Latero-posterior marginal setae of pterothorax; *P:* Pronotum; *Pt:* Pteronotum; *TI-TVIII:* Tergites I-VIII; *tlps:* Tergal latero-posterior setae.

preantennal seta short; conus very reduced; preantennal carina extended towards temporal margins; tentorium visible and thickly sclerotized; antennae long, filiform, sexually dimorphic (Fig. 13a-c), female antennae shorter in length than that of male; antennal segment I broad, segment II slender and slightly shorter than the combined length of segments III and IV in both sexes, which is 0.066 ± 0.001 and 0.07 ± 0.003 in male; 0.062 ± 0.003 and 0.066 ± 0.003 in female, respectively; segment III without any process; gular plate short, darkly pigmented and moderately sclerotized (Fig. 14), roughly triangular in shape, seems fused with the rhombic sclerite posteriorly; temples widely rounded with thin temporal carina, pigmented patches present, temporal setae 1, 2 and 4 microsetae and seta 3 dominant, short, fine seta; ocular seta

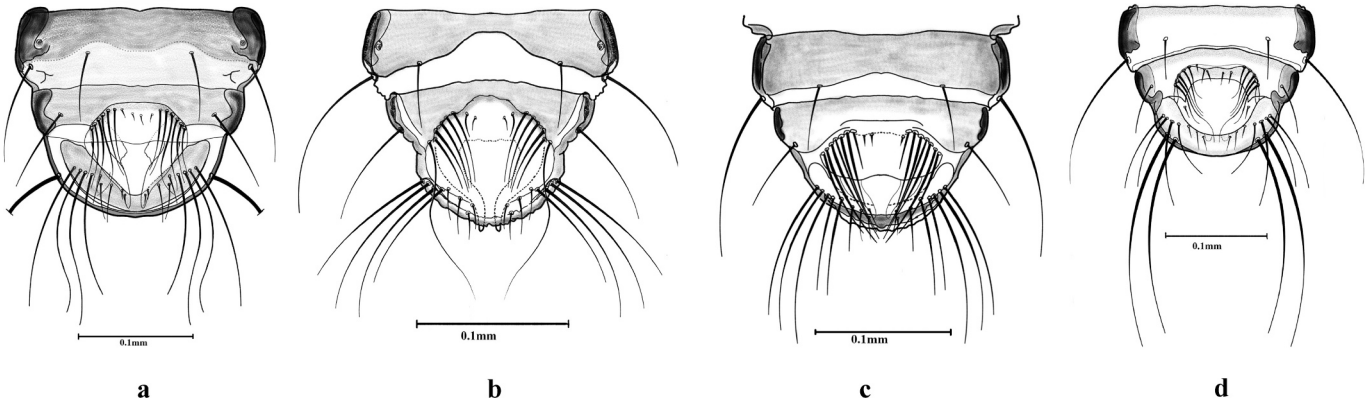

Fig. 6. *Neopsittaconirmus lybartota* (Ansari, 1947). Male terminalia in dorsal view: A-B. ex *Psittacula krameri krameri*; C. ex *Psittacula krameri borealis;* D. ex *Psittacula eupatria nipalensis.*

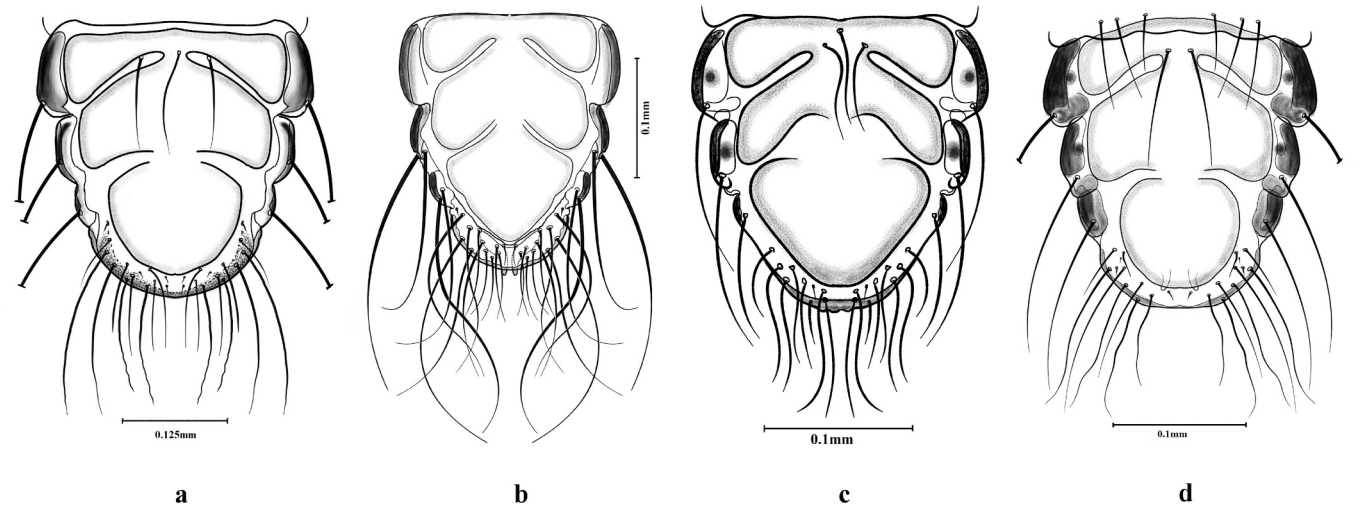

Fig. 7. *Neopsittaconirmus lybartota* (Ansari, 1947). Male terminalia in ventral view: A-B. ex *Psittacula krameri krameri*; C. ex *Psittacula krameri borealis;* D. ex *Psittacula eupatria nipalensis.*

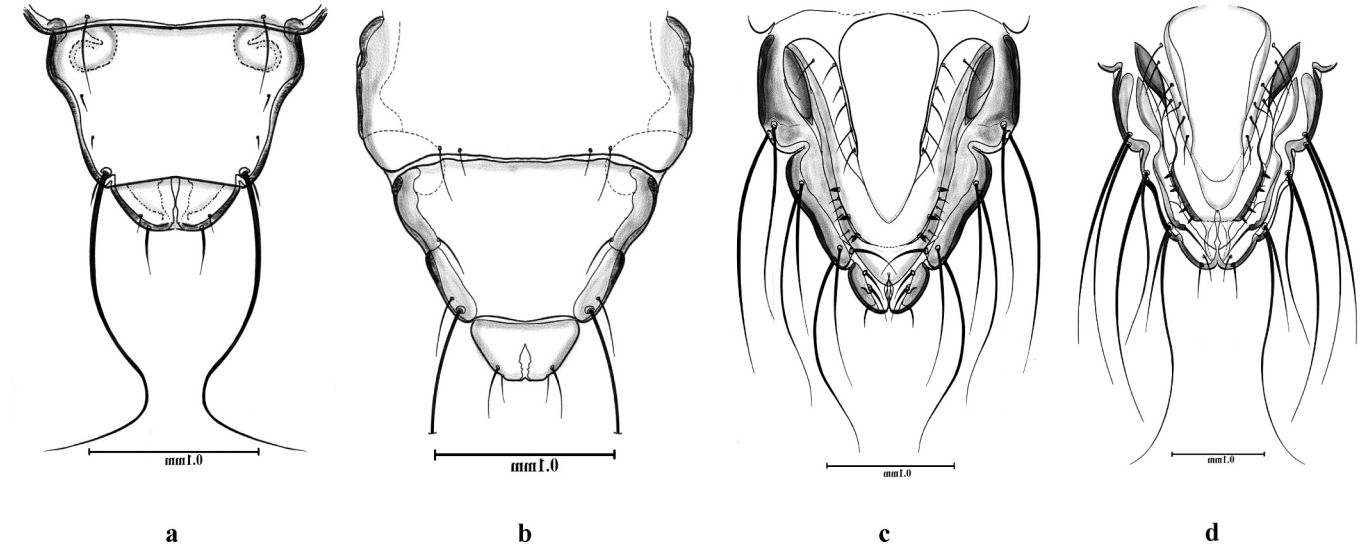

Fig. 8. *Neopsittaconirmus lybartota* (Ansari, 1947). Female terminalia in dorsal view: A. ex *Psittacula eupatria nipalensis*; B. ex *Psittacula krameri krameri;* Female Terminalia in ventral view: C. ex *Psittacula eupatria nipalensis*; D. ex *Psittacula. krameri krameri.*

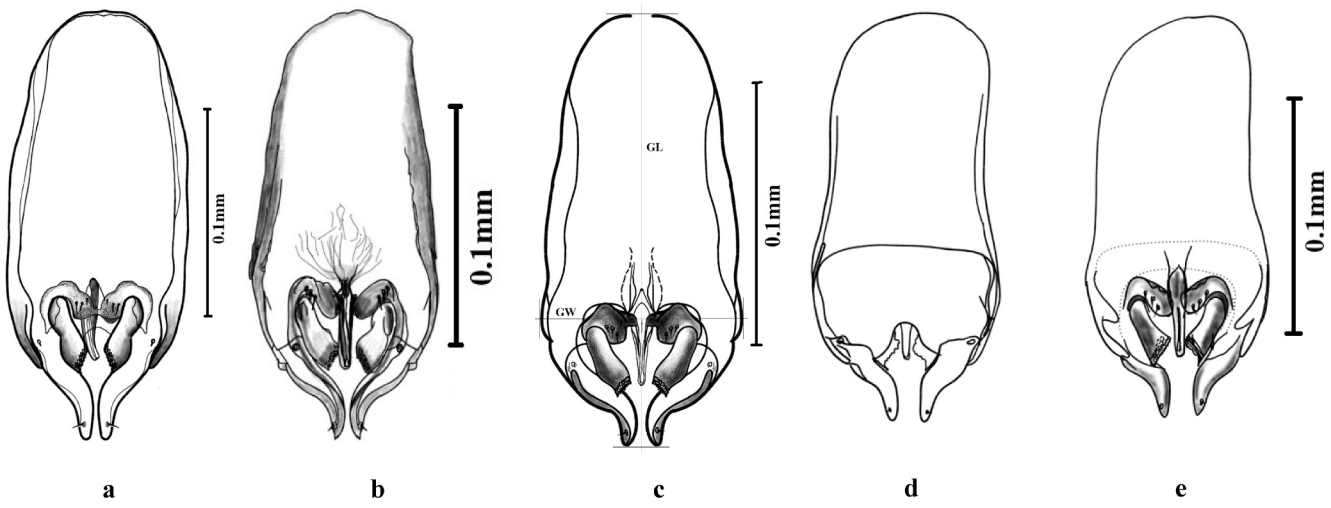

Fig. 9. *Neopsittaconirmus lybartota* (Ansari, 1947). Male genitalia: A-B. ex *Psittacula krameri krameri*; C. ex *Psittacula krameri borealis*; D-E. ex *Psittacula eupatria nipalensis* in dorsal and ventral views, respectively. GL: Genital length; GW: Genital width.

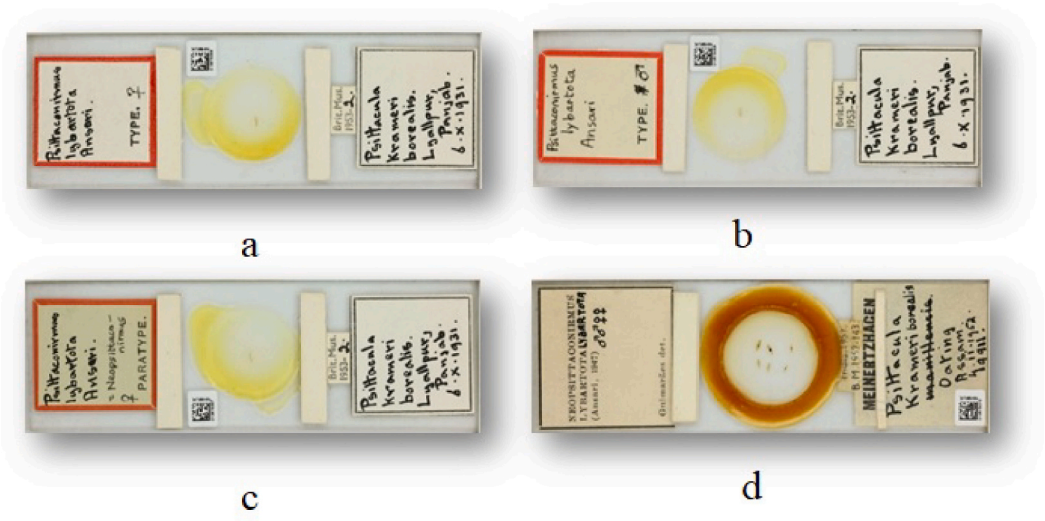

Fig. 10. The type specimen of *Neopsittaconirmus lybartota* (Ansari, 1947): A. Photograph of holotype female from Ansari's collection in NHML; B. Allotype male of the same; C. Paratype female of the same; D. Photograph of the specimen from Meinertzhagen collection (19.911) in NHML. The photo was taken from the NHML collection data portal.

relatively short and inside the lens; post ocular seta very minute, on the temporal carina behind the eye; post antennal seta short and fine, behind the preantennal nodi; there are 5 pairs of peg-like microsetae at the median dorsal region and 2 pairs at post temporal region (Fig. 12a); post occipital seta very short; occipital margin slightly concave to more or less straight.

Prothorax simple, typical, twice wider than its length, roughly rectangular, bearing small sharp spinous setae on latero-anterior corners, small acuminate setae at latero-posterior margins. Pterothorax (Fig. 15a) more or less equally wide and long, trapezoidal with anterior shoulders narrower than latero-posterior margins; posterior margin broadly convex, with small median bump embedded posteriorly into anterior margin of the abdominal segment; latero-posterior margin fringed with 4 pairs of very long latero-posterior setae, reaching behind to fifth abdominal segment; at latero-posterior corners, a fine thin normal seta and a very small spinous seta present; meso-metasternal plate rhomboid-shaped, longer than broad (Fig. 16), bearing one pair of anterior, one pair of posterior sternal setae.

Abdomen long, narrow, slender, darkly pigmented in both sexes, tergites complete (Fig. 15a and b), widest at segments V and VI; tergites I and II lightly fused into a single plate with slight mark of division at anterior margin, this can be supported by one pair of anterior median and one pair of posterior marginal peg-like setae (Fig. 17a); in male, tergites III–VII contain one pair of very small peg-like microsetae, one pair of thin fine setae and tergite VIII has only one pair of short fine spinous setae in the medio-posterior position, tergites V–VII contain short fine tergo-lateral setae (Fig. 17b-d), tergite IX semicircular with two bunches of fine short tergo-lateral setae with only one very long, crossing the terminal margin far behind (Fig. 18a); genital opening dorsal; in female, tergites III–VIII with one pair of very small peg-like microsetae on mid-posterior margin (Fig. 17e-i); unlike of male tergites, female tergites V–VII bear one pair of short stout tergo-lateral setae much shorter than in male abdomen (Fig. 17g-h); tergites IX and X fused in roughly butterfly-shaped plates with a pair of anterior and a pair of posterior lateral setae and two small and one very long fine tergo-lateral setae at posterior margin (Fig. 19a); sternites complete, rectangular in shape, weakly sclerotized, bearing a fine short pair of setae on sternites II–VI in male and sternites IV–VI in female abdomen; male

Fig. 11. Photomicrographs of *Neopsittaconirmus vendulae* Sychra, 2006: A. Male; B. Female. At the scale of 400 ×.

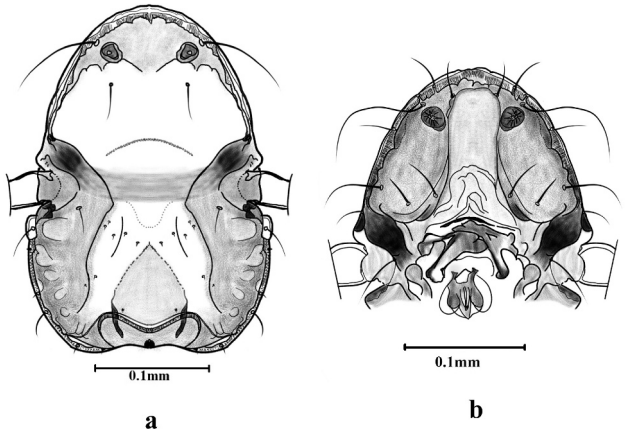

Fig. 12. *Neopsittaconirmus vendulae* Sychra, 2006: A. Head in dorsal view; B. Anterior portion of head in ventral view.

subgenital plate wide, conical posteriorly, partially divided in two plates (Fig. 18b); female subgenital plate similarly wide, bearing a small number of scattered short setae (Fig. 19b); calyx of the spermatheca visible, with thick margins, outer margin measures 0.051 ± 0.0016 and inner margin measures 0.03 ± 0.0013; vulval margin broadly V-shaped, bearing 4–5 thick spinous setae and 6–8 thin sharp setae on lateral margins.

Armature of male genitalia different from the typical armature of the genus (Fig. 20a–b); parameres thick, and broad, containing a thick hyaline spine on posterior termination (Fig. 20c); aedeagus complex peculiar, with wide lateral wing-shaped sclerites bearing 3 microsetae on each side; pineal complex broad anteriorly and narrower posteriorly into the short penis (Fig. 20d).

Remarks: The present specimens of *Neopsittaconirmus vendulae* resembles *N. vendulae* Sychra, 2006, as it has been collected from the same host. The specimens have remarkably similar characters in the male

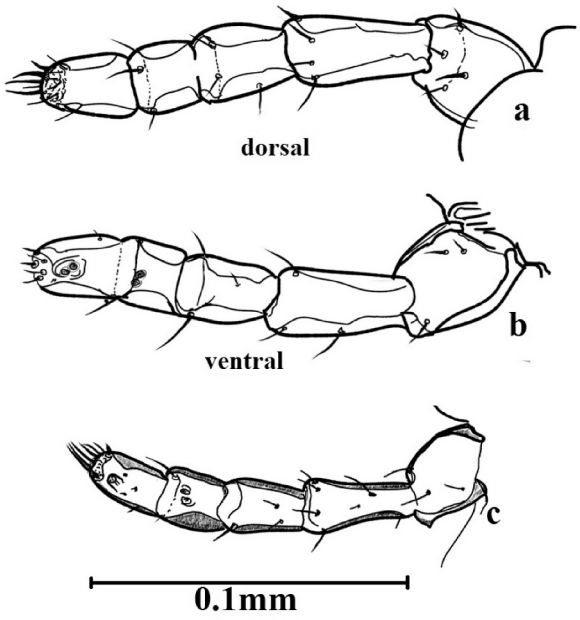

Fig. 13. *Neopsittaconirmus vendulae* Sychra, 2006: A. Male antennae in dorsal view; B. Male antenna in ventral view; C. Female antenna.

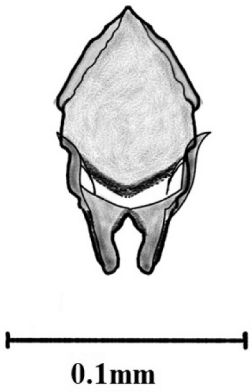

Fig. 14. *Neopsittaconirmus vendulae* Sychra, 2006: Gular plate.

genitalia, male and female terminalia, with reference to their chaetotaxy and pigmentation of the body; however, there were several characters in the previous description that are different, including the group of peg-like microsetae in the mid dorsal region of the head; size and shape of the antennae in both sexes are similar, though sexual dimorphism cannot be considered (Fig. 13); pronotal antero-lateral microseta present; abdominal chaetotaxy however seems different, there is a peg-like microseta present on tergites II–VIII; the male subgenital plate is not divided or split in the middle at posterior end in the present specimens (Figs. 11a and 18a); female subgenital plate is wide with scattered setae and with vulval marginal chaetotaxy. The minute peg-like setae on tergo-lateral position are usually hard to see, so we recommend these parts of the body of *Neopsittaconirmus* spp. be examined carefully to avoid misidentification.

4. Discussion

Two species of *Neopsittaconirmus* have been reported from Pakistan (Ansari, 1947; Naz et al., 2016, 2020). While *N. chandabani* is known only from type material from *Psittacula eupatria* in the upper Punjab province (Guimarães, 1974), *N. lybartota* has wider distribution with several records across the range of its host, *Psittacula krameri* (Table 4).

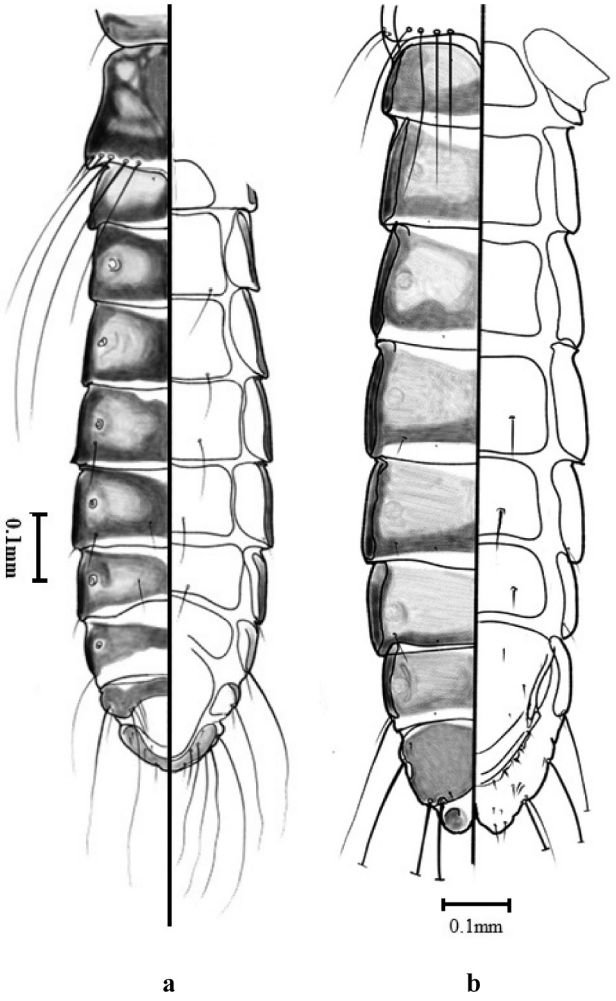

Fig. 15. *Neopsittaconirmus vendulae* Sychra, 2006: A. Male thorax dorsal and abdomen in dorsal and ventral views; B. Female abdomen in dorsal and ventral views.

This parrot is widely distributed in Asia and Africa (Pruett-Jones, 2021). It has been introduced in many countries in Europe (Strubbe and Matthysen, 2009). So dar, *N. lybartota* has been found infesting *P. krameri* in Italy, where the introduced population most likely belong to the Indian subspecies *P. krameri borealis* (Jackson et al., 2015; Mori et al., 2015).

It is interesting that two different species of *Neopsittaconirmus*, *N. chandabani* and *N. lybartota*, have been recorded on *P. eupatria nipalensis* from two different area of Pakistan. It is known that birds with larger distributions can harbour different species of one genus of lice in different parts of its range (Klockenhoff, 1969; Price et al., 2003). This phenomenon has also been documented for *P. eupatria* (see Table 1; Fig. 21). We suppose that *P. krameri* can share *N. lybartota* with *P. eupatria*, because these two species are closely related and may form mixed-species flocks (Ancillotto et al., 2016). Hybridization is known to occur between these two hosts, though it is probably more frequent in introduced locations than in their native range (Viviano and Mori, 2021).

In captive birds, *N. lybartota* has been reported only in the Czech Republic, also from Indian subspecies *P. krameri borealis* (Sychra, 2006). Mey (2004) mentioned this species in his list of chewing lice from Germany, but only in the category of "potential species", without any confirmed records (Mey, 2004, personal communication). Although there is no record of *Neopsittaconirmus* on African subspecies *P. krameri krameri* in the wild, our finding of *N. lybartota* on several *P. krameri krameri* shows that this louse can occur on this African subspecies.

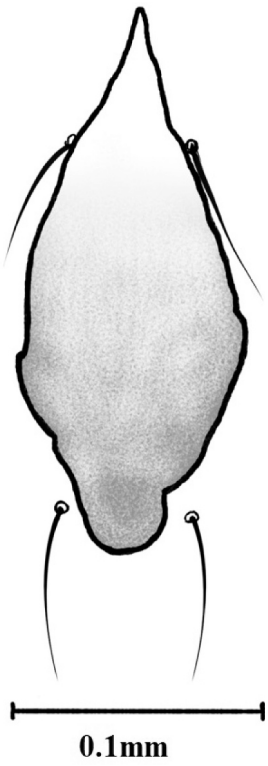

Fig. 16. *Neopsittaconirmus vendulae* Sychra, 2006: Meso-metasternal plate.

Because lice were collected from captive birds in Pakistan, we suppose they most likely represent stragglers from *P. krameri borealis* than as a natural occurrence. From records above, it is clear that *N. lybartota* has the ability to survive on its host despite a limited number of parrots in founder populations and with limited contact between individuals in these populations. It may also have a limited potential to colonize new hosts. In our opinion, this fact may also explain observed differences in morphometric parametres such as dimensions and characters of ventral terminalia or genitalia. Intraspecific variation of lice may be also strongly affected by so called founder effects, because we can expect that lice in captive birds originated from different and most likely small subpopulations.

Since *Neopsittaconirmus* spp. are usually found with low intensity (Table 4), we suppose it may be quite common on parrots in aviaries, but may not be noticed by keepers. Because it probably has no or minimal impact on its host, it may be easily overlooked. On the other hand, parrots are often keept in aviaries that include several individuals of different species. We expect that there is a possibility that atypical hosts may be colonized (see also Larramendy et al., 2017). It is still a question whether such lice can survive on such novel hosts. Sychra (2005) documented that *N. gracilis*, originally described from African Yellow-collared Lovebird, *Agapornis personatus*, established viable populations on budgerigars, *Melopsittacus undulatus*. This case shows that, thanks to pet trade with exotic animals, their ectoparasites can be distributed around the world. So far, *N. gracilis* has been reported from captive budgerigars in the Czech Republic, Australia (Sychra, 2005), Germany (Beck, 1999, 2017; Mey, 2004), Egypt (E. S. Adly, 2018, personal communication), USA (Mullen and Durden, 2002), and Peru (Gomez-Puerta and Luján-Vega, 2018; Minaya et al., 2021). To our knowledge, there are only two available reports of *N. gracilis* from its type host in captivity by (M.P. Valim 2005, personal communication), from captive yellow-collared lovebird, *Agapornis personatus*, in Brazil and by Larramendy et al. (2017) from Cuba.

Similarly, *N. vendulae* has been reported from captive *N. hollandicus* from Australia, Czech Republic and Germany (Sychra, 2006), Poland

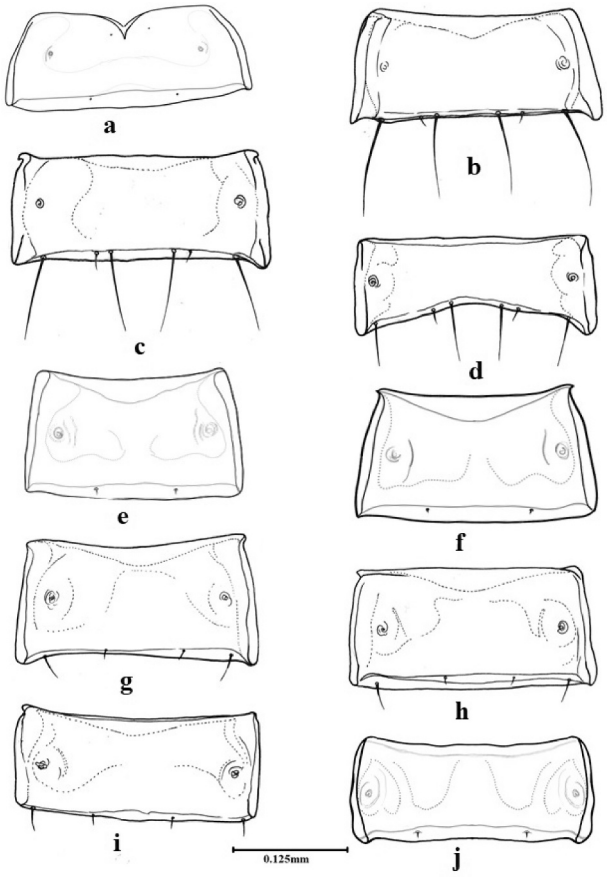

Fig. 17. *Neopsittaconirmus vendulae* Sychra, 2006: Abdominal tergites; A. Tergite I-II fused; B. Male tergite V; C. Male tergite VI; D. Male tergite VII; E. Tergite III; F. Tergite IV; G. Female tergite V; H. Female tergites VI-VII; I. Female tergite VIII.

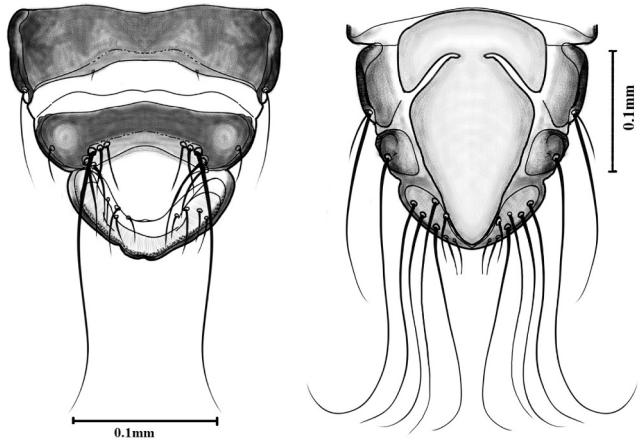

Fig. 18. *Neopsittaconirmus vendulae* Sychra, 2006: A. Male terminalia in dorsal view; B. Male terminalia in ventral view.

(Karocka, 2022), Cuba (Larramendy et al., 2017), Brazil (Neiva and Martins, 2021). Both species, *N. gracilis* and *N. vendulae*, have also been recorded on atypical hosts: *N. gracilis* on *N. hollandicus* in Cuba (Larramendy et al., 2017) and Brazil (Gois et al., 2022), and vice versa i.e., *N. vendulae* on *M. undulatus* in Germany (Sychra, 2006) and Cuba (Larramendy et al., 2017).

These records represent the global distribution of some *Neopsittaconirmus* spp. Despite increasing numbers of published reports in

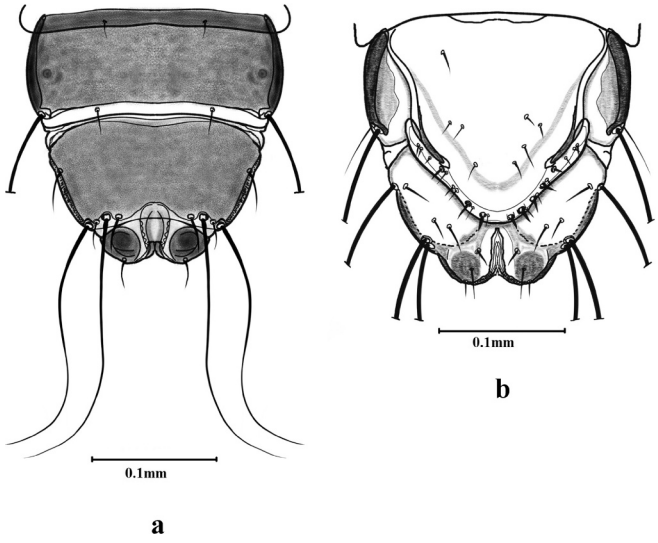

Fig. 19. *Neopsittaconirmus vendulae* Sychra, 2006: A. Female terminalia in dorsal view; B. Female terminalia in ventral view.

recent years, we anticipate that these lice have most likely present infesting captive birds from the time the first parrots had been imported from the wild. *Melopsittacus undulatus* and *N. hollandicus* are among the most common parrots kept as pets, because they reproduce very easily in captivity. Many of these populations in aviaries around the world consist of birds which originated from other captive populations. Conversely, almost 50% of *P. krameri* traded during 1975–2007 were wild-caught (Chan et al., 2021). In this case, populations of lice in captivity can easily persist, supported by continued trade with wild-caught birds, especially in countries where they are also wild. The discovery of lice on captive African *P. krameri krameri* in Pakistan shows that colonization from native Indian *P. krameri borealis* is possible. However, the budgerigar, *Melopsittacus undulatus*, so popular in the pet trade, can be uninfested even in cages where there is a high level of mites (Yildiz and Köse, 2023). It is therefore possible that the cage contamination is not a reason of being infested with lice or other species of mites.

The presence of these lice is probably known to keepers and veterinarians, but they simply have not been documented, because in these cases, the only goal is usually "just" to eliminate lice on infested host(s), rather than collect and identify them. Such a case was reported for lice in a conservation breeding program for the critically endangered crested ibis, *Nipponia nippon* (Temminck) (Gustafsson et al., 2021). These authors documented, that despite the regular screening and treatment for parasites, they found viable populations of three species of chewing lice.

Carbaryl dusting powder or pyrethrin sprays are widely recommended against parrot lice (Indranil and Samiran, 2017). In connection with the increasing resistance of lice to widely used insecticides including pyrethrin or carbaryl, new substances such as fipronil or selamectin are being used (Beck, 2017; Beck and Pantchev, 2006; Gois et al., 2022). Insecticide resistance is well documented in human lice (Durand et al., 2012). Also in animal lice resistance has been reported in several species such as: *Bovicola bovis* (Linnaeus, 1758), *Bovicola ovis* (Schrank, 1781) or, *Bovicola ocellatus* (Piaget, 1880) (Ellse et al., 2012; Levot et al., 1995; Sands et al., 2015). To our knowledge there is no confirmed case of resistance in avian lice (see also Levot, 2000). More research is necessary to evaluate whether there is sufficient sustained selection pressure for *Neopsittaconirmus* lice on parrots in aviaries to lead to a resistance problem.

Antiparasitic medicines are usually applied on nape, back and wings where *Neopsittaconirmus* is the most often found (Beck and Pantchev, 2006; Sychra, 2005). Most medications and treatments should be repeated after several days (7–10 days in Beck, 1999), because eggs are less effectively killed than adults. This period is in accordance with

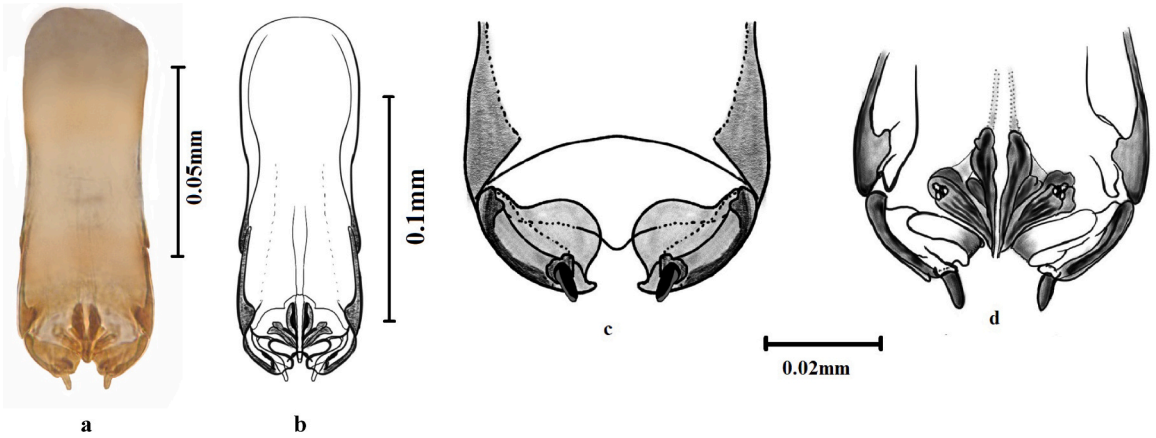

Fig. 20. *Neopsittaconirmus vendulae* Sychra, 2006: A. Photomicrograph of the male genitalia at 400×; B. Male genitalia; C. Details of male genitalia in dorsal view; D. Details of male genitalia with aedeagus complex in ventral view.

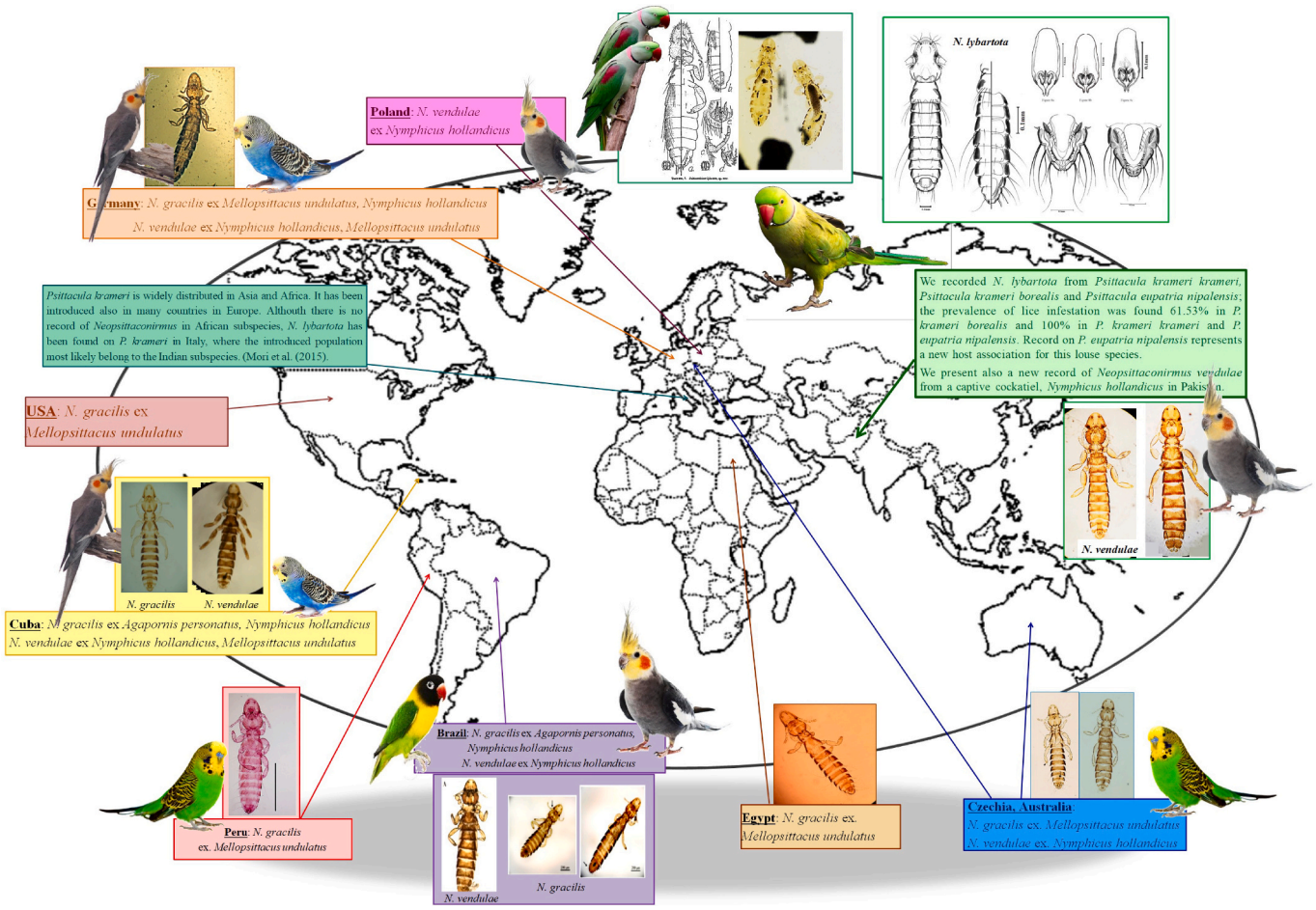

Fig. 21. Worldwide distribution of known species of the genus *Neopsittaconirmus,* parasitizing parrots of the genus, *Psittacula* (family Psittaculidae).

Saxena et al. (2009), who reported the incubation period of *N. elbeli* to be 4–6 days. Moreover, eggs are mostly located on the head, which not is usually treated adequately (Beck, 1999). This will facilitate subsequent "re-colonization" of the same host.

Neopsittaconirmus spp. demonstrate that despite long-standing systematic veterinary care, some lice are able to adapt to life in captivity and successfully survive and reproduce there with their hosts. Cosmopolitan distribution and ability to colonize novel hosts makes these lice an interesting subject for further research.

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Declaration of Competing Interest

None.

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