Interactive HTML-based Dichotomous Key to Female Rhinonyssidae (Mesostigmata) from Birds in Canada

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Abstract. Several lineages of mites (Arachnida: Acari) inhabit the nasal and respiratory tracts of birds. The Rhinonyssidae (Mesostigmata) are the most diverse group of avian nasal mites. While surveying the nasal mites associated with birds of western Canada, we became aware of the need for an interactive, image-rich dichotomous key to the Rhinonyssidae of Canada. Using FrontPage we made the first HTML-based key to rhinonyssids, and the first key to the rhinonyssids of Canada. It covers 47 species of rhinonyssids, including five new species that were discovered during the course of the survey, and described in Knee (2008). For each species, information pages are provided including North American host records, diagnostic characters, a dorsal habitus image, and illustrated dorsal and ventral aspects.

Introduction

Birds are host to a diverse fauna of symbiotic arthropods. Mites (Arachnida: Acari) represent one of the most species-rich groups of arthropods associated with birds (Proctor and Owens 2000). Some mite species are relatively benign such as most feather mites (Astigmata: Analgoidea, Pterolichoidea, Freyanoidea), but others are highly detrimental parasites such as the nasal mite *Sternostoma tracheacolum* Lawrence, 1948 (Mesostigmata: Rhinonyssidae) (Stephan et al. 1950; Proctor and Owens 2000). The Rhinonyssidae are obligate blood-feeding endoparasites in the nasal passages of non-ratite birds worldwide. Rhinonyssids are distributed among eight genera, believed to have descended from ectoparasitic ancestors related to the Macronyssidae (Strandtmann 1948). Rhinonyssid genera vary in their degree of host specificity, with some genera being restricted to a single host family, and others collected in hosts from different orders (Pence 1973c). The genera *Ptilonyssus* (Berlese and Trouessart), *Sternostoma* Berlese and Trouessart, *Tinaminyssus* Strandtmann and Wharton, and *Rhinonyssus* Trouessart exhibit broad host ranges in North America. *Ptilonyssus* species have been collected from passeriform, caprimulgiform, falconiform, and apodiform hosts, *Sternostoma* from passeriform, charadriiform, and piciform birds, *Tinaminyssus* from ciconiiform and columbiform hosts, and *Rhinonyssus* from anseriform, charadriiform, and podicipediform birds. Among more host-specific rhinonyssids, *Rhinoecius* Cooreman species parasitize owls (Strigiformes), with each species generally occurring in a different species of owl; *Rallinyssus* Strandtmann species parasitize birds of the family Rallidae; and *Larinyssus* Strandtmann species parasitize gulls and terns (Laridae).

Rhinonyssids are sluggish, slow moving mites that usually occupy the scroll-like and highly vascularized nasal turbinates, but some species invade the lungs, air sacs, tracheal tissues and body cavity (Porter and Strandtmann 1952; Krantz 1978). Rhinonyssid feeding activity may cause trauma to the nasal epithelium (De-Rojas et al. 2002), but generally they are not considered to cause significant pathology. The main exception is *S. tracheacolum* which invades the lower respiratory tract, lungs, and air sacs of the host (Stephan et al. 1950). *Sternostoma tracheacolum* has been collected from 37 species, 32 genera and 11 families of captive and wild birds (Bell 1996). Generally the pathology experienced by captive birds is more severe than that of wild birds (Fain and Hyland 1962). The decline of the endangered Gouldian finch, *Erythrura gouldiae* (Gould), may be the result of *S. tracheacolum* infesting wild birds

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from individuals originally held in captivity (Tidemann et al. 1992).

While surveying the parasitic nasal mites associated with birds of Alberta and Manitoba (Knee et al. 2008), we became aware of the need for an image-rich, interactive key to rhinonyssids of Canada. There has never been a key to Canadian rhinonyssids. The best previously published key for nasal mites of North American birds is a paper-based dichotomous key by Pence (1975), but the key lacks a number of rhinonyssid species known to occur in Canada. Because most bird species in Canada are widely distributed and migrate annually (Kaufman 2000), a key to rhinonyssids of Canada should be useful throughout much of northern North America.

Materials and Methods

Collection of mites from birds took place independently in the laboratories of Heather Proctor at the University of Alberta and Terry Galloway at the University of Manitoba. At the University of Alberta, we examined approximately 450 frozen bird carcasses from Alberta, largely from the contributions of the Alberta Fish & Wildlife Forensic Laboratory, the Royal Alberta Museum, waterfowl hunters, and colleagues at the University of Alberta. Collection data were sparse for many of these specimens, and for some it can only be said that the birds were collected somewhere in Alberta. Bird bodies were maintained at -20ºC until processing. A partially thawed bird was placed in a suitably sized container, ranging from 4-18 L, with a drop of dish detergent, enough 95% ethanol to soak the plumage of the bird, and enough water to submerge it, the nares and mouth were rinsed with 95% ethanol as well. The whole bird was washed in order to collect all mites and lice (Phthiraptera) associated with the host. The sealed container was then shaken vigorously for five minutes. Particularly large birds were washed in a basin and thoroughly massaged while in the solution. Each bird was then removed from the container and rinsed thoroughly over a Fisher Scientific 53 µm mesh sieve; large birds were rinsed over the washing basin. The washing liquid was filtered and the container and lid were rinsed thoroughly over the same 53 µm sieve. The material remaining in the sieve was stored in 30 mL snap cap or scintillation vials in 80% ethanol.

At the University of Manitoba, nasal cavities were flushed using orthodontic syringes, 15 mL for larger birds and 3 mL for smaller birds. A solution of warm water and mild soap was flushed through each nostril, back out the mouth and into a Petri dish. Occasionally nasal mites were also collected in whole-body washings of birds. Body-washing methods were similar to those described above, except that ethanol was not added to the washing solution, and the washing solution was filtered through a 90 µm sieve. Specimens were preserved in 70% ethanol.

Mites were removed from ethanol and cleared in 85% lactic acid for 1-24 hours depending on the degree of original opacity. Mites were mounted in a polyvinyl alcohol medium (6371A, BioQuip Products, Rancho Dominguez, CA). Slides were cured on a slide warmer at about 40ºC for 3-4 days. Slide-mounted specimens were examined on a Leica DMLB compound microscope with differential interference contrast (DIC) at 400x magnification. Species level identifications were made using keys (Pence 1975) and species descriptions from the primary literature.

The HTML-based dichotomous key to the female Rhinonyssidae species of Canada was made using FrontPage. Illustrations were made on paper using camera lucida, merged in Adobe Photoshop CS version 8.0, and redrawn in Adobe Illustrator CS version 11.0 using an Intuos 2 Graphics Tablet from WACOM Co., Ltd. FrontPage was used to create an HTML 'species page' for each species. Each of these species pages includes North American host records, diagnostic characteristics, relevant references, and scaled habitus images. The *Sternostoma laniorum* Fain, 1956 habitus image was redrawn from Pence (1975) with permission from Pence, due to the poor condition of the single specimen in our possession. *Rallinyssus* caudistigmus Strandtmann, 1948 and *Sternostoma boydi* Strandtmann, 1951 were not collected during our survey, but these species are included in the key since specimens were collected in Canada and deposited in the Canadian National Collection of Insects, Arachnids and Nematodes. Most character states are accompanied by a labeled image indicating the structures of interest. Illustrations of the dorsum and venter of a generalized rhinonyssid female are also included. Photos of slide-mounted mites were taken with a Canon Powershot S40 digital camera mounted on a Leica DMLB compound microscope with differential interference contrast (DIC), at 200-400x magnification. Images were captured in the Canon Utilities Remote Capture program, version 2.2.0.11, and edited using Adobe Photoshop CS version 8.0. Voucher specimens are deposited in the University of Alberta E.H. Strickland Museum of Entomology, and in the University of Manitoba J.B. Wallis Museum of Entomology. Host taxonomy and authorities follow Clements (1991) provided by

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Andrew and McAllan (1998) in Nomina version 1.0, using the 'Clements 1991-1996' taxonomy option.

Results and Discussion

This key provides species level identifications for 47 species and six genera of rhinonyssids collected from birds of Canada (Table 1), illustrated in 116 figures. The key includes all of the known rhinonyssid species from Canada, with 45 species collected from birds of Alberta and Manitoba, five of which were described as new to science (Knee 2008), and two species from birds of the Northwest Territories. The illustrations of the dorsum and venter of a generalized rhinonyssid female, the labeled images indicating the structures of interest, and HTML species pages can be accessed by clicking on the links in the key. Additional keys to species of nasal mites collected from North American birds can be found in Pence (1975). Keys to other blood- and tissue-feeding mites associated with birds of Alberta can be found in Knee and Proctor (2006).

Occasionally certain character states were inconsistent intraspecifically, including the presence of unpaired setae, the extent of dorsal or ventral shields, and the form of shield margins; this variation was taken into consideration when building the key. In addition, the posterior pair of "ventral" opisthosomal setae (JV4) are sometimes shifted dorsally or terminally, making them difficult to recognize as being "ventral", in such cases setae JV4 were excluded from the total count for ventral opisthosomal setae. Intraspecific morphological variation can be quite common, and it must be taken into consideration while creating and using any key. Records of the same species of rhinonyssid in related European and North American birds, or of the same mite species in very different host families, should be interpreted cautiously. Careful morphological and molecular investigations are likely to reveal that many such species are actually clusters of a closely related species, or are more distantly related species that have independently converged on similar morphology. This key is based upon the species collected during a survey of approximately 35% of Canada's avian fauna, there are many host species left to be examined (*e.g.*, Procellariiformes, marine Charadriiformes) (Knee *et al.* 2008). It has been estimated that there are 70-80 species of rhinonyssids in Canada; thus, this key is not complete, and it is likely that many more species will be uncovered with further examination of Canada's avian fauna (Knee *et al.* 2008). This key will serve as the foundation for any future work on avian nasal mites in Canada.

Interactive HTML-based Dichotomous Key to Female Rhinonyssidae (Mesostigmata) from Birds in Canada.

Key to Rhinonyssidae genera of Canada:

1 Female genital shield (Fig 4) present between coxa IV .....2 (Female)

-. Sternogenital shield with male gonopore (Fig 5) anteromedially..... Male - not keyed further

2 Chelicerae distally attenuated, digits minute (Fig 6) 6

- Chelicerae approximately uniform diameter, digits robust (Fig 7) 3

3 Posterior adhesive disk present (Fig 8) .....*Rallinyssus**

- Posterior adhesive disk absent.....4

4 Chelicerae with one digit (Fig 9), Strigiformes host species..... *Rhinoecius*

- Chelicerae with two digits (Fig 10), host not a strigiform species 5

5 Peritreme absent (Fig 11) .....*Rhinonyssus*

- Peritreme present (Fig 12)..... *Tinaminyssus*

6 Peritreme always absent (Fig 11), gnathosoma ventroterminal, anus terminal .....*Sternostoma*

- Peritreme present (Fig 12) (except absent (Fig 11) in *Ptilonyssus angrensis* (Fig 93), P. vireonis (Fig 97), and P. hoseini which do show the following character states), gnathosoma terminal, anus ventroterminal .....*Ptilonyssus*

***Rallinyssus:**

Only *Rallinyssus caudistigmus* (Fig 70) has so far been found in Canada. Two other species, *R. sorae* Pence and Young, 1979, and *R. verheyeni* Fain, 1963 have been recorded from North American birds. *Rallinyssus*

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verheyeni and *R. sorae* differ from *R. caudistigmus* by having an extensively fragmented podosomal shield, as well as different chaetotaxy.

Key to *Rhinoecius* species*:*

1 Subposterior pair of dorsal podosomal setae set on posterior margin of podosomal shield and very long (Fig 13) (at least 70 µm long). Host species *Aegolius funereus and A. acadicus* ..... *Rhinoecius aegolii* (Fig 71)

- Subposterior pair of dorsal podosomal setae on or off posterior margin of podosomal shield and short (Fig 14) (less than 70 µm long) 2

2 Sternal shield highly reduced, all sternal setae off shield. Host species *Strix nebulosa* ..... *Rhinoecius cooremani* (Fig 72)

- Sternal shield more complete (Fig 15), st1 and st2 on shield and st3 off shield 3

3 Postanal seta absent. Host species *Asio otus* ..... *Rhinoecius brikinboricus* (Fig 73)

- Postanal seta present 4

4 Posterior margin of sternal shield with posteromedial projection (Fig 16). Host species *Bubo virginianus* ..... *Rhinoecius grandis* (Fig 74)

- Posterior margin of sternal shield straight without projection (Fig 17) 5

5 Anterior margin of sternal shield does not extend far beyond st1. Host species *Asio flammeus* ..... *Rhinoecius alifanovi* (Fig 75)

- Anterior margin of sternal shield extends anteriorly beyond st1 (Fig 18). Host species *Nyctea scandiaca* ..... *Rhinoecius nycteae* (Fig 76)

Key to *Rhinonyssus* species:

1 Podosomal shield complete, without medial erosion (Fig 19). Nine or more pairs of ventral opisthosomal setae ..... *Rhinonyssus rhinolethrum* (Fig 77)

- Podosomal shield medially eroded (Fig 20), often divided medially. Five or fewer pairs of ventral opisthosomal setae ..... *Rhinonyssus coniventris* (Fig 78)

Key to *Tinaminyssus* species:

1 Poststigmatal platelet absent, five or fewer pairs of ventral opisthosomal setae ..... *Tinaminyssus columbae* (Fig 79)

- Poststigmatal platelet present (Fig 21), ten or more pairs of ventral opisthosomal setae 2

2 Paranal setae anterior to anus, opisthosomal shield narrows posteriorly (Fig 22), posterior portion is less than 1/2 the width of the anterior portion ..... *Tinaminyssus melloi* (Fig 80)

- Paranal setae level with anus, opisthosomal shield occupying most of the dorsal opisthosoma (Fig 23) ..... *Tinaminyssus zenaidurae* (Fig 81)

Key to *Sternostoma* species:

1 One dorsal shield, sternal setae large, proximally inflated blunt tipped spines (Fig 24) ..... *Sternostoma technaui* (Fig 82)

- Two dorsal shields, sternal setae minute spines (Fig 25) 2

2 Apical setal pair on palp tarsus proximally inflated, medially constricted and distally flattened, in form of a T with an inflated base (Fig 26). Tarsi II – IV subapical ventral and ventrolateral setae relatively long spines (Fig 27) ..... *Sternostoma longisetosae* (Fig 83)

- Apical setal pair on palp tarsus long spines (Fig 28), short spines, or short bulbs (Fig 29), not T-like. Tarsi II – IV subapical ventral and ventrolateral setae either relatively long spines or otherwise 3

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3 Tarsus IV anterodorsal apical seta long prominently swollen spike with flexible tip (Fig 30). Tarsi II - IV subapical ventral setal pair short blunt tipped stout spines (Fig 31), especially noticeable on tarsus IV ..... *Sternostoma porteri* (Fig 84)

- Tarsus IV anterodorsal apical seta not swollen, long hair-like (Fig 32). Tarsi II – IV subapical ventral setal pair either short blunt tipped stout spines or otherwise 4

4 Tarsi II – IV subapical ventral setal pair short blunt tipped stout spines (Fig 31), especially noticeable on tarsus IV. Postanal seta present ..... *Sternostoma hylandi* (Fig 85)

- Tarsi II – IV subapical ventral setal pair otherwise. Postanal seta absent 5

5 Tarsi II – IV subapical ventral setal pair short flattened setae with rounded tips (Fig 33). No setae in dorsal opisthosomal unsclerotized integument ..... *Sternostoma boydi* (Fig 86)

- Tarsi II – IV subapical ventral setal pair otherwise. One or more pairs of setae in dorsal opisthosomal unsclerotized integument 6

6 Tarsi II – IV subapical ventral and ventrolateral setae relatively long spines (Fig 27). More than three pairs of setae in dorsal opisthosomal unsclerotized integument ..... *Sternostoma setifer* (Fig 87)

- Tarsi II – IV subapical ventral and ventrolateral setae otherwise. Fewer than three pairs of setae in dorsal opisthosomal unsclerotized integument 7

7 Tarsi II – IV subapical ventral and ventrolateral setae minute spines (Fig 34), barely visible. Two pairs of setae in dorsal opisthosomal unsclerotized integument ..... *Sternostoma tracheacolum* (Fig 88)

- Tarsi II – IV subapical ventral and ventrolateral setae variously modified, not minute spines. One or two pairs of setae in dorsal opisthosomal unsclerotized integument 8

8 Tarsi II – IV subapical ventral and ventrolateral setae hook-like short spines (Fig 35). Two pairs of setae in dorsal opisthosomal unsclerotized integument ..... *Sternostoma laniorum* (Fig 89)

- Tarsi II – IV subapical ventral and ventrolateral setae distally inflated setae (Fig 36). One or two pairs of setae in dorsal opisthosomal unsclerotized integument 9

9 Tarsi II – IV subapical ventral and ventrolateral setae distally inflated symmetrical setae (Fig 36). Two pairs of setae in dorsal opisthosomal unsclerotized integument. Paranal setae at level with anal opening ..... *Sternostoma cryptorhynchum* (Fig 90)

- Tarsi II – IV subapical ventral and ventrolateral setae distally inflated asymmetrical setae (Fig 37). One pair of setae in dorsal opisthosomal unsclerotized integument. Paranal setae posterior to anal opening 10

10 One pair of setae and one pair of pores in dorsal opisthosomal unsclerotized integument .... *Sternostoma loxiae* (Fig 91)

- One pair of setae in dorsal opisthosomal unsclerotized integument ..... *Sternostoma sialiphilus* (Fig 92)

Key to *Ptilonyssus* species:

1 Second cheliceral segment prominently inflated proximally with marked constriction distally (Fig 38) 14

- Second cheliceral segment without marked inflation and constriction (Fig 39) 2

2 One dorsal shield present (podosomal), sternal shield absent, peritreme absent (Fig 11), and cribrum absent (Fig 40) or unnoticeable ..... *Ptilonyssus angrensis* (Fig 93)

- Two dorsal shields present (podosomal plus a posterior shield composed of either pygidial shield alone, or fused opisthosomal and pygidial shields), sternal shield present, peritreme present (Fig 12) or absent, and cribrum present (Fig 41) 3

3 Ventral hypostomal setae distally inflated bulb setae (Fig 42) 4

- Ventral hypostomal setae not distally inflated bulb setae (Fig 43) 5

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4 Six pairs of ventral opisthosomal setae, anal setae tapered distally (Fig 44) with filamentous, spike, or rounded tip. Tarsus IV subapical ventral setal pair relatively long, one strong spike and one filamentous spike (Fig 47). Subposterior pair of dorsal podosomal setae as long or almost as long as longest mesolateral setae ..... *Ptilonyssus coccothraustis* (Fig 94)

- Seven pairs of ventral opisthosomal setae, anal setae constricted proximally (within 1/3 of length from base) with long filamentous tip (Fig 45). Tarsus IV subapical ventral setal pair relatively long strong spikes (Fig 46). Subposterior pair of dorsal podosomal setae longer than mesolateral setae .... *Ptilonyssus plesiotypicus* (Fig 95)

5 Podosomal shield with lateral wing-like processes (Fig 48), posterior margin of podosomal shield rounded (Fig 49), two pairs of mesolateral setae ..... *Ptilonyssus callinectoides* (Fig 96)

- Podosomal shield without lateral wing-like processes, posterior margin of podosomal shield otherwise, more than two pairs of mesolateral setae 6

6 Peritreme absent. Opisthosomal shield laterally excavated medially with excavation extending posteriorly (Fig 50), anterior margin of shield bearing medial lobe without lateral lobes (Fig 51) ..... *Ptilonyssus vireonis* (Fig 97)

- Peritreme present. Opisthosomal shield either laterally excavated along posterior portion (Fig 52) or no lateral excavation (Fig 53), anterior margin of shield either straight (Fig 54) or medially straight with anterolateral projections (Fig 55) 7

7 Sternal setae st1, st2, and st3 off shield in unsclerotized integument 8

- Sternal setae st1, st2, and st3 on shield (Fig 56) 10

8 Four pairs of mesolateral setae, six pairs of ventral opisthosomal setae, opisthosomal shield without lateral excavation (Fig 53), subapical ventral setal pair on tarsus IV with pointed terminus (Fig 46) 9

- Three pairs of mesolateral setae, six pairs of ventral opisthosomal setae, opisthosomal shield laterally excavated along the posterior portion (Fig 52), subapical ventral setal pair on tarsus IV relatively long strong spikes with a rounded terminus (Fig 57) ..... *Ptilonyssus tyrannus* (Fig 98)

9 Opisthosomal shield twice as long as wide. Subapical ventral setal pair on tarsus IV relatively long filamentous spikes, long flexible tip (Fig 58). Paranal setae posterior to anus, paranal and postanal setae unequal length (Fig 45) ..... *Ptilonyssus hirsti* (Fig 99)

- Opisthosomal shield less than twice as long as wide. Subapical ventral setal pair on tarsus IV long heavyset inflated spikes (Fig 59). Paranal setae level with anus near anterior margin of anus, paranal and postanal setae equal or almost equal length ..... *Ptilonyssus icteridius* (Fig 100)

10 Subapical ventral setal pair on tarsus IV one short filamentous spike and one short partially inflated bulb (Fig 60). Sternal shield wider than long, four or five pairs of ventral opisthosomal setae ..... *Ptilonyssus morofskyi* (Fig 101)

- Subapical ventral setal pair on tarsus IV either relatively long strong spikes (Fig 46), or one strong spike and one filamentous spike (Fig 47). Sternal shield longer than wide, five or six pairs of ventral opisthosomal setae 11

11 Subapical ventral setal pair on tarsus IV relatively long, one strong spike and one filamentous spike (Fig 47). Three pairs of mesolateral setae ..... *Ptilonyssus nivalis* (Fig 102)

- Subapical ventral setal pair on tarsus IV relatively long strong spikes (Fig 46). Four pairs of mesolateral setae 12

12 Mesosomal shieldlets absent, anterior margin of opisthosomal shield medially straight with anterolateral projections (Fig 55), podosomal shield posterior margin trilobed (Fig 61), subposterior pair of dorsal podosomal setae as long or longer than the longest mesolateral setae 13

- Mesosomal shieldlets present, anterior margin of opisthosomal shield straight (Fig 54), podosomal shield posterior margin straight (Fig 62), subposterior pair of dorsal podosomal setae less than half the length of longest mesolateral setae ..... *Ptilonyssus pirangae* (Fig 103)

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13 Five pairs of ventral opisthosomal setae, subposterior pair of dorsal podosomal setae as long or almost as long as longest mesolateral setae, paranal and postanal setae equal or almost equal length ..... *Ptilonyssus carduelis* (Fig 104)

- Six pairs of ventral opisthosomal setae, subposterior pair of dorsal podosomal setae longer than longest mesolateral setae, paranal and postanal setae unequal length (Fig 45)..... *Ptilonyssus pinicola* (Fig 105)

14 Subapical ventral setal pair on tarsus IV relatively long strong spikes with rounded terminus (Fig 57), four pairs of ventral opisthosomal setae, three pairs of mesolateral setae, postanal seta absent ..... *Ptilonyssus perisorei* (Fig 106)

- Subapical ventral setal pair on tarsus IV relatively long strong spikes (Fig 46), more than four pairs of ventral opisthosomal setae, three or more pairs of mesolateral setae, postanal seta present or absent.. 15

15 Pygidial shield in two fragments (Fig 63), subposterior setal pair either on or off fragments 16

- Pygidial shield entire (Fig 64) 18

16 Genital shield arrow-shaped, pointed terminus (Fig 65), 10 times longer than wide. Sternal shield absent, seven or more pairs of ventral opisthosomal setae ..... *Ptilonyssus echinatus* (Fig 107)

- Genital shield thumb-shaped, rounded terminus (Fig 66). Sternal shield present, six pairs of ventral opisthosomal setae..... 17

17 Paranal setae posterior to anal opening, postanal setae absent. Pygidial shield in two fragments without subposterior setal pair on fragments, subposterior pair of dorsal podosomal setae longer than longest mesolateral setae, three pairs of mesolateral setae. ..... *Ptilonyssus cerchneis* (Fig 108)

- Paranal setae level with anal opening, postanal seta present. Pygidial shield in two fragments with subposterior setal pair on fragments, subposterior pair of dorsal podosomal setae half as long as longest mesolateral setae, six pairs of mesolateral setae..... *Ptilonyssus troglodytis* (Fig 109)

18 No two pairs of mesolateral setae are twice as long as other mesolateral setae 19

- At least two pairs of mesolateral setae are twice as long as other mesolateral setae 21

19 Posterior margin of podosomal shield trilobed (Fig 61), subposterior setal pair off podosomal shield and as long or almost as long as longest mesolateral setae, five pairs of mesolateral setae. Sternal setae st1 on shield, st2 and st3 off shield (Fig 67)..... 20

- Posterior margin of podosomal shield rounded (Fig 49), subposterior setal pair on podosomal shield and less than half the length of longest mesolateral setae, three pairs of mesolateral setae. Sternal setae st1, st2, and st3 on shield (Fig 56)..... *Ptilonyssus nudus* (Fig 110)

20 Cribrum extends to anal shield terminus (Fig 41), paranal setae posterior to anal opening, paranal and postanal setae equal or almost in equal length ..... *Ptilonyssus bombycillae* (Fig 111)

- Cribrum does not extend to anal shield terminus (Fig 68), paranal setae level with anal opening, paranal and postanal setae of unequal length (Fig 45) ..... *Ptilonyssus calvaria* (Fig 112)

21 Six pairs of mesolateral setae, paranal and postanal setae of unequal length (Fig 45)..... ..... *Ptilonyssus euroturdi* (Fig 113)

- Fewer than six pairs of mesolateral setae, paranal and postanal setae equal or almost in equal length..... 22

22 Posterior margin of podosomal shield medially straight with lateral lobes (Fig 69), subposterior setal pair on podosomal shield and as long or almost as long as longest mesolateral setae .... *Ptilonyssus acrocephali* (Fig 114)

- Posterior margin of podosomal shield either trilobed (Fig 61) or straight (Fig 62), subposterior setal pair off podosomal shield and less than half the length of longest mesolateral setae..... 23

23 Posterior margin of podosomal shield trilobed (Fig 61), four pairs of mesolateral setae..... ..... *Ptilonyssus japuibensis* (Fig 115)

- Posterior margin of podosomal shield straight (Fig 62), five pairs of mesolateral setae..... ..... *Ptilonyssus sairae* (Fig 116)

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Species Information Pages:

***Rallinyssus caudistigmus* Strandtmann, 1948** (Figs 70 a-c)

North American host records:

Rallidae:
Fulica americana, American Coot (Strandtmann 1948; Pence 1972a, 1975; Knee *et al.* 2008)
Rallus elegans, King Rail (Strandtmann 1948; Pence 1975)

Diagnostic characteristics:

- podosomal shield largely complete, without extensive fragmentation

Note:

Only *Rallinyssus caudistigmus* has so far been found in Canada. Two other species, *R. sorae* Pence and Young, 1979, and *R. verheyeni* Fain, 1963 have been recorded from North American birds. *Rallinyssus verheyeni* and *R. sorae* differ from *R. caudistigmus* by having an extensively fragmented podosomal shield, as well as different chaetotaxy.

***Rhinoecius aegolii* Butenko, 1971** (Figs 71 a-c)

North American host records:

Strigidae:
Aegolius funereus, Boreal Owl (Knee *et al.* 2008) (has been recorded from *A. funereus* in Russia by Butenko (1984))
Aegolius acadicus, Northern Saw-whet Owl (Knee *et al.* 2008)

Diagnostic characteristics:

- subposterior pair of dorsal podosomal setae on posterior margin of podosomal shield and very long, at least 70 µm long
- sternal shield absent
- paranal setae at level with anal opening, and postanal seta absent

***Rhinoecius cooremani* Strandtmann, 1952** (Figs 72 a-c)

North American host records:

Strigidae:
Strix nebulosa, Great Gray Owl (Knee *et al.* 2008)
Strix varia, Barred Owl (Strandtmann 1952; Pence 1973a, 1975)

Diagnostic characteristics:

- subposterior pair of dorsal podosomal setae in unsclerotized integument just off posterior margin of podosomal shield and much < 70 µm long
- sternal shield highly reduced, and sternal setae not on shield
- paranal setae anterior to anal opening, and postanal seta absent

***Rhinoecius brikinboricus* Butenko, 1976** (Figs 73 a-c)

North American host records:

Strigidae:
Asio otus, Long-eared Owl (Knee *et al.* 2008) (has been recorded from *A. otus* in Russia by Butenko (1976))

Diagnostic characteristics:

- subposterior pair of dorsal podosomal setae on posterior margin of podosomal shield, and much < 70 µm long
- sternal shield with posteromedial projection, st1 and st2 on shield, and shielding extends anteriorly beyond st1
- paranal setae anterior to anal opening, and postanal seta absent

Note:

R. alifanovi, R. brikinboricus, R. grandis, and *R. nycteae* comprise the *Rhinoecius* "*grandis*" species complex. These four species are difficult to separate. In particular, the sternal shield morphology used to separate species is not always consistent across individuals for a particular species. I find host species to be the best character to delineate among these species.

***Rhinoecius grandis* Strandtmann, 1952**
(Figs 74 a-c)

North American host records:

Strigidae:

Bubo virginianus, Great Horned Owl (Strandtmann 1952; Pence 1975; Knee *et al.* 2008)

Diagnostic characteristics:

- subposterior pair of dorsal podosomal setae on posterior margin of podosomal shield,
and much < 70 µm long
- sternal shield with posteromedial projection, st1 and st2 on shield, and shielding extends anteriorly beyond st1
- paranal setae anterior to anal opening, and postanal seta present

Note:

R. alifanovi, R. brikinboricus, R. grandis, and *R. nycteae* comprise the *Rhinoecius* "*grandis*" species complex. These four species are difficult to separate. In particular, the sternal shield morphology used to separate species is not always consistent across individuals for a particular species. I find host species to be the best character to delineate among these species.

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***Rhinoecius alifanovi* Butenko, 1976** (Figs 75 a-c)

North American host records:

Strigidae:

Asio flammeus, Short-eared Owl (Knee *et al.* 2008) (has been recorded from *A. flammeus* in Russia by Butenko (1976))

Diagnostic characteristics:

- subposterior pair of dorsal podosomal setae on posterior margin of podosomal shield, and much < 70 µm long
- posterior margin of sternal shield straight, st1 and st2 on shield, and shielding does not extend far beyond st1
- paranal setae anterior to anal opening, and postanal seta present

Note:

R. alifanovi, R. brikinboricus, R. grandis, and *R. nycteae* comprise the *Rhinoecius* "*grandis*" species complex. These four species are difficult to separate. In particular, the sternal shield morphology used to separate species is not always consistent across individuals for a particular species. I find host species to be the best character to delineate among these species.

***Rhinoecius nycteae* Butenko, 1976** (Figs 76 a-c)

North American host records:

Strigidae:

Nyctea scandiaca, Snowy Owl (Knee *et al.* 2008) (has been recorded from *N. scandiaca* in Russia by Butenko (1976))

Diagnostic characteristics:

- subposterior pair of dorsal podosomal setae on posterior margin of podosomal shield, and much < 70 µm long
- posterior margin of sternal shield straight, st1 and st2 on shield, and shielding extends anteriorly beyond st1
- vestigial tritosternum present
- paranal setae anterior to anal opening, and postanal seta present

Note:

R. alifanovi, R. brikinboricus, R. grandis, and *R. nycteae* comprise the *Rhinoecius* "*grandis*" species complex. These four species are difficult to separate. In particular, the sternal shield morphology used to separate species is not always consistent across individuals for a particular species. I find host species to be the best character to delineate among these species.

***Rhinonyssus rhinolethrum* (Trouessart, 1895)** (Figs 77 a-c)

Rhinonyssus (=*Sternostomum*) *rhinolethrum* (Trouessart, 1895)

North American host records:

Anatidae:

Aix sponsa, Wood Duck (Pence 1972a, 1975; Knee *et al.* 2008)

Anas acuta, Northern Pintail (Strandtmann 1951, 1956; Mitchell and Rhodes 1960; Pence 1975)

Anas americana, American Wigeon (Strandtmann 1951, 1956; Mitchell and Rhodes 1960; Wilson 1968; Pence 1975)

Anas crecca carolinensis, Common Teal (Strandtmann 1951, 1956; Mitchell and Rhodes 1960; Wilson 1968; Pence 1975)

Anas clypeata, Northern Shoveler (Strandtmann 1951, 1956; Mitchell and Rhodes 1960; Wilson 1968; Pence 1975)

Anas discors, Blue-winged Teal (Mitchell and Rhodes 1960; Pence 1972a, 1975)

Anas platyrhynchos, Mallard (Strandtmann 1951, 1956; Mitchell and Rhodes 1960; Pence 1975; Knee *et al.* 2008)

Anas strepera, Gadwall (Strandtmann 1951, 1956; Pence 1975)

Anser caerulescens, Snow Goose (Mitchell and Rhodes 1960; Pence 1975)

Anser rossii, Ross' Goose (Mitchell and Rhodes 1960; Pence 1975; Knee *et al.* 2008)

Aythya affinis, Lesser Scaup (Strandtmann 1951, 1956; Mitchell and Rhodes 1960; Pence 1975; Spicer 1987)

Aythya valisineria, Canvasback (Mitchell and Rhodes 1960; Pence 1975)

Branta canadensis, Canada Goose (Strandtmann 1951, 1956; Mitchell and Rhodes 1960; Pence 1975; Knee *et al.* 2008)

Cygnus columbianus, Tundra Swan (Strandtmann 1956; Knee *et al.* 2008)

Melanitta fusca deglandi, White-winged Scoter (Strandtmann 1956; Pence 1975)

Mergus merganser, Common Merganser (Strandtmann 1956; Wilson 1964)

Mergus serrator, Red-breasted Merganser (Strandtmann 1956; Mitchell and Rhodes 1960; Pence 1975)

Rallidae:

Fulica americana, American Coot (Pence 1972a, 1975)

Diagnostic characteristics:

- podosomal shield entire, not medially eroded
- nine or more pairs of ventral opisthosomal setae

***Rhinonyssus coniventris* Trouessart, 1894**
(Figs 78 a-c)

North American host records:

Charadriidae:
Charadrius alexandrinus, Snowy Plover (Strandtmann 1956; Pence 1975)
Charadrius hiaticula, Common Ringed Plover (Strandtmann 1956; Pence 1975)
Charadrius melodus, Piping Plover (Pence 1975)
Charadrius semipalmatus, Semipalmated Plover (Strandtmann 1951)
Charadrius wilsonia, Wilson's Plover (Pence 1975)
Pluvialis squatarola, Grey Plover (Mitchell 1961)
Scolopacidae:
Arenaria interpres, Ruddy Turnstone (Strandtmann 1951, 1956; Pence 1975)
Calidris alba, Sanderling (Strandtmann 1951, 1956; Pence 1972a)
Calidris alpina, Dunlin (Strandtmann 1956; Pence 1975)
Calidris canutus, Red Knot (Mitchell 1961; Canadian National Collection of Insects and Arachnids)
Calidris ptilocnemis, Rock Sandpiper (Strandtmann 1956; Pence 1975)
Catoptrophorus semipalmatus, Willet (Strandtmann 1951, 1956; Pence 1972a, 1975)
Tringa flavipes, Lesser Yellowlegs (Strandtmann 1951, 1956; Pence 1972a, 1975)

Diagnostic characteristics:

- podosomal shield is medially eroded, often medially divided.
- five or fewer pairs of ventral opisthosomal setae

***Tinaminyssus columbae* (Crossley, 1950)**
(Figs 79 a-c)
Tinaminyssus (=*Neonyssus*) *columbae* (Crossley, 1950)

North American host records:

Columbidae:
Columba livia, Rock Dove (Crossley 1950, as *C. domestica*; Strandtmann 1961; Wilson 1964; Pence 1975; Knee *et al.* 2008)

Diagnostic characteristics:

- poststigmatal platelets absent
- relatively short body and leg setae

***Tinaminyssus melloi* (Castro, 1948)** (Figs 80 a-c)
Tinaminyssus (=*Neonyssus*) *melloi* (Castro, 1948)

North American host records:

Columbidae:
Columba livia, Rock Dove (Strandtmann 1961; Wilson 1964; Pence 1975; Zamudio 1988; Knee *et al.* 2008)
Zenaida macroura, Mourning Dove (Knee *et al.* 2008)

Diagnostic characteristics:

- poststigmatal platelets present
- relatively long body and leg setae
- paranal setae anterior to anal opening

***Tinaminyssus zenaidurae* (Crossley, 1952)**
(Figs 81 a-c)
Tinaminyssus (=*Neonyssus*) *zenaidurae* (Crossley, 1952)

North American host records:

Columbidae:
Columbina passerina, Common Ground-Dove (Crossley 1952; Strandtmann 1961; Wilson 1964; Pence 1975)
Zenaida macroura, Mourning Dove (Crossley 1952; Owen 1958; Strandtmann 1961; Wilson 1964, 1968; Pence 1973a, 1975; Spicer 1987; Knee *et al.* 2008)

Diagnostic characteristics:

- poststigmatal platelet present
- paranal setae at level with anal opening

***Sternostoma technaui* (Vitzthum, 1935)**
(Figs 82 a-c)
Sternostoma (=*Sternostomum*) *technaui* (Vitzthum, 1935)

North American host records:

Turdidae:
Turdus migratorius, American Robin (Pence 1972b, 1975; Knee *et al.* 2008)

Diagnostic characteristics:

- one dorsal shield
- sternal setae are large, proximally inflated blunt-tipped spines
- subapical ventral and ventrolateral setae of tarsi II
- IV relative to body setae are short spines
- at least five pairs of setae in the dorsal opisthosomal unsclerotized integument
- paranal setae level with anal opening, and postanal seta present

***Sternostoma longisetosae* Hyland, 1961**
(Figs 83 a-c)

North American host records:

Tyrannidae:
Empidonax alnorum, Alder Flycatcher (Hyland and Moorhouse 1970; Pence 1975)
Empidonax minimus, Least Flycatcher (Knee *et al.* 2008)
Empidonax traillii, Willow Flycatcher (Hyland and Moorhouse 1970; Pence 1975)

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Empidonax virescens, Acadian Flycatcher (Hyland and Moorhouse 1970; Pence 1975)
Pyrocephalus rubinus, Vermilion Flycatcher (Hyland and Moorhouse 1970; Pence 1975)
Tyrannus savana, Fork-tailed Flycatcher (Hyland and Moorhouse 1970)
Tyrannus tyrannus, Eastern Kingbird (Hyland 1961; Pence 1975; Knee *et al.* 2008)

Diagnostic characteristics:

- apical setal pair on palp tarsus is proximally inflated, medially constricted, and distally flattened, resembling a T with an inflated base
- subapical ventral and ventrolateral setae of tarsi II - IV are relatively long spines
- no setae in the dorsal opisthosomal unsclerotized integument
- paranal setae level with anal opening, and postanal seta absent

***Sternostoma porteri* Hyland, 1962** (Figs 84 a-c)

North American host records:

Picidae:
Colaptes auratus, Northern Flicker (Hyland 1962; Pence 1972b, 1975; Knee *et al.* 2008)
Melanerpes aurifrons, Golden-fronted Woodpecker (Pence and Casto 1975; Estebanes-Gonzalez 1997)
Picoides pubescens, Downy Woodpecker (Hyland 1962; Fain and Johnson 1966)
Sphyrapicus varius, Yellow-bellied sapsucker (Knee *et al.* 2008)

Diagnostic characteristics:

- anterodorsal apical seta on tarsus IV is a long prominently swollen spike with flexible tip
- subapical ventral setal pair on tarsi II - IV are short blunt-tipped stout spines, most obvious on tarsus IV
- four pairs of setae in the dorsal opisthosomal unsclerotized integument
- paranal setae posterior to anal opening, and postanal seta present

***Sternostoma hylandi* Fain and Johnston, 1966** (Figs 85 a-c)

North American host records:

Picidae:
Picoides pubescens, Downy Woodpecker (Pence 1975; Knee *et al.* 2008)

Diagnostic characteristics:

- anterodorsal apical seta on tarsus IV is a long hair-like seta without swelling
- subapical ventral setal pair on tarsi II - IV are short blunt-tipped stout spines, most obvious on tarsus IV
- three pairs of setae in the dorsal opisthosomal unsclerotized integument
- paranal setae posterior to anal opening, and postanal seta present

***Sternostoma boydi* Strandtmann, 1951** (Figs 86 a-c)

North American host records:

Laridae:
Larus argentatus, Herring Gull (TerBush 1963; Pence 1972b, 1975)
Larus atricilla, Laughing Gull (Pence 1975)
Larus californicus, California Gull (Spicer 1978)
Larus delawarensis, Ring-billed Gull (Pence 1972b, 1975)
Larus occidentalis, Western Gull (Spicer 1978)
Sterna forsteri, Forster's Tern (Mitchell 1961)
Sterna hirundo, Common Tern (Pence 1972b, 1975)
Scolopacidae:
Arenaria interpres, Ruddy Turnstone (Pence 1975; Canadian National Collection of Insects and Arachnids)
Calidris alba, Sanderling (Strandtmann 1951; Pence 1975)
Calidris canutus, Red Knot (Mitchell 1961)
Tringa melanoleuca, Greater Yellowlegs (Mitchell 1961; Pence 1972b, 1975)

Diagnostic characteristics:

- subapical ventral setal pair on tarsi II - IV are short flattened setae with rounded tips
- no setae in the dorsal opisthosomal unsclerotized integument
- paranal setae posterior to anal opening, and postanal seta absent

***Sternostoma setifer* Knee, 2008** (Figs 87 a-c)

North American host records:

Tyrannidae:
Empidonax minimus, Least Flycatcher (Knee *et al.* 2008)

Diagnostic characteristics:

- subapical ventral and ventrolateral setae of tarsi II - IV are relatively long spines
- four pairs of setae in the dorsal opisthosomal unsclerotized integument
- paranal setae posterior to anal opening, and postanal seta absent

***Sternostoma tracheacolum* Lawrence, 1948** (Figs 88 a-c)

North American host records:

Emberizidae:

Cardinalis sinuatus, Pyrrhuloxia (Pence and Casto 1975; Estebanes-Gonzalez 1997)
Melospiza melodia, Song Sparrow (Fain and Hyland 1962; Pence 1975)
Passerella iliaca, Fox Sparrow (Fain and Hyland 1962; Pence 1975)
Passerina cyanea, Indigo Bunting (Fain and Hyland 1962; Pence 1975)
Pipilo fuscus, Canyon Towhee (Pence and Casto 1975)
Pooecetes gramineus, Vesper Sparrow (Fain and Hyland 1962; Pence 1975)
Spizella pusilla, Field Sparrow (Fain and Hyland 1962; Wilson 1964; Pence 1975)
Fringillidae:
Serinus canaria, Island Canary (Fain and Hyland 1962)
Hirundinidae:
Riparia riparia, Sand Martin (Fain and Hyland 1962; Pence 1975)
Tachycineta bicolor, Tree Swallow (Pence 1972b, 1975)
Icteridae:
Agelaius phoeniceus, Red-winged Blackbird (Hood and Welch 1980)
Agelaius tricolor, Tricolored Blackbird (Furman 1957; Fain and Hyland 1962; Pence 1975)
Icterus bullockii, Bullock's Oriole (Furman 1957; Fain and Hyland 1962; Pence 1975)
Molothrus ater, Brown-headed cowbird (Fain and Hyland 1962; Pence 1972b, 1975)
Sturnella magna, Eastern Meadowlark (Fain and Hyland 1962; Pence 1975)
Parulidae:
Mniotilta varia, Black-and-white Warbler (Knee *et al.* 2008)
Seiurus aurocapillus, Ovenbird (Fain and Hyland 1962; Pence 1975)
Seiurus noveboracensis, Northern Waterthrush (Fain and Hyland 1962; Pence 1975)
Passeridae:
Passer domesticus, House Sparrow (Fain and Hyland 1962; Pence 1975)
Tyrannidae:
Myiarchus crinitus, Great Crested Flycatcher (Pence 1972b, 1975)
Tyrannus melancholicus, Tropical Kingbird (Hyland and Moorhouse 1970)

Diagnostic characteristics:

- subapical ventral and ventrolateral setae of tarsi II - IV are minute spines, barely visible
- two pairs of setae in the dorsal opisthosomal unsclerotized integument
- paranal setae posterior to anal opening, and postanal seta absent

***Sternostoma laniorum* Fain, 1956** (Figs 89 a-b)

North American host records:

Laniidae:
Lanius ludovicianus, Loggerhead Shrike (Pence 1973b, 1975)
Turdidae:
Catharus ustulatus, Swainson's Thrush (Knee *et al.* 2008)

Diagnostic characteristics:

- subapical ventral and ventrolateral setae of tarsi II - IV are hook-like short spines
- two pairs of setae in the dorsal opisthosomal unsclerotized integument
- paranal setae posterior to anal opening, and postanal seta absent

***Sternostoma cryptorhynchum* Berlese and Trouessart, 1889a** (Figs 90 a-c)

North American host records:

Fringillidae:
Pinicola enucleator, Pine Grosbeak (Knee *et al.* 2008)

Diagnostic characteristics:

- subapical ventral and ventrolateral setae of tarsi II - IV are distally inflated symmetrical setae
- two pairs of setae in the dorsal opisthosomal unsclerotized integument
- paranal setae level with anal opening, and postanal seta absent

***Sternostoma loxiae* Fain, 1965** (Figs 91 a-c)

North American host records:

Parulidae:
Dendroica petechia, Yellow Warbler (Knee *et al.* 2008)
Turdidae:
Sialia currucoides, Mountain Bluebird (Knee *et al.* 2008)

Diagnostic characteristics:

- subapical ventral and ventrolateral setae of tarsi II - IV are distally inflated asymmetrical setae
- one pair of setae and one pair of pores in the dorsal opisthosomal unsclerotized integument
- paranal setae posterior to anal opening, and postanal seta absent

***Sternostoma sialiphilus* Hyland and Ford, 1961** (Figs 92 a-c)

North American host records:

Hirundinidae:
Riparia riparia, Sand Martin (Knee *et al.* 2008)
Turdidae:
Sialia sialis, Eastern Bluebird (Hyland 1961; Hyland and Ford 1961; Pence 1972b, 1975)

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Diagnostic characteristics:

- subapical ventral and ventrolateral setae of tarsi II - IV are distally inflated asymmetrical setae
- one pair of setae in the dorsal opisthosomal unsclerotized integument
- paranal setae posterior to anal opening, and paranal seta absent

***Ptilonyssus angrensis* (Castro, 1948)** (Figs 93 a-c)
Ptilonyssus (=*Rhinonyssus*) *angrensis* (Castro, 1948)

North American host records:

Hirundinidae:
Hirundo fulva, Cave Swallow (Pence 1975)
Hirundo pyrrhonota, Cliff Swallow (Pence 1975)
Progne subis, Purple Martin (Pence 1972d, 1975; Knee *et al.* 2008)
Tachycineta bicolor, Tree Swallow (Pence 1975)

Diagnostic characteristics:

- one dorsal shield, podosomal shield
- sternal shield absent
- posterior margin of podosomal shield with a medial lobe and lacking lateral lobes
- peritreme absent
- subapical ventral setal pair on tarsus IV are relatively short spikes proximally inflated
- seven or more pairs of ventral opisthosomal setae
- two pairs of mesolateral setae
- mesolateral setae all approximately equal in length, there are not two pairs of setae that are twice as long as another setal pair
- subposterior pair of dorsal podosomal setae are as long or almost as long as the longest mesolateral setae
- cribrum absent or unnoticeable
- paranal setae level with anal opening, paranal and postanal setae are equal or almost equal in length

Note:

Ptilonyssus species are typically characterized as having peritremes, the exceptions are
P. angrensis, P. vireonis, and *P. hoseini* (Fain and Aitken, 1967) all of which lack
peritremes. These three species are still considered to be *Ptilonyssus* species because
of the ventroterminal placement of the anus, and the terminal placement of the gnathosoma.

***Ptilonyssus coccothraustis* Fain and Bafort, 1963** (Figs 94 a-c)

North American host records:

Fringillidae:
Coccothraustes vespertinus, Evening Grosbeak (Knee *et al.* 2008)

Diagnostic characteristics:

- two dorsal shields, podosomal and fused opisthosomal and pygidial shields
- posterior margin of podosomal shield is straight, occasionally a slight medial lobe is present
- opisthosomal shield is longer than wide, but not twice as long as wide
- opisthosomal shield without lateral excavation
- posterior margin of opisthosomal shield is rounded
- anterior margin of opisthosomal shield is medially straight with anterolateral projections
- st1 st2 and st3 on the sternal shield
- subapical ventral setal pair on tarsus IV are relatively long, one strong spike and one filamentous spike
- six pairs of ventral opisthosomal setae
- four pairs of mesolateral setae
- mesolateral setae all approximately equal in length, there are not two pairs of setae that are twice as long as another setal pair
- subposterior pair of dorsal podosomal setae are as long or almost as long as the longest mesolateral setae
- ventral hypostomal setae large distally inflated bulbs
- paranal setae level with anal opening, paranal and postanal setae are unequal in length

***Ptilonyssus plesiotypicus* Knee, 2008** (Figs 95 a-c)

North American host records:

Fringillidae:
Carpodacus purpureus, Purple Finch (Knee *et al.* 2008)

Diagnostic characteristics:

- two dorsal shields, podosomal and fused opisthosomal and pygidial shields
- posterior margin of podosomal shield is slightly trilobed
- opisthosomal shield is longer than wide, but not twice as long as wide
- opisthosomal shield without lateral excavation
- posterior margin of opisthosomal shield is rounded
- anterior margin of opisthosomal shield is medially straight with anterolateral projections
- st1 st2 and st3 on the sternal shield
- subapical ventral setal pair on tarsus IV are relatively long strong spikes
- seven or more pairs of ventral opisthosomal setae
- four pairs of mesolateral setae
- mesolateral setae all approximately equal in length, there are not two pairs of setae that are twice as long as another setal pair

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- subposterior pair of dorsal podosomal setae are longer than mesolateral setae
- ventral hypostomal setae large distally inflated bulbs
- anal setae constricted proximally (within 1/3 of length from base) forming a long filamentous tip
- paranal setae level with anal opening, paranal and postanal setae are unequal in length

***Ptilonyssus callinectoides* (Brooks and Strandtmann, 1960)** (Figs 96 a-c)
Ptilonyssus (=*Tyranninyssus*) *callinectoides* (Brooks and Strandtmann, 1960)

North American host records:

Tyrannidae:
Myiarchus cinerascens, Ash-throated Flycatcher (Brooks and Strandtmann 1969; Pence 1975)
Myiarchus crinitus, Great Crested Flycatcher (Pence 1972d, 1973b, 1975; Knee *et al.* 2008)
Myiarchus tyrannulus, Brown-crested Flycatcher (Hyland and Moorhouse 1970)

Diagnostic characteristics:

- two dorsal shields, podosomal and fused opisthosomal and pygidial shields
- podosomal shield with lateral winglike processes
- posterior margin of podosomal shield is rounded
- opisthosomal shield is twice as long as wide
- lateral excavation of the posterior portion of the opisthosomal shield
- posterior margin of opisthosomal shield is rounded
- anterior margin of opisthosomal shield is straight
- st1 st2 and st3 on the sternal shield
- subapical ventral setal pair on tarsus IV are relatively long strong spikes with a rounded terminus
- four pairs of ventral opisthosomal setae
- two pairs of mesolateral setae
- mesolateral setae all approximately equal in length, there are not two pairs of setae that are twice as long as another setal pair
- subposterior pair of dorsal podosomal setae are as long or almost as long as the longest mesolateral setae
- dorsum of genu III with oblique row of four stout spine setae close together
- paranal setae level with anal opening, paranal and postanal setae are unequal in length

***Ptilonyssus vireonis* (Dusbabek, 1969)**
(Figs 97 a-c)
Ptilonyssus (=*Passeronyssus*) *vireonis* (Dusbabek, 1969)

North American host records:

Vireonidae:
Vireo olivaceus, Red-eyed Vireo (Pence 1972d, 1975; Knee *et al.* 2008)
Vireo solitarius, Solitary Vireo (Knee *et al.* 2008)

Diagnostic characteristics:

- two dorsal shields, podosomal and fused opisthosomal and pygidial shields
- peritreme absent
- posterior margin of podosomal shield with a medial lobe and lacking lateral lobes
- opisthosomal shield is almost as wide as long
- opisthosomal shield laterally excavated medially with excavation extending posteriorly
- posterior margin of opisthosomal shield is rounded
- anterior margin of opisthosomal shield with a medial lobe and lacking lateral lobes
- st1 on with st2 and st3 off the sternal shield
- subapical ventral setal pair on tarsus IV are long heavyset inflated spikes
- six pairs of ventral opisthosomal setae
- three pairs of mesolateral setae
- mesolateral setae all approximately equal in length, there are not two pairs of setae that are twice as long as another setal pair
- subposterior pair of dorsal podosomal setae are as long or almost as long as the longest mesolateral setae
- paranal setae anterior to anal opening, paranal and postanal setae are unequal in length

Note:

Ptilonyssus species are typically characterized as having peritremes, the exceptions are *P. angrensis, P. vireonis*, and *P. hoseini* (Fain and Aitken, 1967) all of which lack peritremes. These three species are still considered to be *Ptilonyssus* species because of the ventroterminal placement of the anus, and the terminal placement of the gnathosoma.

***Ptilonyssus tyrannus* (Brooks and Strandtmann, 1960)** (Figs 98 a-c)
Ptilonyssus (=*Tyranninyssus*) *tyrannus* (Brooks and Strandtmann, 1960)

North American host records:

Tyrannidae:
Contopus borealis, Olive-sided Flycatcher (Brooks and Strandtmann 1969; Hyland and Moorhouse 1970; Pence 1975)
Contopus sordidulus, Western Wood-Peewee (Brooks and Strandtmann 1969; Hyland and Moorhouse 1970; Pence 1975; Knee *et al.* 2008)
Contopus virens, Eastern Wood-Peewee (Pence 1972d, 1975)
Empidonax alnorum, Alder Flycatcher (Hyland and Moorhouse 1970; Pence 1975)

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Empidonax flaviventris, Yellow-bellied Flycatcher (Hyland and Moorhouse 1970; Pence 1975)
Empidonax minimus, Least Flycatcher (Brooks and Strandtmann 1969; Hyland and Moorhouse 1970; Pence 1975; Spicer 1987)
Empidonax traillii, Willow Flycatcher (Hyland and Moorhouse 1970; Pence 1975)
Empidonax virescens, Acadian Flycatcher (Pence 1972d, 1975)
Sayornis phoebe, Eastern Phoebe (Pence 1972d, 1975; Knee *et al.* 2008)
Sayornis saya, Say's Phoebe (Brooks and Strandtmann 1969; Hyland and Moorhouse 1970; Pence 1975)
Tyrannus melancholicus, Tropical Kingbird (Hyland and Moorhouse 1970)

Diagnostic characteristics:

- two dorsal shields, podosomal and fused opisthosomal and pygidial shields
- posterior margin of podosomal shield with a medial lobe and lacking lateral lobes
- opisthosomal shield is twice as long as wide
- lateral excavation of the posterior portion of the opisthosomal shield
- posterior margin of opisthosomal shield is rounded
- anterior margin of opisthosomal shield is straight
- st1 st2 and st3 off the sternal shield
- subapical ventral setal pair on tarsus IV are relatively long strong spikes with a rounded terminus
- six pairs of ventral opisthosomal setae
- three pairs of mesolateral setae
- mesolateral setae all approximately equal in length, there are not two pairs of setae that are twice as long as another setal pair
- subposterior pair of dorsal podosomal setae are as long or almost as long as the longest mesolateral setae
- dorsum of genu III with oblique row of four stout spine setae close together
- paranal setae anterior to anal opening, paranal and postanal setae are unequal in length

***Ptilonyssus hirsti* (Castro & Periera, 1947)** (Figs 99 a-c)
Ptilonyssus (=*Neonyssus*) *hirsti* (Castro & Periera, 1947)

North American host records:

Passeridae
Passer domesticus, House Sparrow (Porter and Strandtmann 1952; Fain and Hyland 1963; Wilson 1964; Pence 1975; Knee *et al.* 2008)

Diagnostic characteristics:

- two dorsal shields, podosomal and fused opisthosomal and pygidial shields
- posterior margin of podosomal shield is straight
- opisthosomal shield is twice as long as wide
- opisthosomal shield without lateral excavation
- posterior margin of opisthosomal shield is rounded, occasionally it is invaginated forming an inverted V indent
- anterior margin of opisthosomal shield is straight
- st1 st2 and st3 off the sternal shield
- subapical ventral setal pair on tarsus IV are relatively long filamentous spikes with long flexible tips
- six pairs of ventral opisthosomal setae
- four pairs of mesolateral setae
- mesolateral setae all approximately equal in length, there are not two pairs of setae that are twice as long as another setal pair
- minute subposterior pair of dorsal podosomal setae are as long or almost as long as the longest mesolateral setae
- paranal setae posterior to anal opening, paranal and postanal setae are unequal in length

***Ptilonyssus icteridius* (Strandtmann and Furman, 1956)** (Figs 100 a-c)
Ptilonyssus (=*Paraneonyssus*) *icteridius* (Strandtmann and Furman, 1956)

North American host records:

Emberizidae:
Piranga ludoviciana, Western Tanager (Strandtmann and Furman 1956; Pence 1975)
Spiza americana, Dickcissel (Spicer 1977b, 1987)
Sturnella magna, Eastern Meadowlark (Spicer 1987)
Icteridae:
Agelaius phoeniceus, Red-winged Blackbird (Strandtmann and Furman 1956; Wilson 1964; Pence 1972d, 1975; Knee *et al.* 2008)
Agelaius tricolor, Tricolored Blackbird (Strandtmann and Furman 1956)
Euphagus carolinus, Rusty Blackbird (Pence 1972d, 1975)
Euphagus cyanocephalus, Brewer's Blackbird (Strandtmann and Furman 1956; Pence 1972d, 1975; Knee *et al.* 2008)
Icterus galbula, Baltimore Oriole (Pence 1972d, 1975; Knee *et al.* 2008)
Molothrus ater, Brown-headed cowbird (Strandtmann and Furman 1956; Wilson 1964; Pence 1972d, 1975; Knee *et al.* 2008)
Quiscalus quiscula, Common Grackle (Strandtmann and Furman 1956; Wilson 1964; Pence 1972d, 1975; Knee *et al.* 2008)

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Sturnella magna, Eastern Meadowlark (Strandtmann and Furman 1956; Pence 1972d, 1975)
Sturnella neglecta, Western Meadowlark (Spicer 1978)
Xanthocephalus xanthocephalus, Yellow-headed Blackbird (Strandtmann and Furman 1956; Pence 1975)
Tyrannidae:
Myiarchus crinitus, Great Crested Flycatcher (Knee *et al.* 2008)

Diagnostic characteristics:

- two dorsal shields, podosomal and fused opisthosomal and pygidial shields
- posterior margin of podosomal shield is straight, occasionally a slight medial lobe is present
- opisthosomal shield is longer than wide, but not twice as long as wide
- opisthosomal shield without lateral excavation
- posterior margin of opisthosomal shield is invaginated forming an inverted V indent, occasionally it is rounded
- anterior margin of opisthosomal shield is straight
- st1 st2 and st3 off the sternal shield
- subapical ventral setal pair on tarsus IV are long heavyset inflated spikes
- six pairs of ventral opisthosomal setae
- four pairs of mesolateral setae
- mesolateral setae all approximately equal in length, there are not two pairs of setae that are twice as long as another setal pair
- subposterior pair of dorsal podosomal setae are as long or almost as long as the longest mesolateral setae
- paranal setae level with anal opening, paranal and postanal setae are equal or almost equal in length

***Ptilonyssus morofskyi* Hyland, 1962** (Figs 101 a-c)

North American host records:

Emberizidae:
Ammodramus maritimus, Seaside Sparrow (Pence 1972d, 1975)
Calamospiza melanocorys, Lark Bunting (Spicer 1978)
Calcarius ornatus, Chestnut-collared Longspur (Spicer 1978)
Dendroica coronata, Yellow-rumped Warbler (Spicer 1987)
Junco hyemalis, Dark-eyed Junco (Pence 1975; Spicer 1978; Knee *et al.* 2008)
Melospiza georgiana, Swamp Sparrow (Pence 1972d, 1975)
Melospiza melodia, Song Sparrow (Pence 1975)
Passerculus sandwichensis, Savannah Sparrow (Hyland 1962; Pence 1975)
Passerella iliaca, Fox Sparrow (Pence 1975; Knee *et al.* 2008)
Pipilo erythrophthalmus, Eastern Towhee (Pence 1972d, 1975)
Plectrophenax nivalis, Snow Bunting (Knee *et al.* 2008)
Pooecetes gramineus, Vesper Sparrow (Pence 1972d, 1975)
Spizella pusilla, Field Sparrow (Pence 1975)
Zonotrichia albicollis, White-throated Sparrow (Pence 1972d, 1975; Spicer 1987)
Zonotrichia leucophrys, White-crowned Sparrow (Spicer 1978)
Zonotrichia querula, Harris's Sparrow (Spicer 1977a, 1987)
Fringillidae:
Carduelis flammea, Common Redpoll (Knee *et al.* 2008)
Carduelis tristis, American Goldfinch (Hyland 1962; Pence 1975; Knee *et al.* 2008)
Parulidae:
Dendroica coronata, Yellow-rumped Warbler (Pence 1972d, 1975)
Dendroica pinus, Pine Warbler (Pence 1972d, 1975; Knee *et al.* 2008)
Geothlypis trichas, Common Yellowthroat (Pence 1972d, 1975)
Seiurus motacilla, Louisiana Waterthrush (Pence 1972d, 1975)
Setophaga ruticilla, American Redstart (Knee *et al.* 2008)
Vermivora peregrina, Tennessee Warbler (Knee *et al.* 2008)
Wilsonia pusilla, Wilson's Warbler (Spicer 1978)

Diagnostic characteristics:

- two dorsal shields, podosomal and fused opisthosomal and pygidial shields
- sternal shield wider than long
- posterior margin of podosomal shield is straight
- opisthosomal shield is longer than wide, but not twice as long as wide
- lateral excavation of the posterior portion of the opisthosomal shield
- posterior margin of opisthosomal shield is rounded
- anterior margin of opisthosomal shield is either straight, or medially straight with anterolateral projections
- st1 st2 and st3 on the sternal shield
- subapical ventral setal pair on tarsus IV are one short filamentous spike and one short partially inflated bulb
- four or five pairs of ventral opisthosomal setae
- three pairs of mesolateral setae

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- mesolateral setae all approximately equal in length, there are not two pairs of setae that are twice as long as another setal pair
- subposterior pair of dorsal podosomal setae are as long or almost as long as the longest mesolateral setae
- paranal setae level with anal opening, paranal and postanal setae are unequal in length

***Ptilonyssus nivalis* Knee, 2008** (Figs 102 a-c)

North American host records:

Emberizidae:
Plectrophenax nivalis, Snow Bunting (Knee *et al.* 2008)

Diagnostic characteristics:

- two dorsal shields, podosomal and fused opisthosomal and pygidial shields
- posterior margin of podosomal shield is trilobed
- opisthosomal shield is longer than wide, but not twice as long as wide
- lateral excavation of the posterior portion of the opisthosomal shield
- posterior margin of opisthosomal shield is invaginated forming an inverted V indent
- anterior margin of opisthosomal shield is straight
- st1 st2 and st3 on the sternal shield
- subapical ventral setal pair on tarsus IV are relatively long, one strong spike and one filamentous spike
- six pairs of ventral opisthosomal setae
- three pairs of mesolateral setae
- mesolateral setae all approximately equal in length, there are not two pairs of setae that are twice as long as another setal pair
- subposterior pair of dorsal podosomal setae are less than half the length of the longest mesolateral setae
- paranal setae anterior to anal opening, paranal and postanal setae are unequal in length

***Ptilonyssus pirangae* (Cerny, 1969)** (Figs 103 a-c)
Ptilonyssus (=*Neonyssus*) *pirangae* (Cerny, 1969)

North American host records:

Emberizidae:
Piranga ludoviciana, Western Tanager (Knee *et al.* 2008)
Piranga rubra, Summer Tanager (Pence 1972d, 1975)
Paridae:
Parus bicolor, Tufted Titmouse (Pence 1972d, 1975)

Diagnostic characteristics:

- two dorsal shields, podosomal and fused opisthosomal and pygidial shields
- posterior margin of podosomal shield is straight
- opisthosomal shield is longer than wide, but not twice as long as wide
- lateral excavation of the posterior portion of the opisthosomal shield
- posterior margin of opisthosomal shield is invaginated forming an inverted V indent
- anterior margin of opisthosomal shield is straight
- st1 st2 and st3 on the sternal shield
- subapical ventral setal pair on tarsus IV are relatively long strong spikes
- five pairs of ventral opisthosomal setae
- four pairs of mesolateral setae
- mesolateral setae all approximately equal in length, there are not two pairs of setae that are twice as long as another setal pair
- subposterior pair of dorsal podosomal setae are less than half the length of the longest mesolateral setae
- paranal setae anterior to anal opening, paranal and postanal setae are equal or almost equal in length

***Ptilonyssus carduelis* Fain, 1962** (Figs 104 a-c)

North American host records:

Fringillidae:
Carduelis flammea, Common Redpoll (Wilson and Haas 1980; Knee *et al.* 2008)
Loxia leucoptera, White-winged Crossbill (Knee *et al.* 2008)

Diagnostic characteristics:

- two dorsal shields, podosomal and fused opisthosomal and pygidial shields
- posterior margin of podosomal shield is trilobed
- opisthosomal shield is longer than wide, but not twice as long as wide
- opisthosomal shield without lateral excavation
- posterior margin of opisthosomal shield is rounded, occasionally it is invaginated forming an inverted V indent
- anterior margin of opisthosomal shield is medially straight with anterolateral projections
- st1 st2 and st3 on the sternal shield
- subapical ventral setal pair on tarsus IV are relatively long strong spikes
- five pairs of ventral opisthosomal setae
- four pairs of mesolateral setae
- mesolateral setae all approximately equal in length, there are not two pairs of setae that are twice as long as another setal pair
- subposterior pair of dorsal podosomal setae are as long or almost as long as the longest mesolateral setae
- paranal setae level with anal opening, paranal and postanal setae are almost equal in length

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***Ptilonyssus pinicola* Knee, 2008** (Figs 105 a-c)

North American host records:

Fringillidae:
Pinicola enucleator, Pine Grosbeak (Knee *et al.* 2008)

Diagnostic characteristics:

- two dorsal shields, podosomal and fused opisthosomal and pygidial shields
- posterior margin of podosomal shield is trilobed
- opisthosomal shield is longer than wide, but not twice as long as wide
- opisthosomal shield without lateral excavation
- posterior margin of opisthosomal shield is rounded
- anterior margin of opisthosomal shield is medially straight with anterolateral projections
- st1 st2 and st3 on the sternal shield
- subapical ventral setal pair on tarsus IV are relatively long strong spikes
- six pairs of ventral opisthosomal setae
- four pairs of mesolateral setae
- mesolateral setae all approximately equal in length, there are not two pairs of setae that are twice as long as another setal pair
- subposterior pair of dorsal podosomal setae are longer than mesolateral setae
- paranal setae level with anal opening, paranal and postanal setae are unequal in length

***Ptilonyssus perisorei* George, 1961** (Figs 106 a-c)

North American host records:

Corvidae:
Aphelocoma coerulescens, Florida Scrub-jay (Spicer 1978)
Cyanocitta stelleri, Stellar's Jay (George 1961; Pence 1975)
Perisoreus canadensis, Gray Jay (George 1961; Pence 1975; Wilson and Haas 1980; Knee *et al.* 2008)

Diagnostic characteristics:

- two dorsal shields, podosomal and pygidial shields
- posterior margin of podosomal shield is trilobed
- poorly defined sternal shield
- subapical ventral setal pair on tarsus IV are relatively long strong spikes with a rounded terminus
- four pairs of ventral opisthosomal setae
- three pairs of mesolateral setae
- mesolateral setae all approximately equal in length, there are not two pairs of setae that are twice as long as another setal pair
- subposterior pair of dorsal podosomal setae are as long or almost as long as the longest mesolateral setae
- long seta with frayed tip dorsally on tarsus I apical margin
- paranal setae posterior to anal opening, and postanal seta absent
- pygidial shield is sometimes entire and sometimes in two fragments with subposterior setal pair on the fragments

***Ptilonyssus echinatus* Berlese & Trouessart, 1889b** (Figs 107 a-c)

North American host records:

Hirundinidae:
Hirundo pyrrhonota, Cliff Swallow (George 1961; Pence 1975; Spicer 1987; Knee *et al.* 2008)
Hirundo rustica, Barn Swallow (George 1961; Pence 1972c, 1975; Spicer 1987; Knee *et al.* 2008)
Riparia riparia, Sand Martin (Wilson 1964; Pence 1975)
Tachycineta bicolor, Tree Swallow (Pence 1975; Knee *et al.* 2008)

Diagnostic characteristics:

- two dorsal shields, podosomal and pygidial shields
- genital shield arrow-shaped, pointed terminus, 10 times longer than wide
- pygidial shield in two fragments with subposterior setal pair on the fragments
- sternal shield absent
- posterior margin of podosomal shield either medially straight with lateral lobes, or trilobed, shield highly reduced
- subapical ventral setal pair on tarsus IV are relatively long strong spikes
- seven or more pairs of ventral opisthosomal setae
- at least five pairs of mesolateral setae
- mesolateral setae all approximately equal in length, there are not two pairs of setae that are twice as long as another setal pair
- subposterior pair of dorsal podosomal setae are as long or almost as long as the longest mesolateral setae
- paranal setae posterior to anal opening, paranal and postanal setae are equal or almost equal in length

***Ptilonyssus cerchneis* Fain, 1957** (Figs 108 a-c)

North American host records:

Falconidae:
Falco sparverius, American Kestrel (Strandtmann 1962; Pence 1975; Knee *et al.* 2008)

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Diagnostic characteristics:

- two dorsal shields, podosomal and pygidial shields
- pygidial shield in two fragments without subposterior setal pair on the fragments
- posterior margin of podosomal shield is trilobed
- dorsal opisthosoma with narrow area of thickened cuticle
- serrated deutosternal teeth in a single file
- st1 on with st2 and st3 off the sternal shield
- subapical ventral setal pair on tarsus IV are relatively long strong spikes
- six pairs of ventral opisthosomal setae
- three pairs of mesolateral setae
- subposterior pair of dorsal podosomal setae are longer than the longest mesolateral setae
- paranal setae posterior to anal opening, postanal seta absent

***Ptilonyssus troglodytis* Fain, 1964** (Figs 109 a-c)

North American host records:

Troglodytidae:
Troglodytes troglodytes, Winter Wren (Knee *et al.* 2008)

Diagnostic characteristics:

- two dorsal shields, podosomal and pygidial shields
- pygidial shield in two fragments with subposterior setal pair on the fragments
- posterior margin of podosomal shield medially straight with lateral lobes, shield highly reduced
- st1 on sternal shield, st2 and st3 off shield
- subapical ventral setal pair on tarsus IV are relatively long strong spikes
- six pairs of ventral opisthosomal setae
- six pairs of mesolateral setae
- mesolateral setae all approximately equal in length, there are not two pairs of setae that are twice as long as another setal pair
- subposterior pair of dorsal podosomal setae are half as long as the longest mesolateral setae
- paranal setae level with anal opening, paranal and postanal setae are equal or almost equal in length

***Ptilonyssus nudus* Berlese & Trouessart, 1889a** (Figs 110 a-c)

North American host records:

Hirundinidae:
Hirundo rustica, Barn Swallow (Pence 1975)
Riparia riparia, Sand Martin (Pence 1975)
Paridae:
Parus atricapillus, Black-capped Chickadee (Pence 1975)
Passeridae:
Passer domesticus, House Sparrow (Porter and Strandtmann 1952; George 1961; Wilson 1964; Pence 1975; Knee *et al.* 2008)
Sturnidae:
Sturnus vulgaris, Common Starling (Pence 1975)

Diagnostic characteristics:

- two dorsal shields, podosomal and pygidial shields
- posterior margin of podosomal shield is rounded
- st1 st2 and st3 on the sternal shield
- subapical ventral setal pair on tarsus IV are relatively long strong spikes
- seven pairs of ventral opisthosomal setae
- three pairs of mesolateral setae
- mesolateral setae all approximately equal in length, there are not two pairs of setae that are twice as long as another setal pair
- subposterior pair of dorsal podosomal setae are less than half the length of the longest mesolateral setae
- paranal setae posterior to anal opening, paranal and postanal setae are equal or almost equal in length

***Ptilonyssus bombycillae* Fain, 1972** (Figs 111 a-c)

North American host records:

Bombycillidae:
Bombycilla cedrorum, Cedar Waxwing (Pence 1973a, 1975; Knee *et al.* 2008)
Bombycilla garrulus, Bohemian Waxwing (Spicer 1978; Canadian National Collection of Insects and Arachnids; Knee *et al.* 2008)

Diagnostic characteristics:

- two dorsal shields, podosomal and pygidial shields
- posterior margin of podosomal shield is trilobed
- st1 on sternal shield, st2 and st3 off shield
- subapical ventral setal pair on tarsus IV are relatively long strong spikes
- six pairs of ventral opisthosomal setae
- five pairs of mesolateral setae
- mesolateral setae all approximately equal in length, there are not two pairs of setae that are twice as long as another setal pair
- subposterior pair of dorsal podosomal setae are as long or almost as long as the longest mesolateral setae
- paranal setae posterior to anal opening, paranal and postanal setae are equal or almost equal in length

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***Ptilonyssus calvaria* Knee, 2008** (Figs 112 a-c)

North American host records:

Emberizidae:
Spizella passerina, Chipping Sparrow (Knee *et al.* 2008)

Diagnostic characteristics:

- two dorsal shields, podosomal and pygidial shields
- posterior margin of podosomal shield is trilobed
- st1 on with st2 and st3 off the sternal shield
- subapical ventral setal pair on tarsus IV are relatively long strong spikes
- six pairs of ventral opisthosomal setae
- five pairs of mesolateral setae
- mesolateral setae all approximately equal in length, there are not two pairs of setae that are twice as long as another setal pair
- subposterior pair of dorsal podosomal setae are half as long as the longest mesolateral setae
- cribrum does not extend to posterior end of anal shield
- paranal setae level with anal opening, paranal and postanal setae are unequal in length

***Ptilonyssus euroturdi* Fain & Hyland, 1963**
(Figs 113 a-c)

North American host records:

Mimidae:
Dumetella carolinensis, Gray Catbird (Pence 1972c, 1975; Knee *et al.* 2008)
Turdidae:
Turdus migratorius, American Robin (Spicer 1987)
Catharus mustelinus, Wood Thrush (Pence 1972c, 1975)

Diagnostic characteristics:

- two dorsal shields, podosomal and pygidial shields
- posterior margin of podosomal shield either medially straight with lateral lobes, or trilobed
- st1 on with st2 and st3 off the sternal shield
- subapical ventral setal pair on tarsus IV are relatively long strong spikes
- six pairs of ventral opisthosomal setae
- six pairs of mesolateral setae
- at least two pairs of mesolateral setae twice as long as other mesolateral setae
- subposterior pair of dorsal podosomal setae are half as long as the longest mesolateral setae
- paranal setae level with anal opening, paranal and postanal setae are unequal in length

***Ptilonyssus acrocephali* Fain, 1964** (Figs 114 a-c)

North American host records:

Regulidae:
Regulus calendula, Ruby-crowned Kinglet (Pence 1972c, 1975; Spicer 1987; Knee *et al.* 2008)

Diagnostic characteristics:

- two dorsal shields, podosomal and pygidial shields
- posterior margin of podosomal shield medially straight with lateral lobes, shield highly reduced
- st1 on sternal shield, st2 and st3 off shield
- subapical ventral setal pair on tarsus IV are relatively long strong spikes
- six pairs of ventral opisthosomal setae
- five pairs of mesolateral setae
- at least two pairs of mesolateral setae twice as long as other mesolateral setae
- subposterior pair of dorsal podosomal setae are as long or almost as long as the longest mesolateral setae
- paranal setae level with anal opening, paranal and postanal setae are equal or almost equal in length

***Ptilonyssus japuibensis* Castro, 1948**
(Figs 115 a-c)

North American host records:

Emberizidae:
Amphispiza bilineata, Black-throated Sparrow (Pence 1975)
Calamospiza melanocorys, Lark Bunting (Pence 1975)
Chondestes grammacus, Lark Sparrow (Pence 1975)
Melospiza georgiana, Swamp Sparrow (Pence 1972c, 1975)
Melospiza lincolnii, Lincoln's Sparrow (Pence 1975)
Passerculus sandwichensis, Savannah Sparrow (Pence 1975)
Passerina cyanea, Indigo Bunting (Pence 1975)
Pheucticus ludovicianus, Rose-breasted Grosbeak (Knee *et al.* 2008)
Pipilo erythrophthalmus, Eastern Towhee (Pence 1972c, 1973b, 1975)
Pipilo fuscus, Canyon Towhee (Pence 1975)
Pooecetes gramineus, Vesper Sparrow (Pence 1975)
Spizella pallida, Clay-colored Sparrow (Knee *et al.* 2008)
Spizella passerina, Chipping Sparrow (Pence 1975)
Spizella pusilla, Field Sparrow (Pence 1972c, 1975)
Zonotrichia albicollis, White-throated Sparrow (Pence 1972c, 1975; Knee *et al.* 2008)
Icteridae:

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Molothrus ater, Brown-headed Cowbird (Spicer 1987; Knee *et al.* 2008)
Parulidae:
Dendroica coronata, Yellow-rumped Warbler (George 1961; Knee *et al.* 2008)
Dendroica magnolia, Magnolia Warbler (Pence 1975; Knee *et al.* 2008)
Dendroica petechia, Yellow Warbler (Pence 1975; Knee *et al.* 2008)
Dendroica pinus, Pine Warbler (George 1961; Knee *et al.* 2008)
Dendroica striata, Blackpoll Warbler (Pence and Casto 1976; Knee *et al.* 2008)
Dendroica tigrina, Cape May Warbler (Pence 1975; Knee *et al.* 2008)
Mniotilta varia, Black-and-white Warbler (George 1961)
Oporornis tolmiei, MacGillivray's Warbler (George 1961)
Seiurus aurocapillus, Ovenbird (Pence and Casto 1976; Knee *et al.* 2008)
Seiurus noveboracensis, Northern Waterthrush (Knee *et al.* 2008)
Setophaga ruticilla, American Redstart (Pence 1975; Knee *et al.* 2008)
Vermivora peregrina, Tennessee Warbler (Knee *et al.* 2008)
Wilsonia canadensis, Canada Warbler (Knee *et al.* 2008)
Wilsonia citrina, Hooded Warbler (George 1961)
Wilsonia pusilla, Wilson's Warbler (George 1961)
Tyrannidae:
Empidonax alnorum, Alder Flycatcher (Hyland and Moorhouse 1970)

Diagnostic characteristics:

- two dorsal shields, podosomal and pygidial shields
- posterior margin of podosomal shield is trilobed
- st1 st2 and st3 off the sternal shield
- subapical ventral setal pair on tarsus IV are relatively long strong spikes
- six pairs of ventral opisthosomal setae
- four pairs of mesolateral setae
- at least two pairs of mesolateral setae twice as long as other mesolateral setae
- subposterior pair of dorsal podosomal setae are less than half the length of the longest mesolateral setae
- paranal setae level with anal opening, paranal and postanal setae are equal or almost equal in length

Note:

Ptilonyssus japuibensis and *P. sairae* are members of the "*sairae*" species complex. The species boundaries between the members of the "*sairae*" complex are very indistinct.

***Ptilonyssus sairae* Castro, 1948** (Figs 116 a-c)

North American host records:

Emberizidae:
Aimophila ruficeps, Rufous-crowned Sparrow (Spicer 1977a, 1987)
Ammodramus savannarum, Grasshopper Sparrow (Spicer 1977a, 1987)
Amphispiza bilineata, Black-throated Sparrow (George 1961; Pence and Casto 1976)
Calamospiza melanocorys, Lark Bunting (George 1961)
Chondestes grammacus, Lark Sparrow (George 1961; Spicer 1987)
Guiraca caerulea, Blue Grosbeak (Spicer 1978)
Junco hyemalis, Dark-eyed Junco (Spicer 1978, 1987)
Melospiza lincolnii, Lincoln's Sparrow (George 1961)
Melospiza melodia, Song Sparrow (Spicer 1987)
Molothrus ater, Brown-headed Cowbird (Spicer 1987)
Passerculus sandwichensis, Savannah Sparrow (George 1961; Spicer 1987)
Passerina ciris, Painted Bunting (Spicer 1977a, 1987)
Passerina cyanea, Indigo Bunting (George 1961)
Pheucticus melanocephalus, Black-headed Grosbeak (Pence and Casto 1976)
Pipilo chlorurus, Green-tailed Towhee (Spicer 1978)
Pipilo erythrophthalmus, Eastern Towhee (George 1961)
Pipilo fuscus, Canyon Towhee (George 1961; Pence and Casto 1976)
Piranga rubra, Summer Tanager (Pence 1975; Pence and Casto 1976)
Pooecetes gramineus, Vesper Sparrow (George 1961; Pence 1975; Spicer 1987)
Spizella passerina, Chipping Sparrow (George 1961; Spicer 1987)
Spizella pusilla, Field Sparrow (Spicer 1987)
Vermivora celata, Orange-crowned Warbler (Spicer 1987)
Vermivora ruficapilla, Nashville Warbler (Spicer 1987)
Wilsonia pusilla, Wilson's Warbler (Spicer 1987)
Zonotrichia querula, Harris's Sparrow (Spicer 1977a, 1987)
Fringillidae:
Carduelis tristis, American Goldfinch (Spicer 1977a, 1987)
Icteridae:
Dolichonyx oryzivorus, Bobolink (Pence 1975, Pence and Casto 1976)
Euphagus cyanocephalus, Brewer's Blackbird (Spicer 1978)

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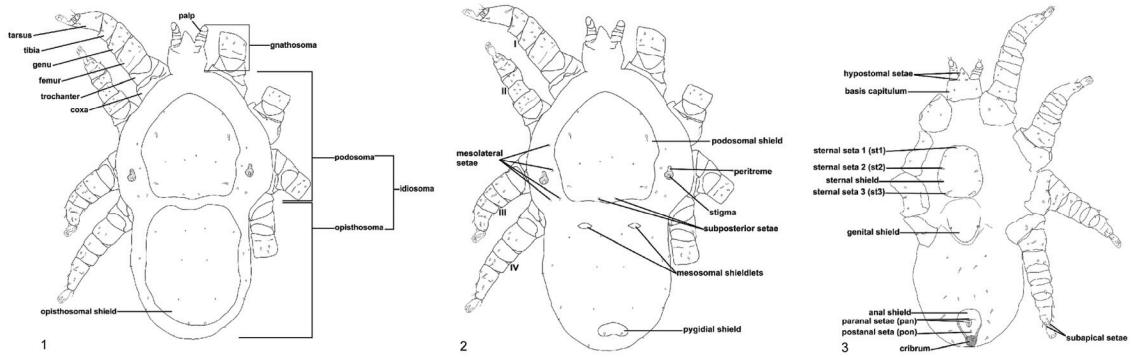
Muscicapidae:
Polioptila albiloris, White-lored Gnatcatcher (Spicer 1987)
Paridae:
Parus carolinensis, Carolina Chickadee (Pence 1972c, 1975)
Parulidae:
Dendroica caerulescens, Black-throated Blue Warbler (Pence and Casto 1976)
Dendroica cerulea, Cerulean Warbler (Pence and Casto 1976)
Dendroica coronata, Yellow-rumped Warbler (Pence 1972c, 1975; Wilson and Haas 1980; Spicer 1987)
Dendroica magnolia, Magnolia Warbler (Pence 1972c, 1975)
Dendroica petechia, Yellow Warbler (Spicer 1977b, 1987)
Dendroica pinus, Pine Warbler (Pence 1972c, 1973b, 1975)
Dendroica striata, Blackpoll Warbler (Pence and Casto 1976)
Dendroica tigrina, Cape May Warbler (Pence and Casto 1976)
Geothlypis trichas, Common Yellowthroat (Pence and Casto 1976; Knee *et al.* 2008)
Limnothlypis swainsonii, Swainson's Warbler (Pence and Casto 1976)
Mniotilta varia, Black-and-white Warbler (Pence 1972c, 1975; Knee et al. 2008)
Oporornis tolmiei, MacGillivray's Warbler (Pence 1975)
Parula americana, Northern Parula (Pence 1972c, 1975; Pence and Casto 1976)
Protonotaria citrea, Prothonotary Warbler (Pence 1972c, 1975)
Seiurus aurocapillus, Ovenbird (Pence and Casto 1976)
Setophaga ruticilla, American Redstart (Pence 1972c, 1975)
Vermivora celata, Orange-crowned Warbler (Spicer 1977a)
Vermivora ruficapilla, Nashville Warbler (Spicer 1977a)
Wilsonia citrina, Hooded Warbler (Pence 1975)
Wilsonia pusilla, Wilson's Warbler (Pence 1975)
Polioptilidae:
Polioptila albiloris, White-lored Gnatcatcher (Spicer 1977b)
Tyrannidae:
Empidonax flaviventris, Yellow-bellied Flycatcher (Pence 1972c, 1975)

Diagnostic characteristics:

- two dorsal shields, podosomal and pygidial shields
- posterior margin of podosomal shield is straight
- st1 st2 and st3 off the sternal shield
- subapical ventral setal pair on tarsus IV are relatively long strong spikes
- six pairs of ventral opisthosomal setae
- five pairs of mesolateral setae
- at least two pairs of mesolateral setae twice as long as other mesolateral setae
- subposterior pair of dorsal podosomal setae are less than half the length of the longest mesolateral setae
- paranal setae level with anal opening, paranal and postanal setae are equal or almost equal in length

Note:

Ptilonyssus sairae and *P. japuibensis* are members of the "sairae" species complex. The species boundaries between the members of the "sairae" complex are very indistinct.



Figs. 1-3: 1, Generalized rhinonyssid female, dorsal aspect, showing major body regions. 2, Generalized rhinonyssid female, dorsal aspect, details of shields and setation. 3, Generalized rhinonyssid female ventral aspect.

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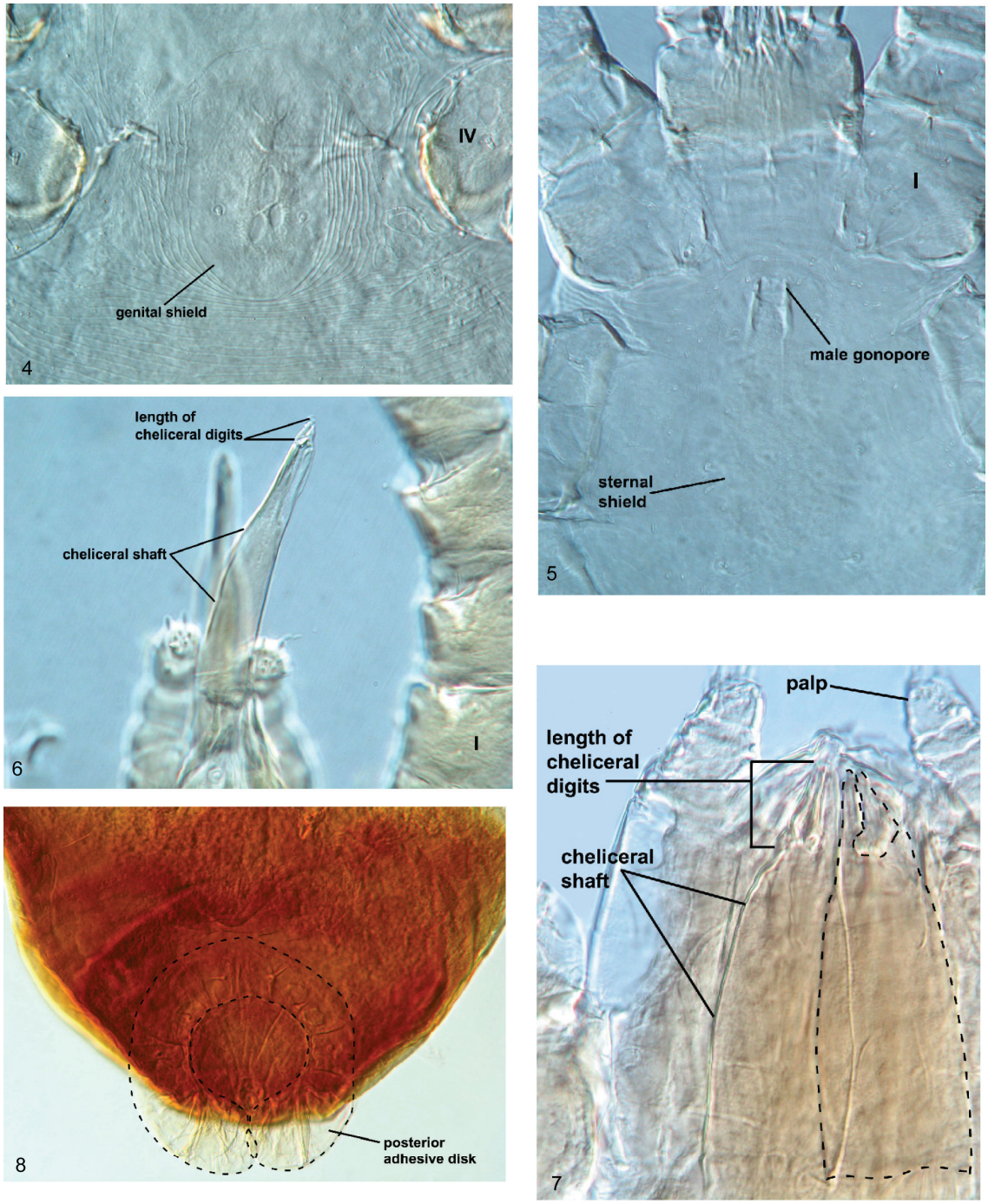
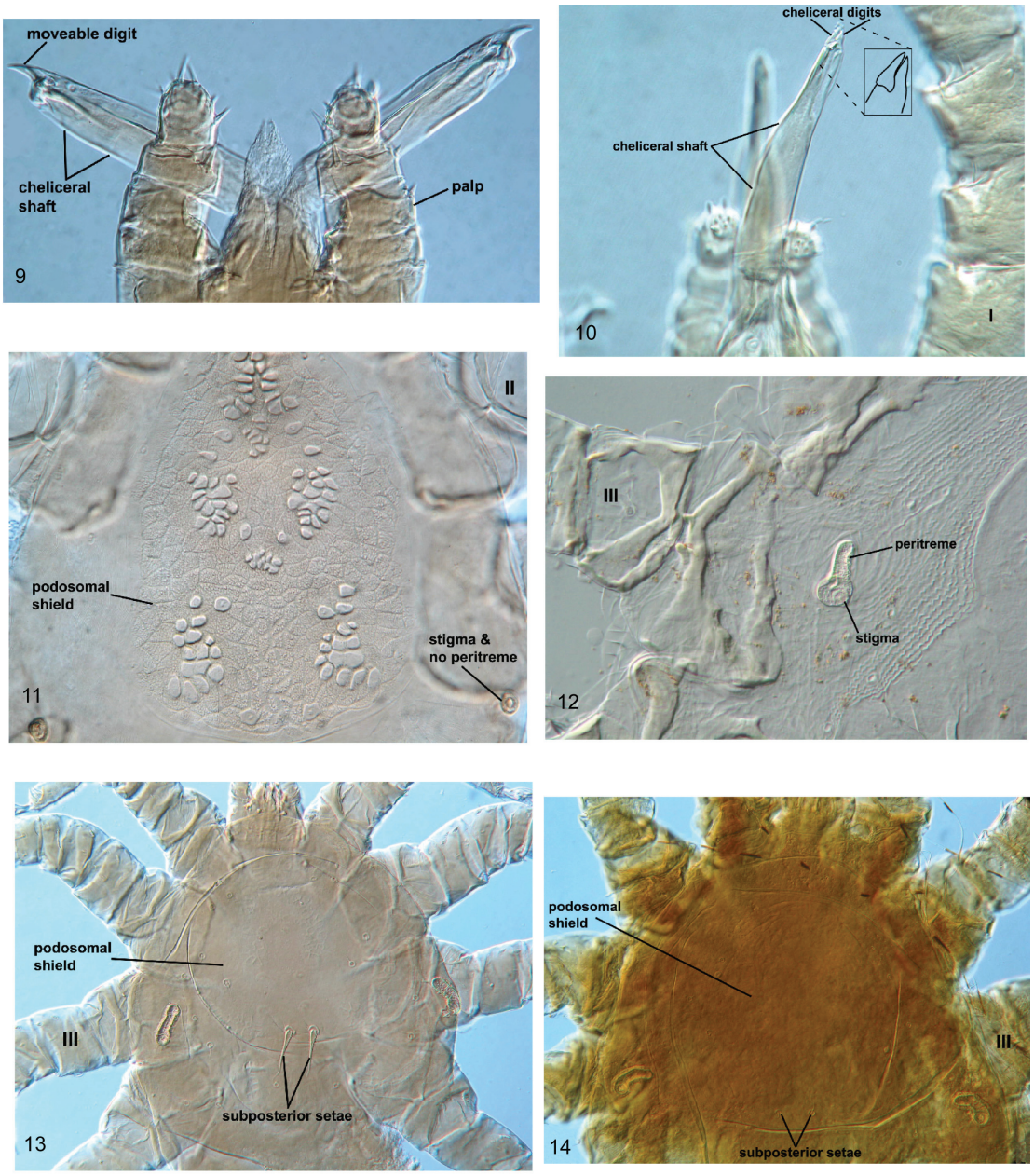


Figures 4-8. 4, *Ptilonyssus tyrannus* female genital shield. 5, *P. icteridius* male gonopore. 6, *P. tyrannus* chelicera. 7, *Rhinonyssus rhinolethrum* chelicerae. 8, *Rallinyssus caudistigmus* posterior adhesive disk.

doi:10.3752/cjai.2010.09



Figures 9-14. 9, *Rhinoecius grandis* chelicerae. 10, *Ptilonyssus tyrannus* chelicerae. 11, *Sternostoma porteri* prodorsal region. 12, *P. japuibensis* stigma. 13, *R. aegolii* podosomal shield with subposterior setae. 14, *R. brikinboricus* podosomal shield with subposterior setae.

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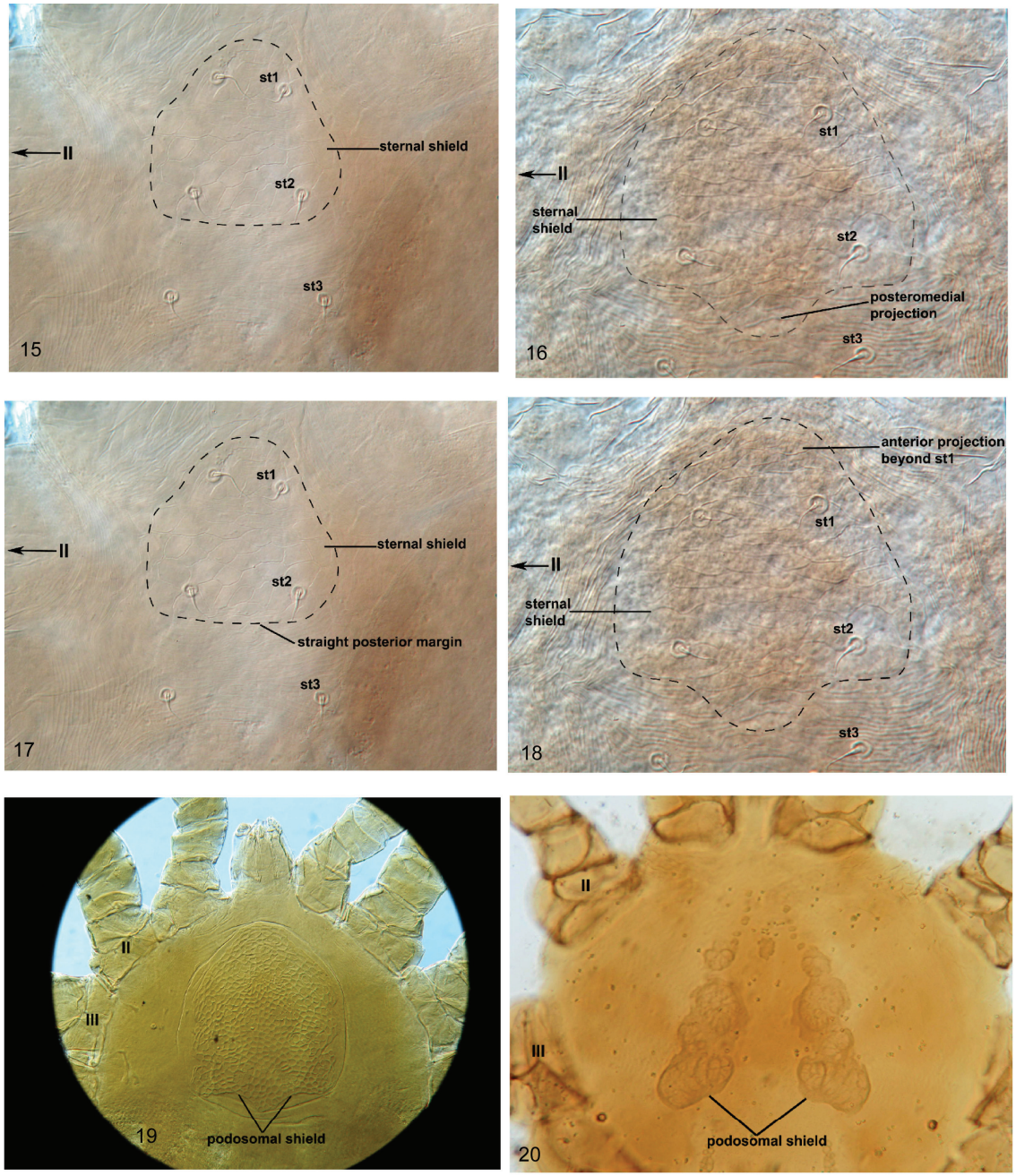
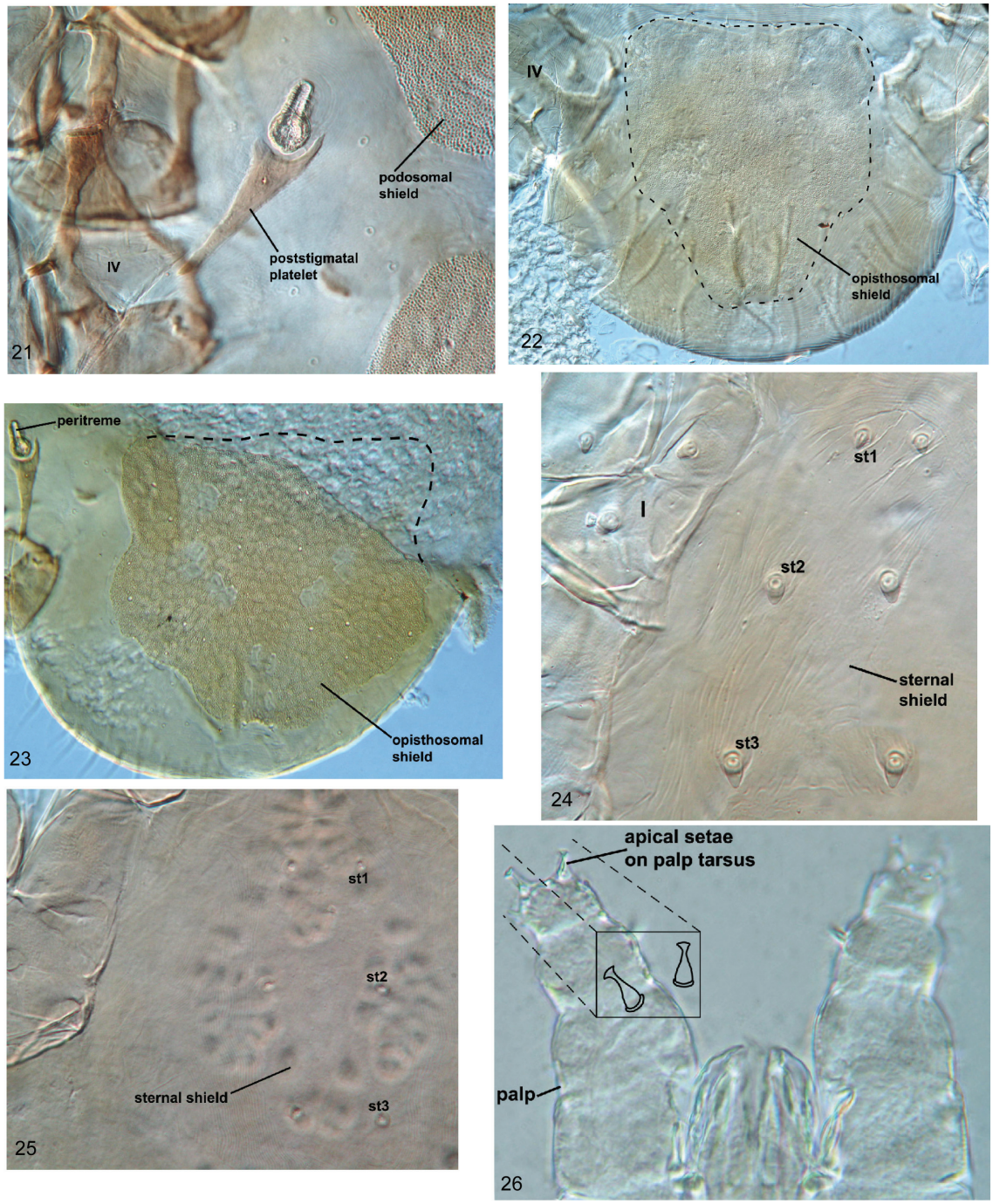


Figures 15-20. 15, *Rhinoecius nycteae* sternal shield. 16, *R. brikinboricus* sternal shield with posteromedial projection. 17, *R. nycteae* sternal shield, straight posterior margin. 18, *R. brikinboricus* sternal shield. 19, *Rhinonyssus rhinolethrum* podosomal shield. 20, *Rhinonyssus coniventris* podosomal shield.

doi:10.3752/cjai.2010.09



Figures 21-26. 21, *Tinaminyssus zenaidurae* poststigmatal platelet. 22, *T. melloi* opisthosomal shield. 23, *T. zenaidurae* opisthosomal shield. 24, *Sternostoma technaui* sternal shield. 25, *S. porteri* sternal shield. 26, *S. longisetosae* palps.

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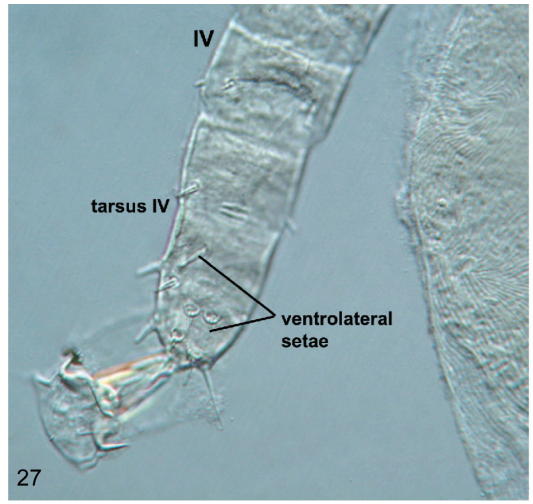

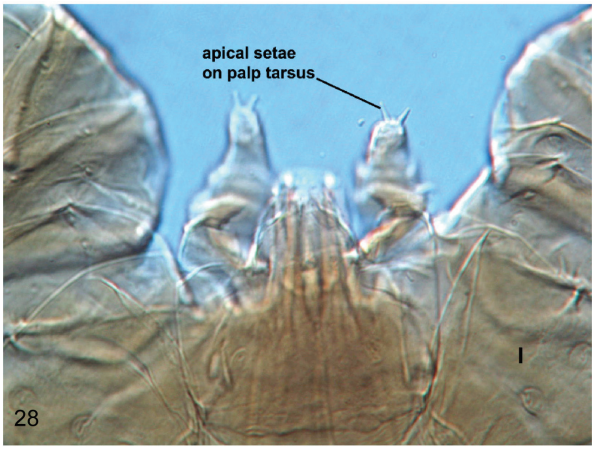

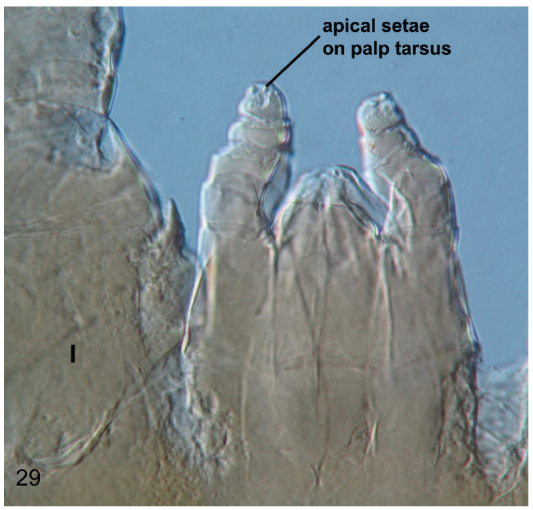

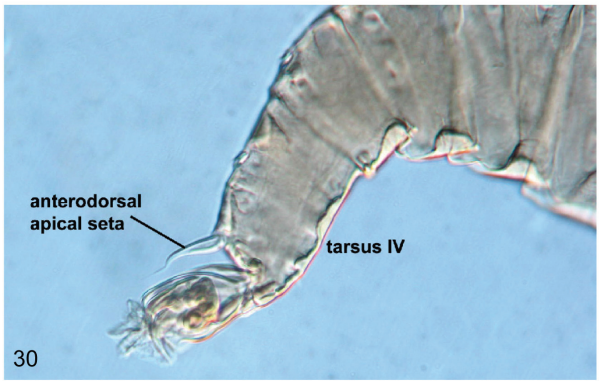

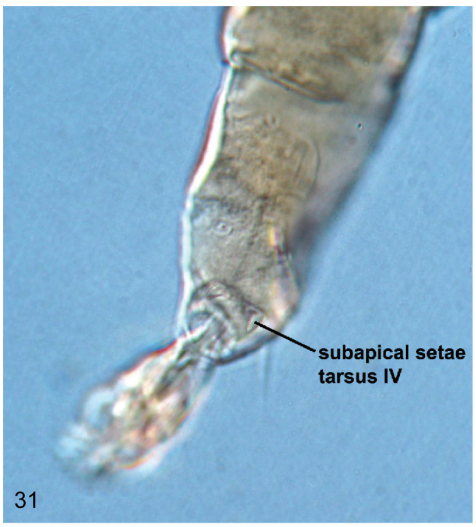

Figures 27-31. 27, *Sternostoma longisetosae* tarsus IV. 28, *S. porteri* palps. 29, *S. cryptorhynchum* palps. 30, *S. porteri* tarsus IV. 31, *S. porteri* tarsus IV.

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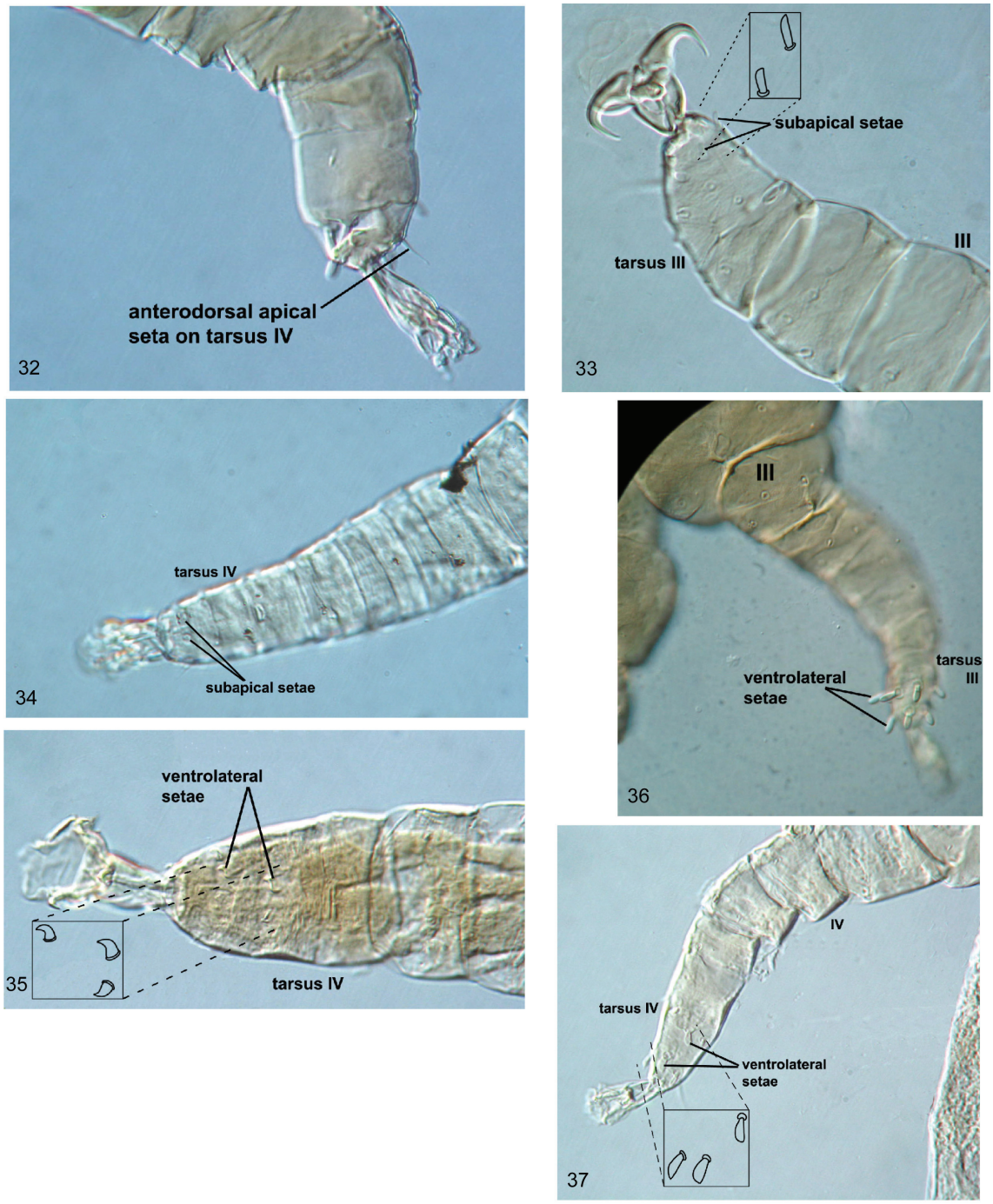
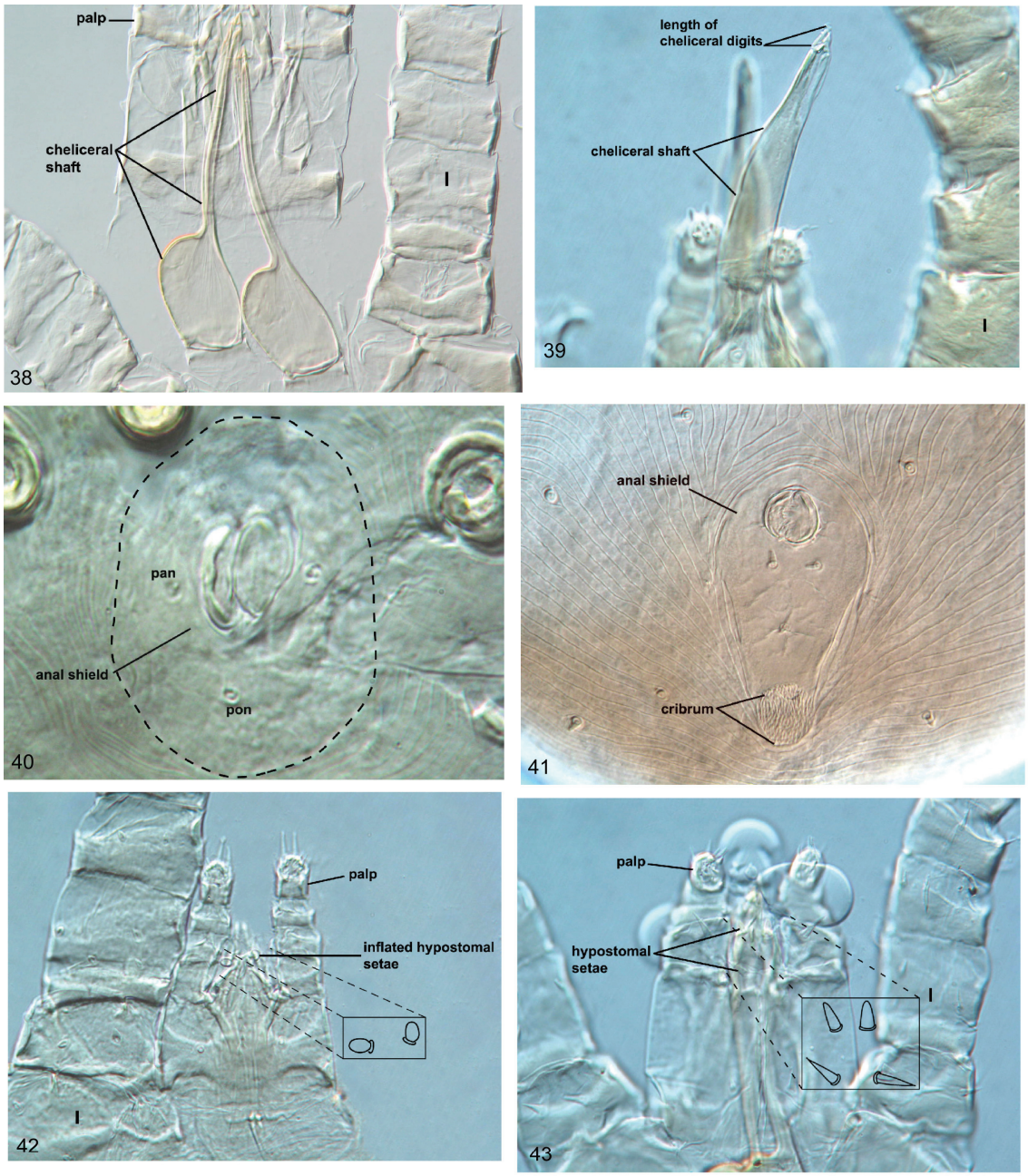


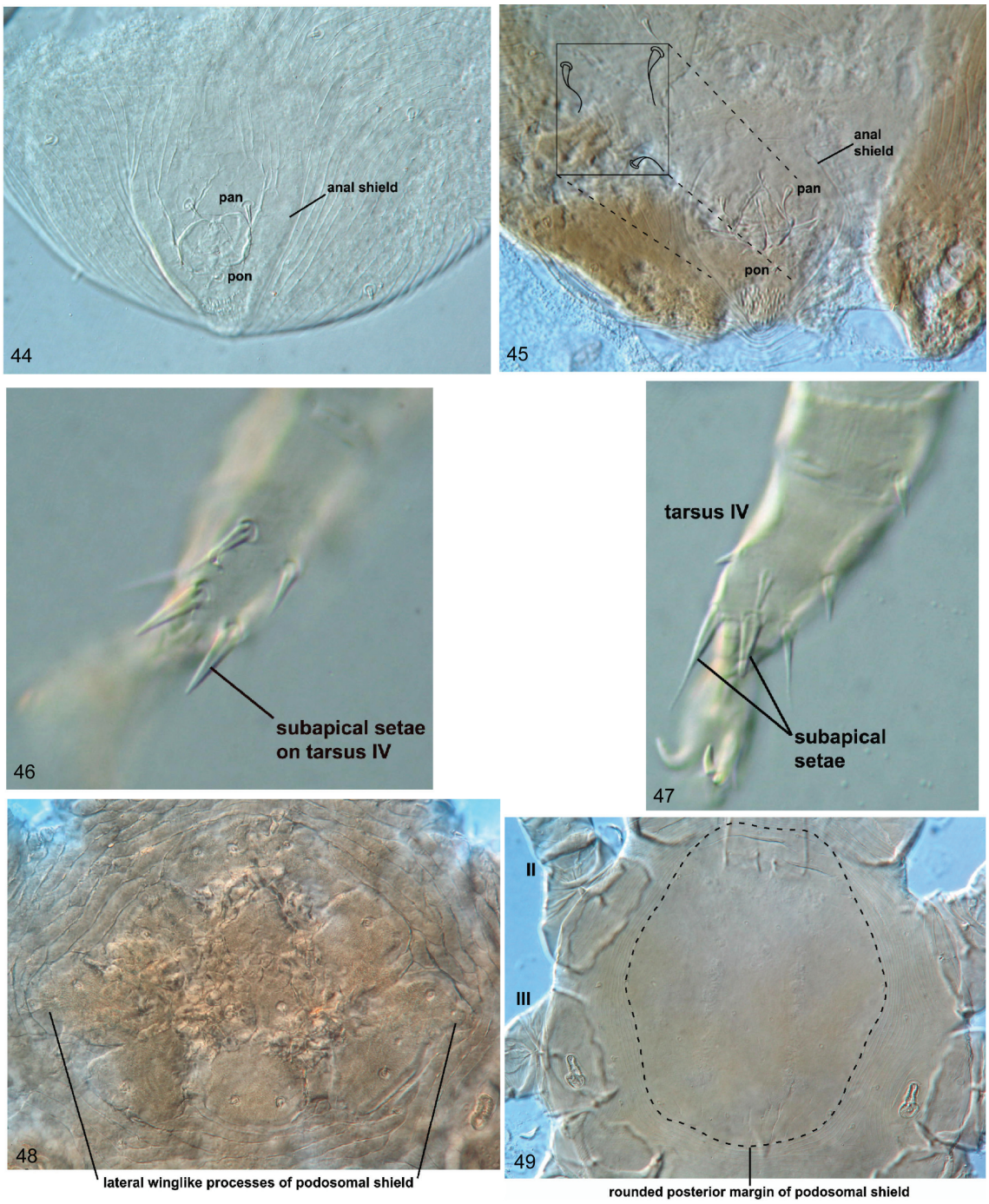
Figures 32-37. 32, *Sternostoma cryptorhynchum* tarsus IV. 33, *S. boydi* tarsus IV. 34, *S. tracheacolum* tarsus IV. 35, *S. laniorum* tarsus IV. 36, *S. cryptorhynchum* leg IV. 37, *S. sialiphilus* leg IV.

 doi:10.3752/cjai.2010.09



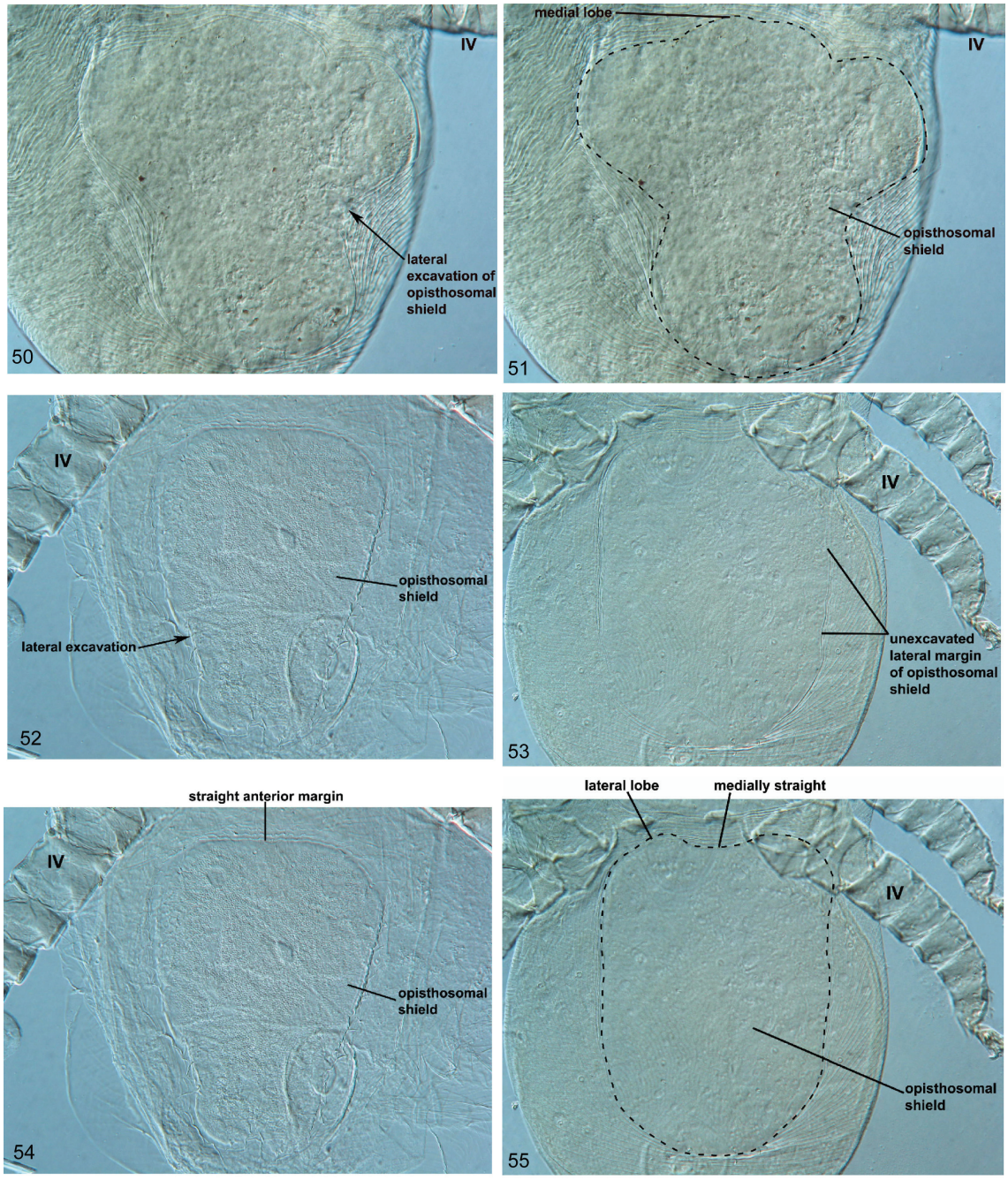
Figures 38-43. 38, *Ptilonyssus japuibensis* chelicerae. 39, *P. tyrannus* chelicera. 40, *P. angrensis* anal shield. 41, *P. bombycillae* anal shield. 42, *P. coccothraustis* ventral gnathosoma. 43, *P. calvaria* ventral gnathosoma.

doi:10.3752/cjai.2010.09



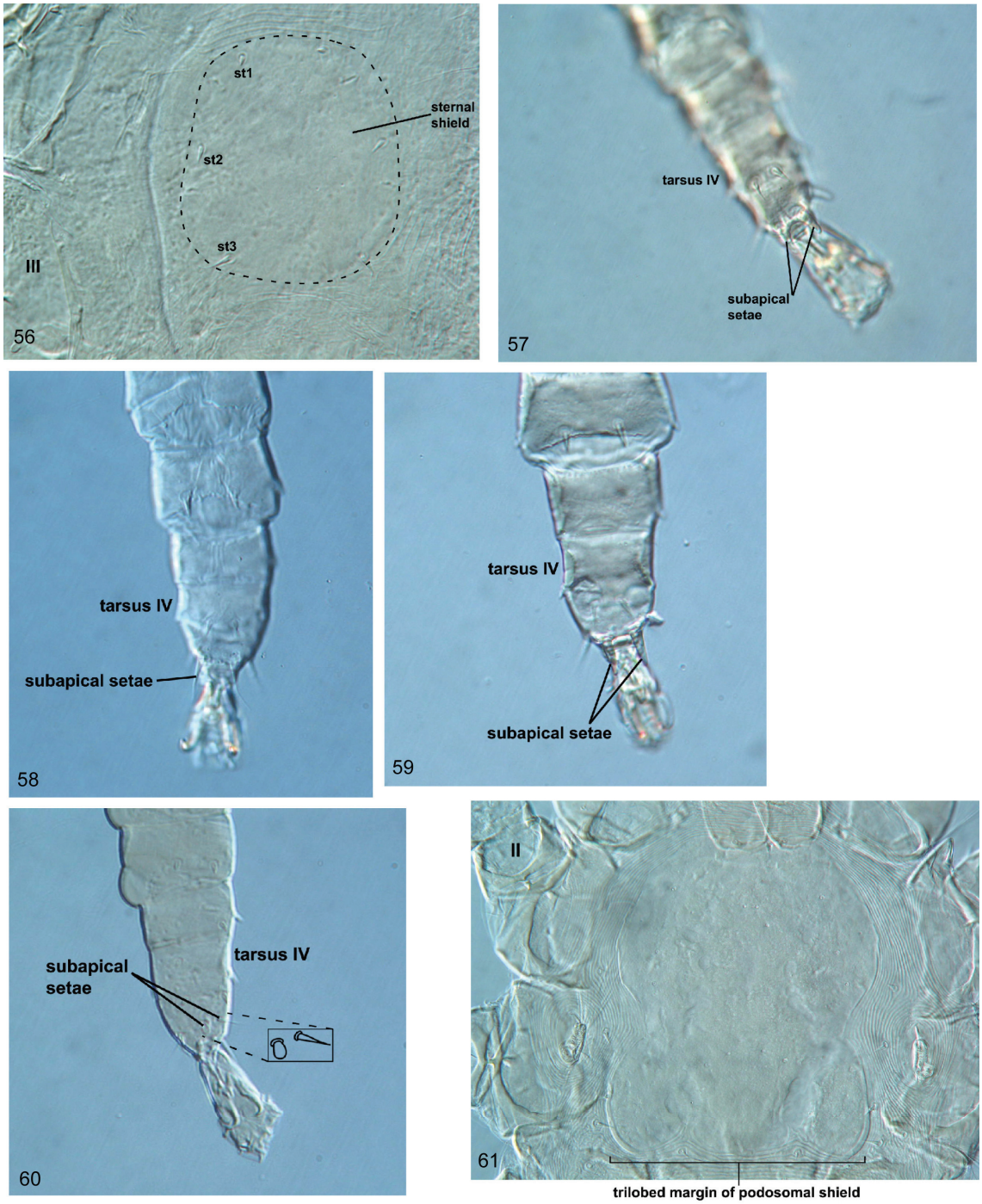
Figures 44-49. 44, *Ptilonyssus tyrannus* anal shield. 45, *P. plesiotypicus* anal shield. 46, *P. pinicola* tarsus IV. 47, *P. coccothraustis* tarsus IV. 48, *P. callinectoides* podosomal shield. 49, *P. nudus* podosomal shield.

 doi:10.3752/cjai.2010.09



Figures 50-55. 50, *Ptilonyssus vireonis* opisthosomal shield. 51, *P. vireonis* opisthosomal shield. 52, *P. pirangae* opisthosomal shield. 53, *P. coccothraustis* opisthosomal shield. 54, *P. pirangae* opisthosomal shield. 55, *P. coccothraustis* opisthosomal shield.

doi:10.3752/cjai.2010.09



Figures 56-61. 56, *Ptilonyssus coccothraustis* sternal shield. 57, *P. tyrannus* tarsus IV. 58, *P. hirsti* tarsus IV. 59, *P. icteridius* tarsus IV. 60, *P. morofskyi* tarsus IV. 61, *P. calvaria* podosomal shield.

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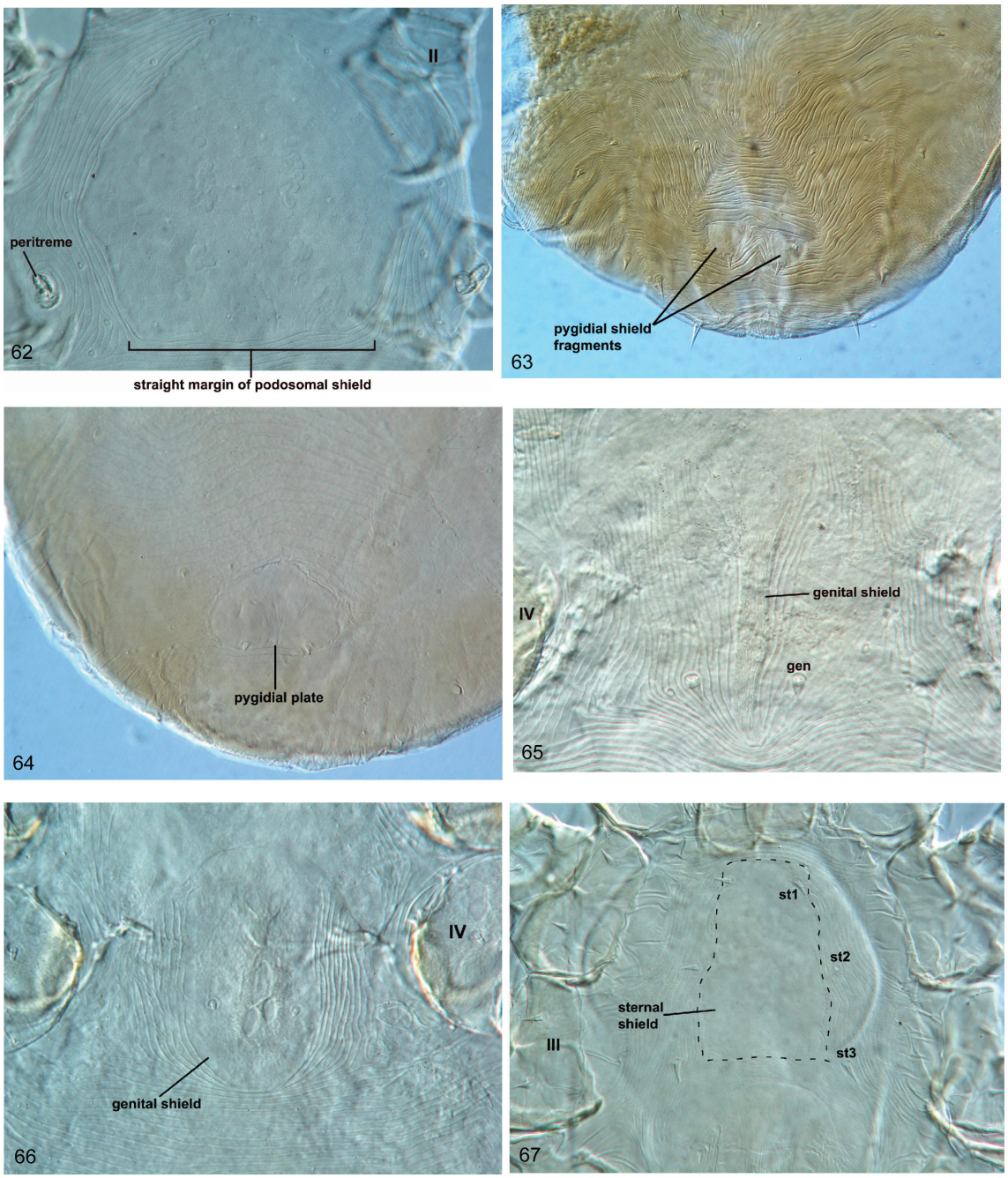
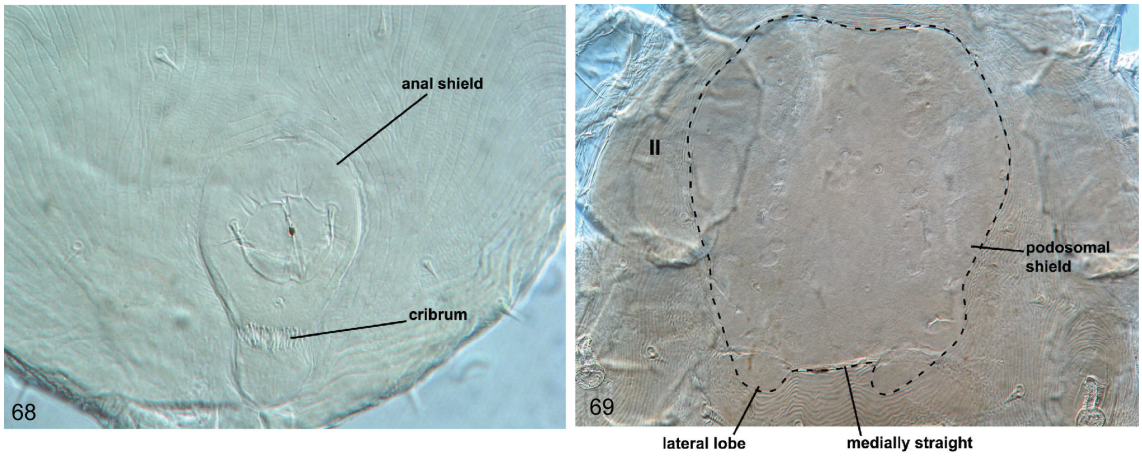


Figures 62-67. 62, *Ptilonyssus hirsti* podosomal shield. 63, *P. troglodytis* pygidial shield. 64, *P. nudus* pygidial shield. 65, *P. echinatus* genital shield. 66, *P. tyrannus* genital shield. 67, *P. calvaria* sternal shield.

doi:10.3752/cjai.2010.09



Figures 68-69. 68, *Ptilonyssus calvaria* anal shield. 69, *P. euroturdi* podosomal shield.

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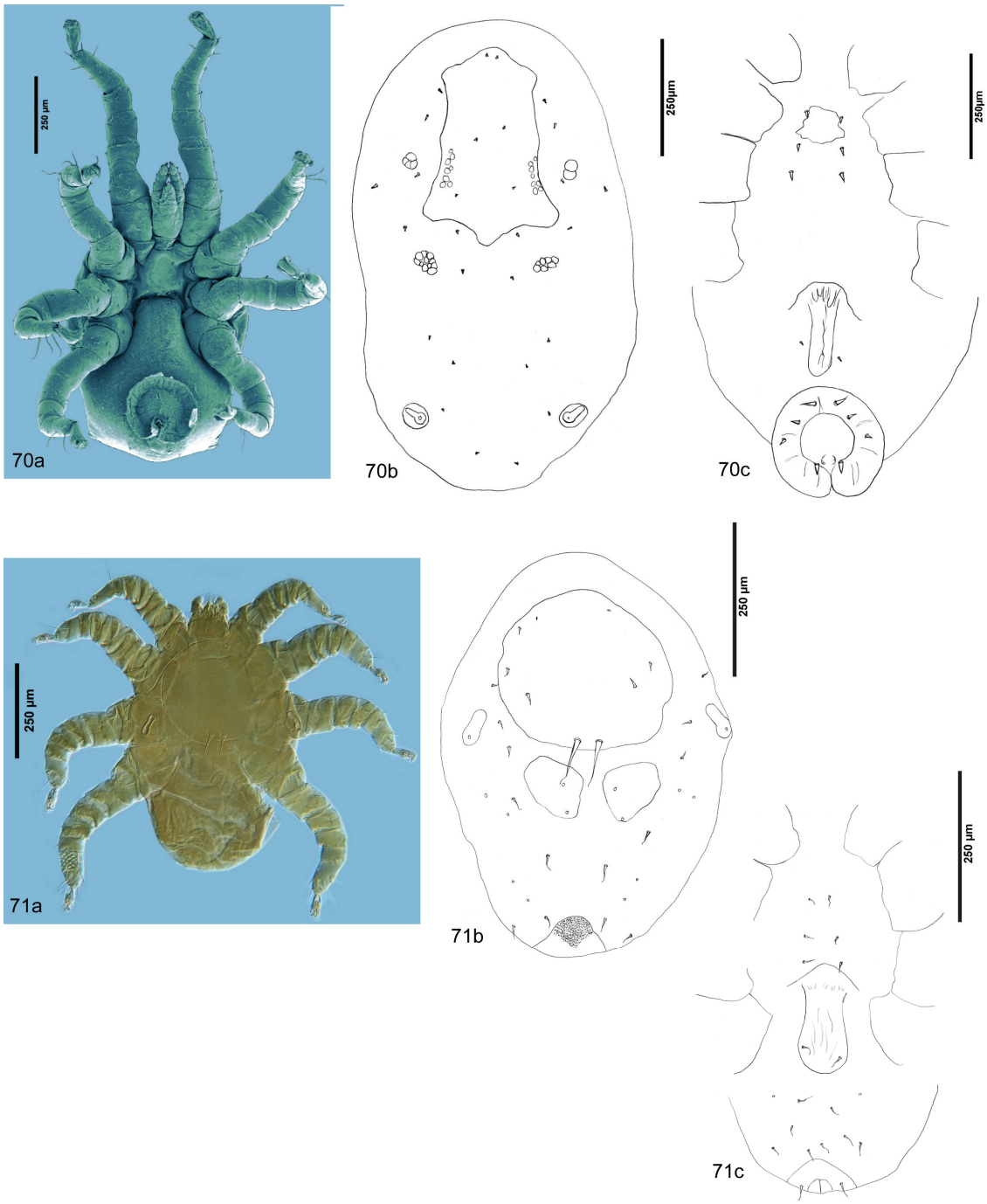
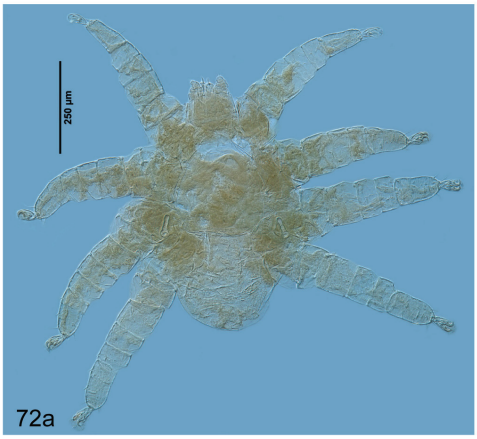
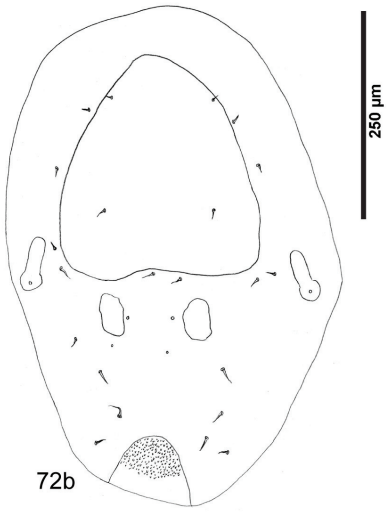
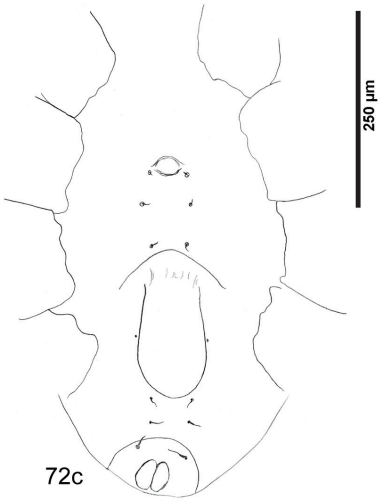


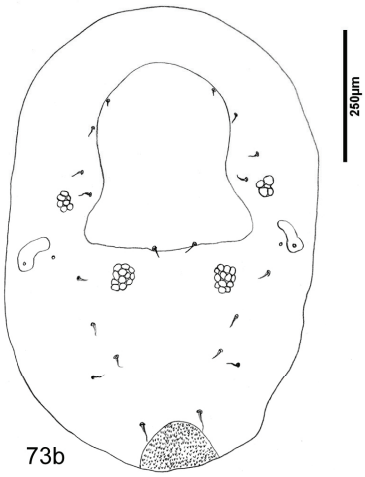
Figures 70-71. 70, *Rallinyssus caudistigmus* female, a. ventral habitus, b. dorsum, c. venter. 71, *Rhinoecius aegolii* female, a. dorsal habitus, b. dorsum, c. venter.

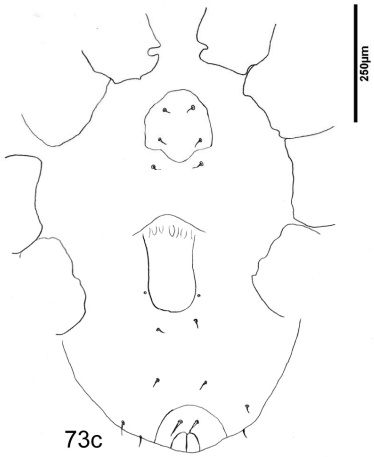
doi:10.3752/cjai.2010.09





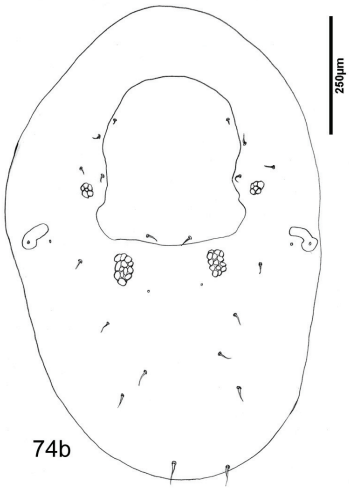


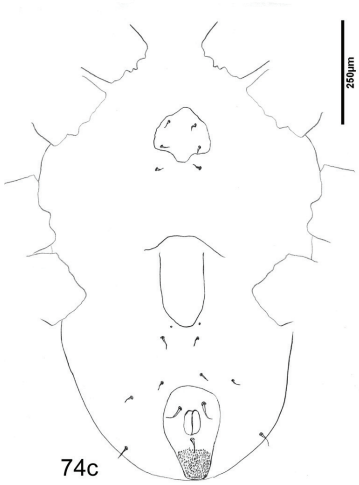


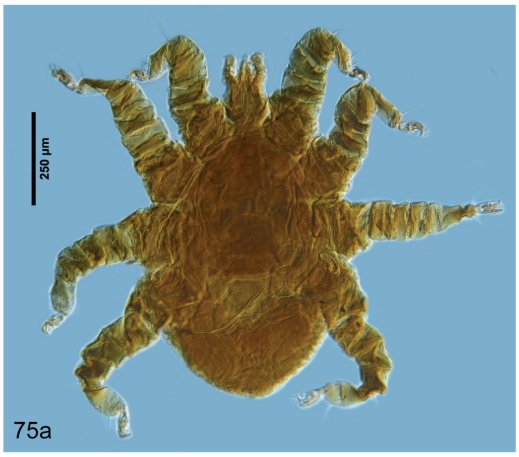


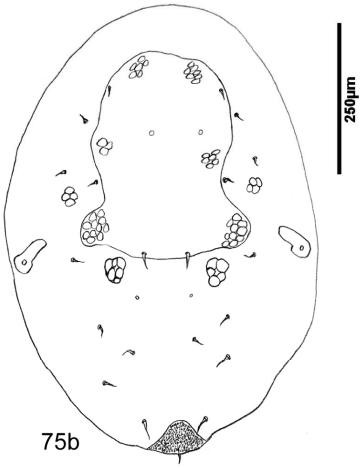
Figures 72-73. 72, *Rhinoecius cooremani* female, a. dorsal habitus, b. dorsum, c. venter. 73, *R. brikinboricus* female, a. dorsal habitus, b. dorsum, c. venter.

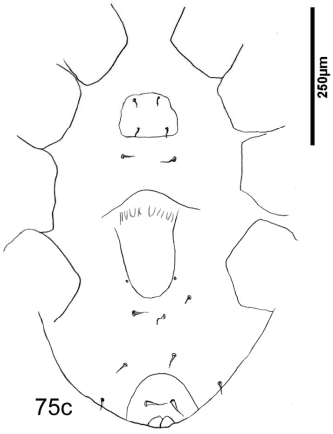
 doi:10.3752/cjai.2010.09





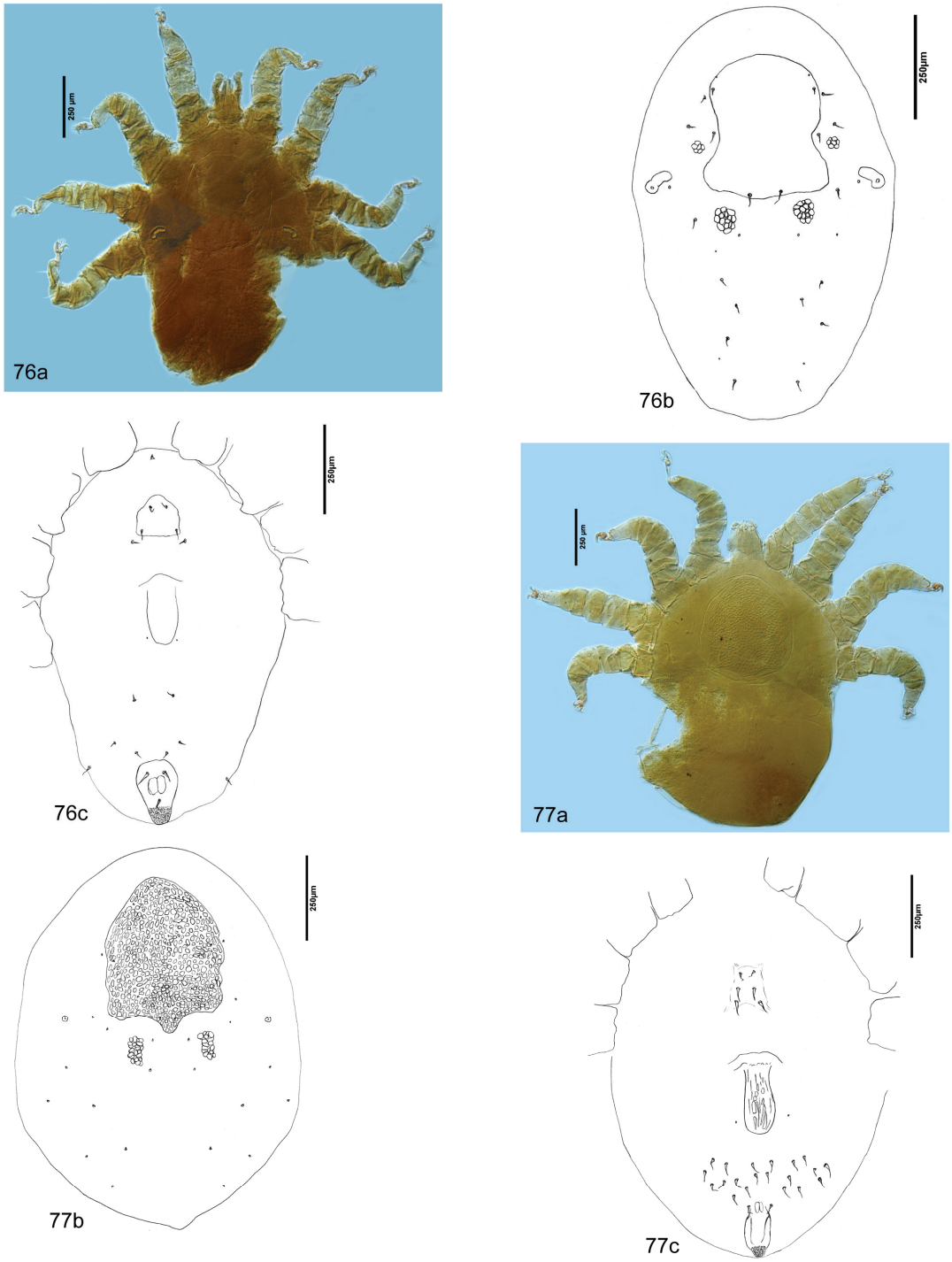






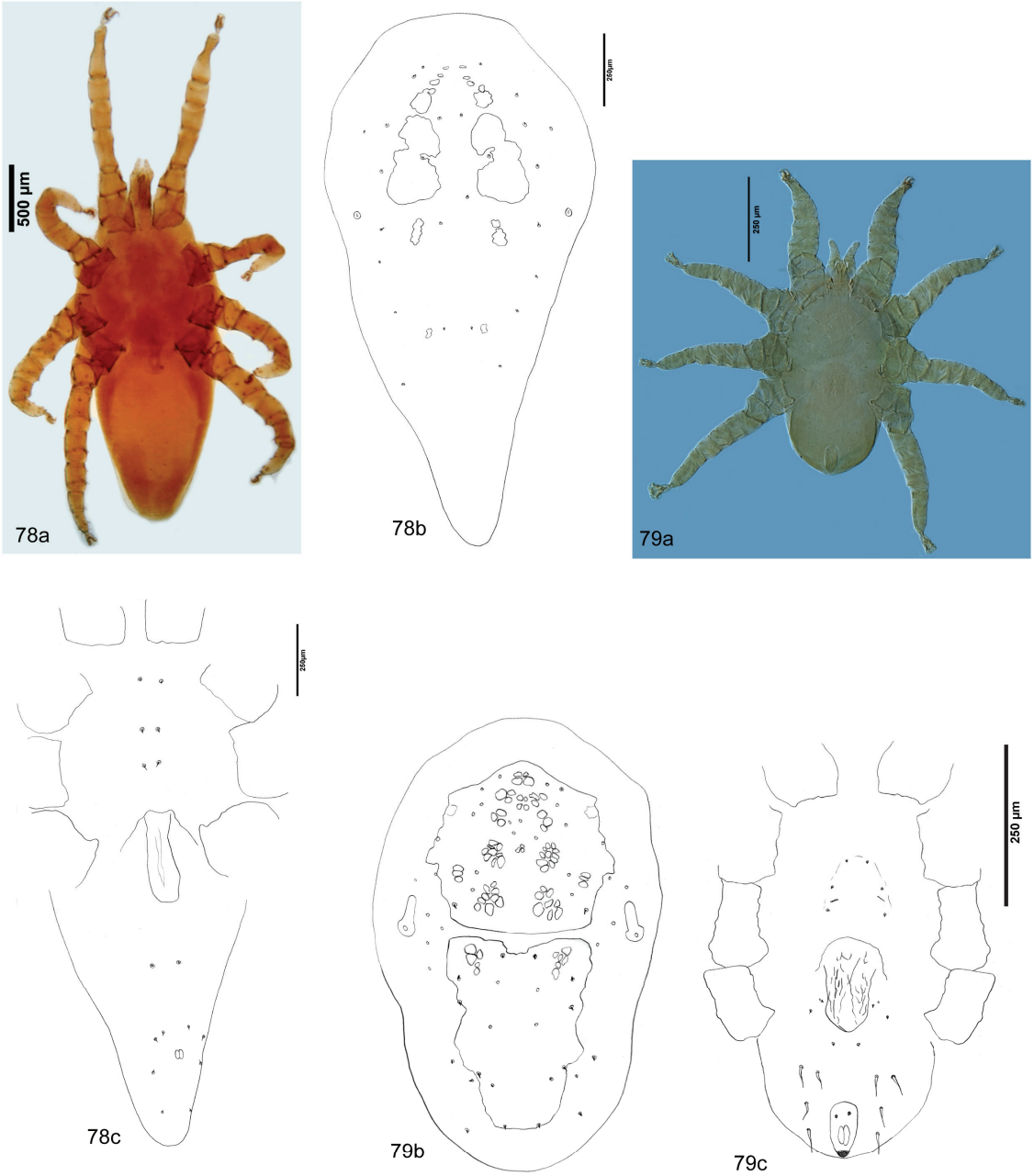
Figures 74-75. 74, *Rhinoecius grandis* female, a. dorsal habitus, b. dorsum, c. venter. 75, *R. alifanovi* female, a. dorsal habitus, b. dorsum, c. venter.

doi:10.3752/cjai.2010.09



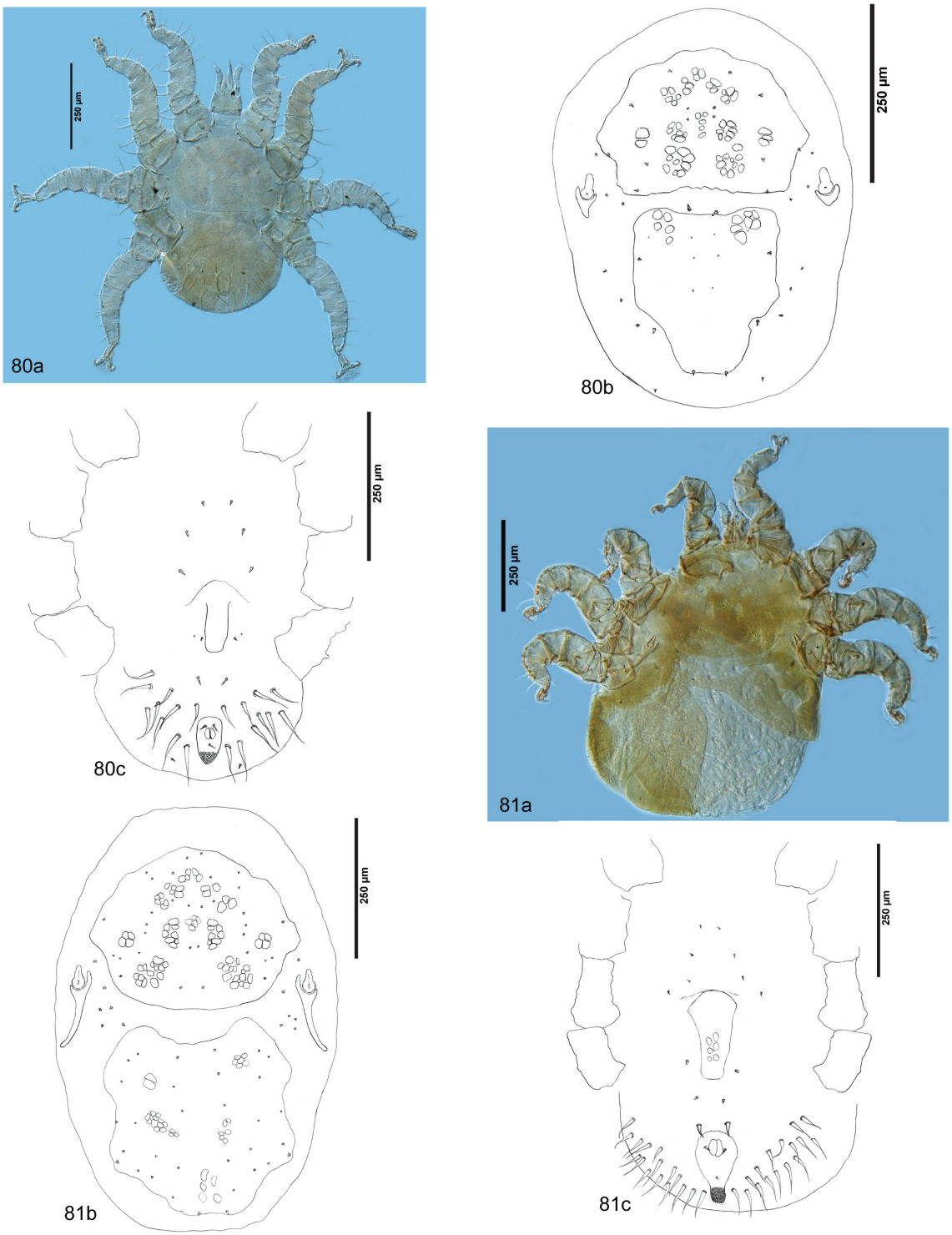
Figures 76-77. 76, *Rhinoecius nycteae* female, a. dorsal habitus, b. dorsum, c. venter. 77, *Rhinonyssus rhinolethrum* female, a. dorsal habitus, b. dorsum, c. venter.

 doi:10.3752/cjai.2010.09



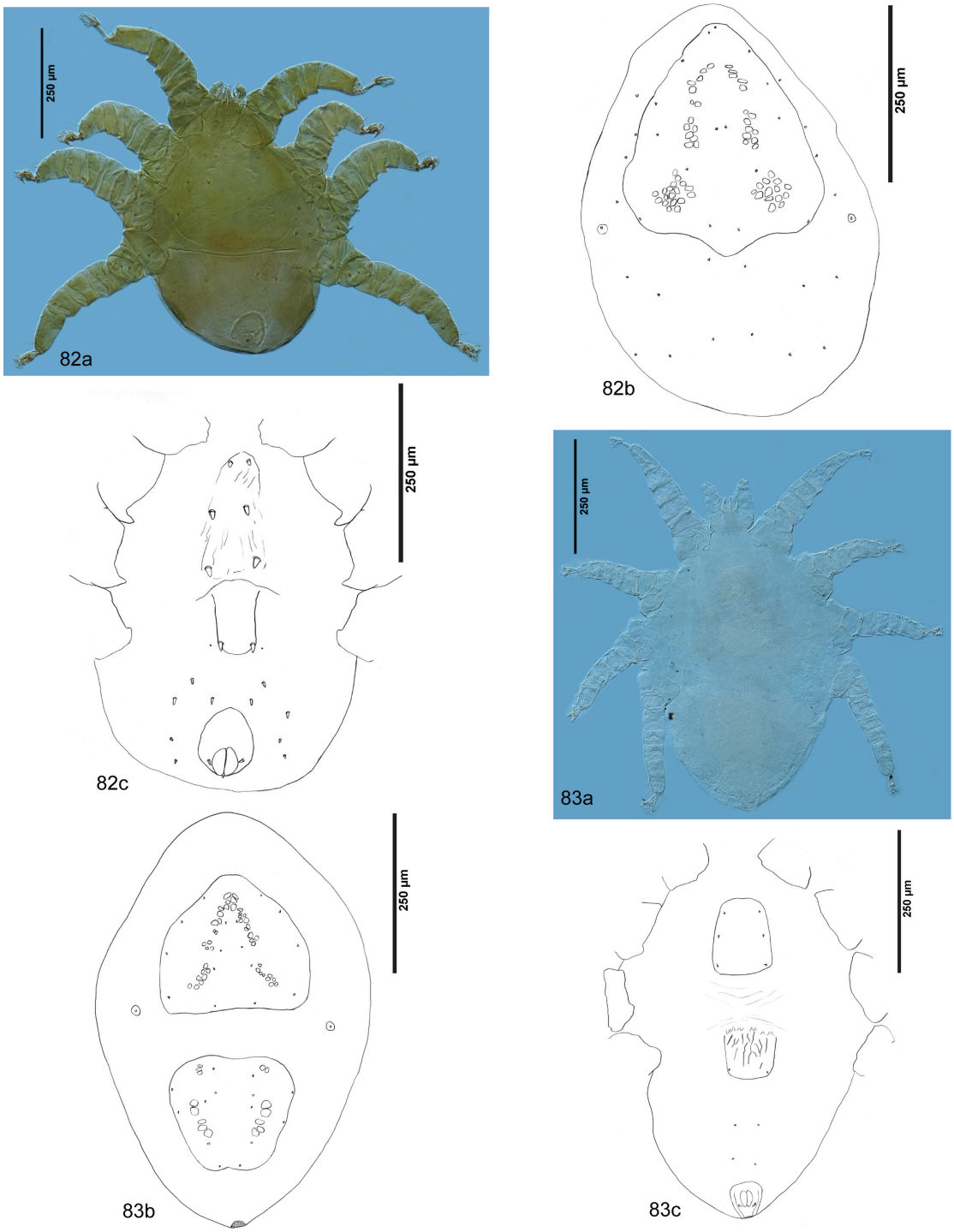
Figures 78-79. 78, *Rhinonyssus coniventris* female, a. dorsal habitus, b. dorsum, c. venter. 79, *Tinaminyssus columbae* female, a. dorsal habitus, b. dorsum, c. venter.

doi:10.3752/cjai.2010.09



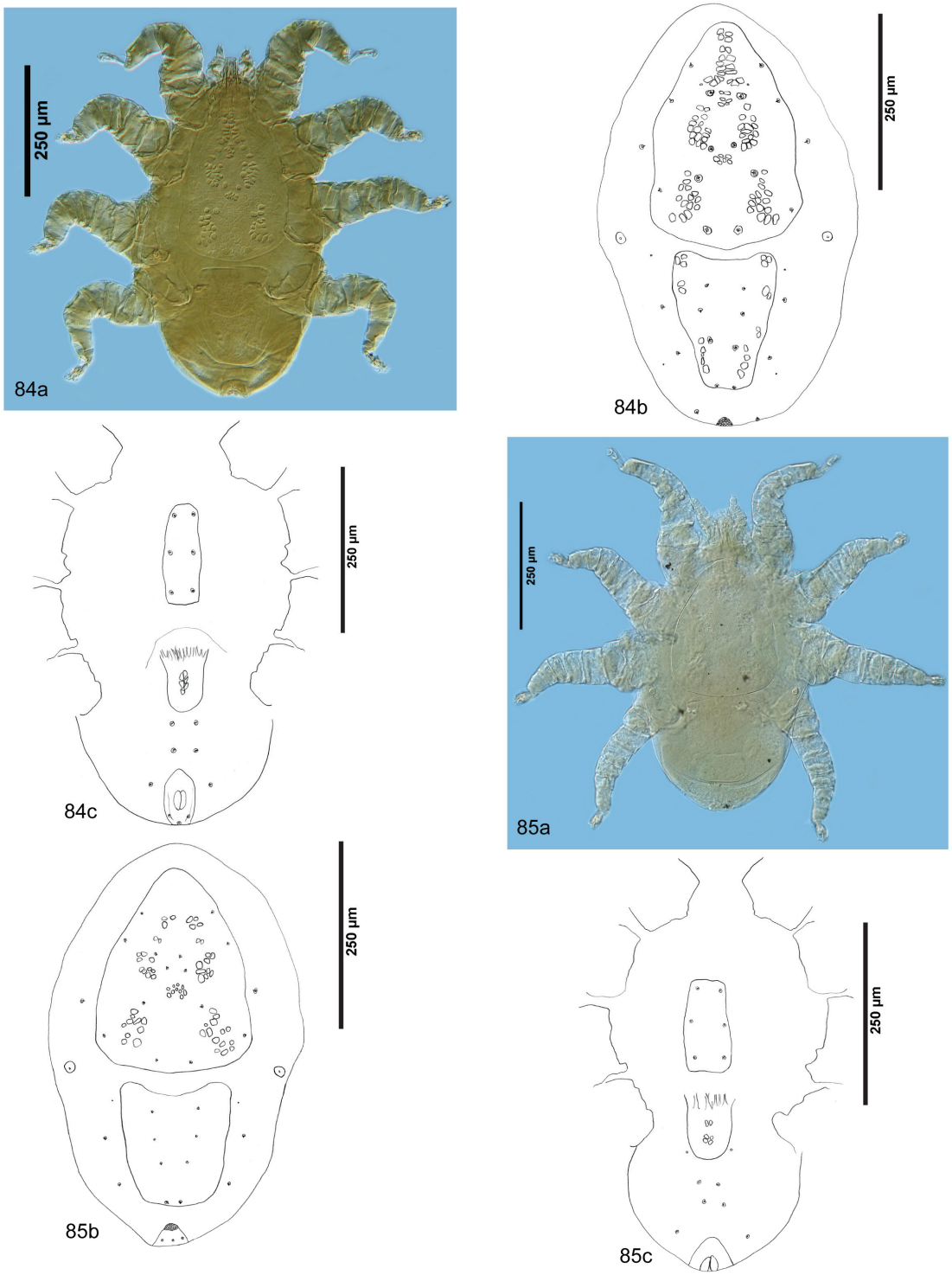
Figures 80-81. 80, *Tinaminyssus melloi* female, a. dorsal habitus, b. dorsum, c. venter. 81, *T. zenaidurae* female, a. dorsal habitus, b. dorsum, c. venter.

 doi:10.3752/cjai.2010.09



Figures 82-83. 82, *Sternostoma technaui* female, a. dorsal habitus, b. dorsum, c. venter. 83, *S. longisetosae* female, a. dorsal habitus, b. dorsum, c. venter.

doi:10.3752/cjai.2010.09



Figures 84-85. 84, *Sternostoma porteri* female, a. dorsal habitus, b. dorsum, c. venter. 85, *S. hylandi* female, a. dorsal habitus, b. dorsum, c. venter.

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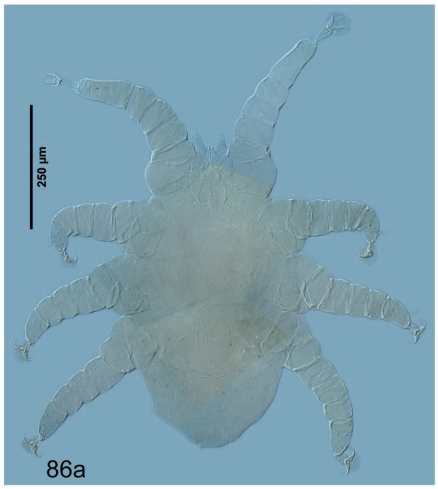
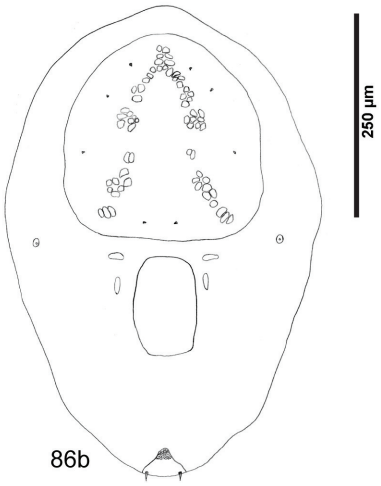
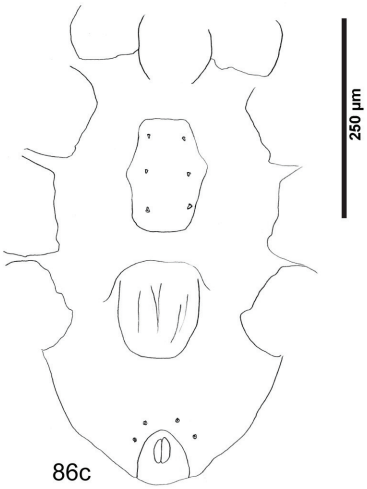
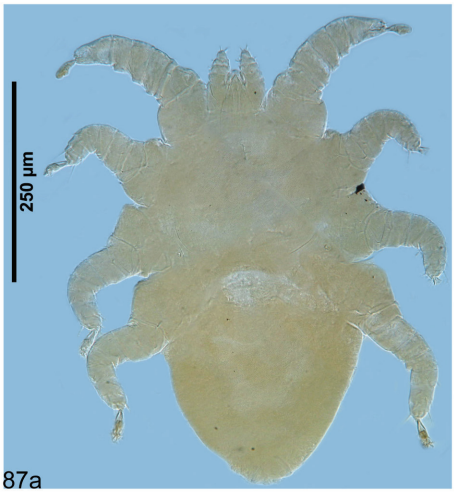
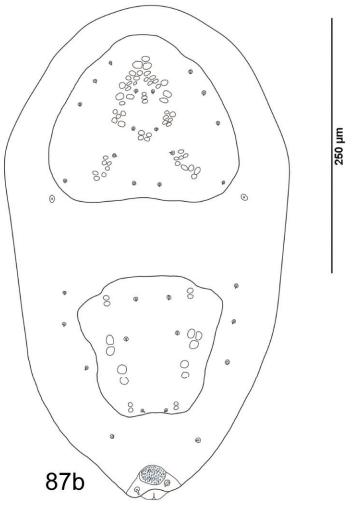
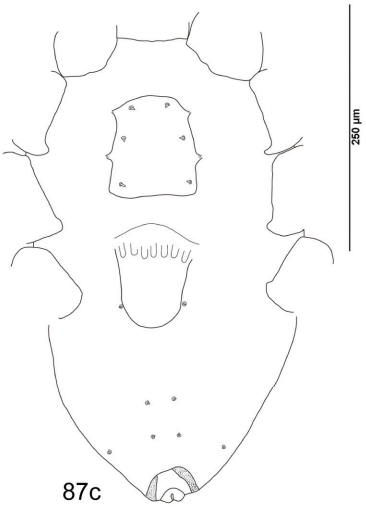






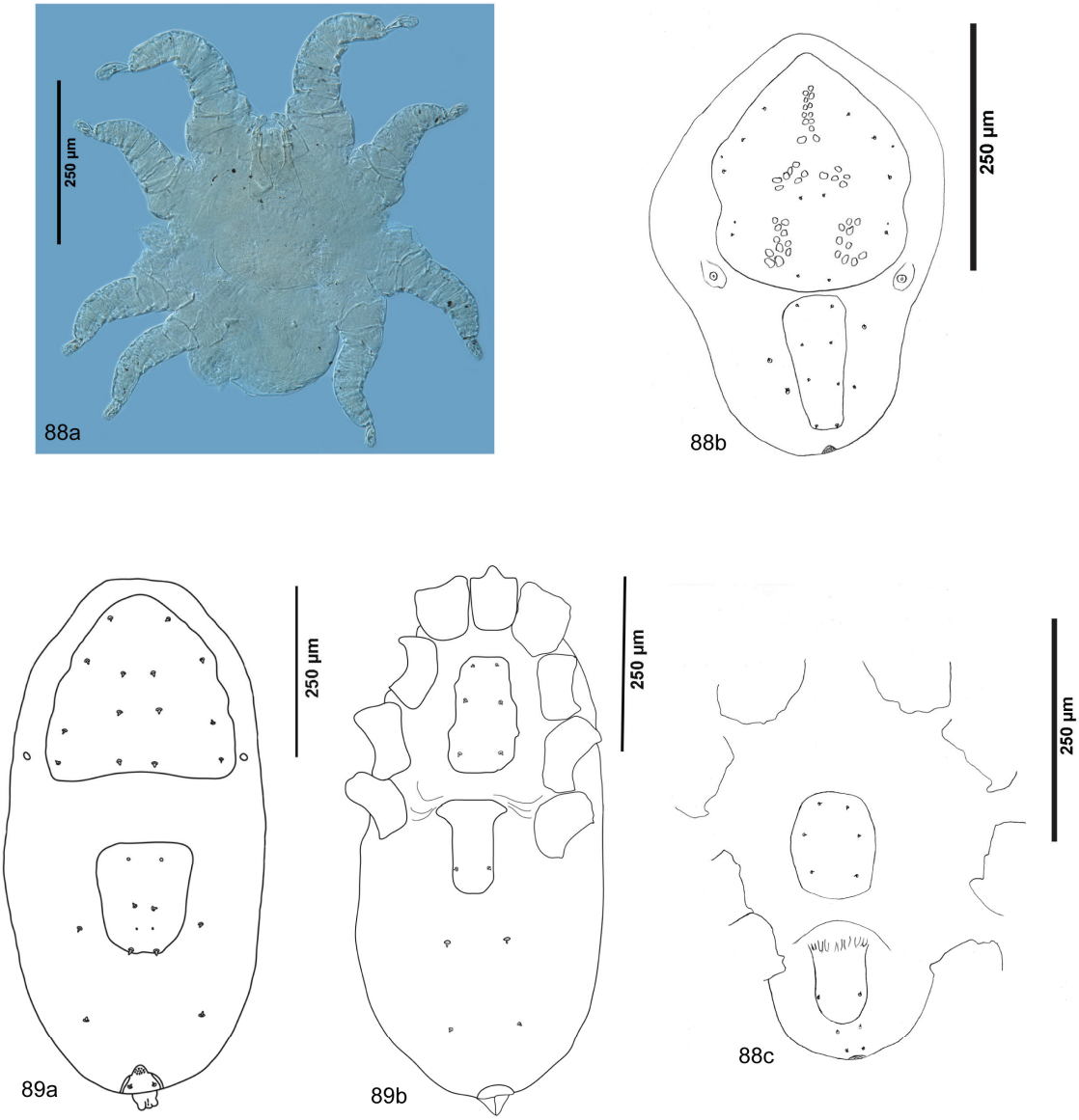






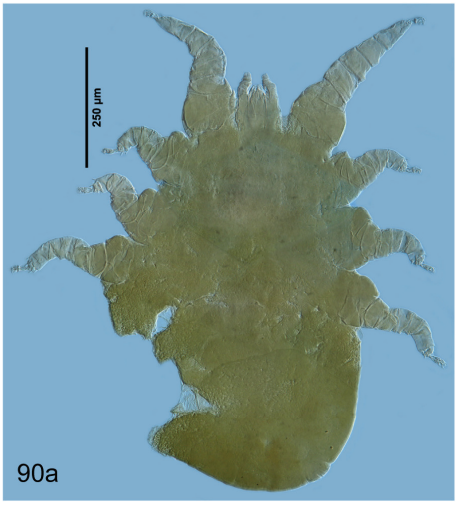
Figures 86-87. 86, *Sternostoma boydi* female, a. dorsal habitus, b. dorsum, c. venter. 87, *S. setifer* female, a. dorsal habitus, b. dorsum, c. venter.

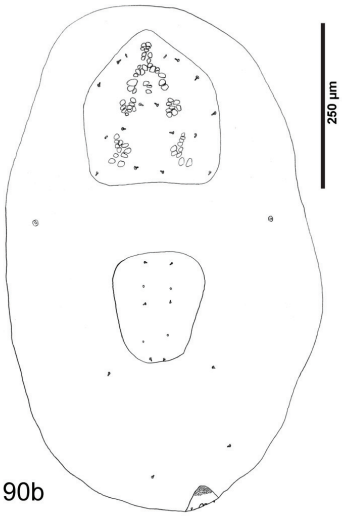
doi:10.3752/cjai.2010.09

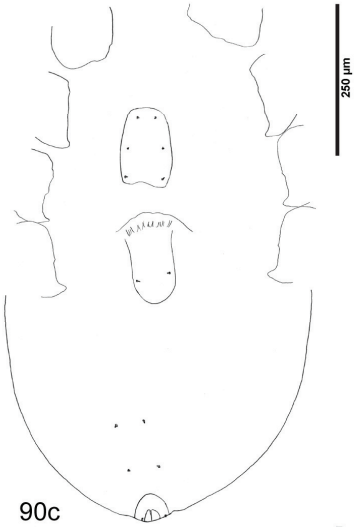


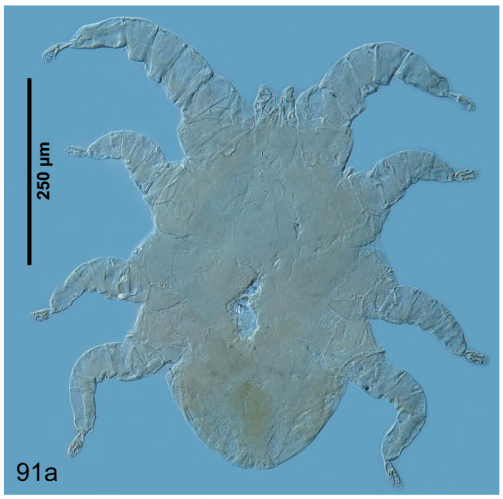
Figures 88-89. 88, *Sternostoma tracheacolum* female, a. dorsal habitus, b. dorsum, c. venter.
89, *S. laniorum* female, a. dorsum, b. venter.

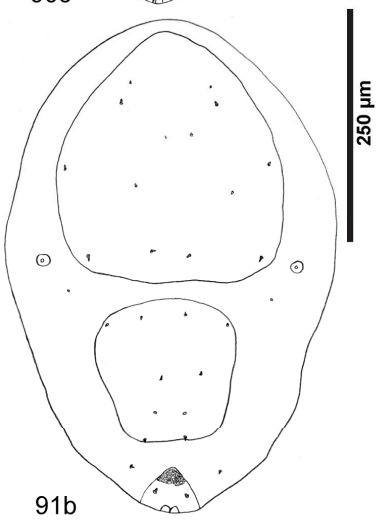
 doi:10.3752/cjai.2010.09

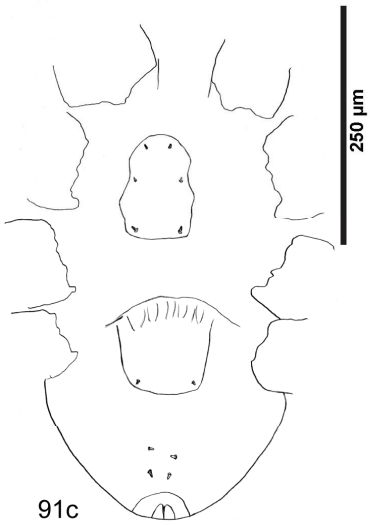












Figures 90-91. 90, *Sternostoma cryptorhynchum* female, a. dorsal habitus, b. dorsum, c. venter. 91, *S. loxiae* female, a. dorsal habitus, b. dorsum, c. venter.

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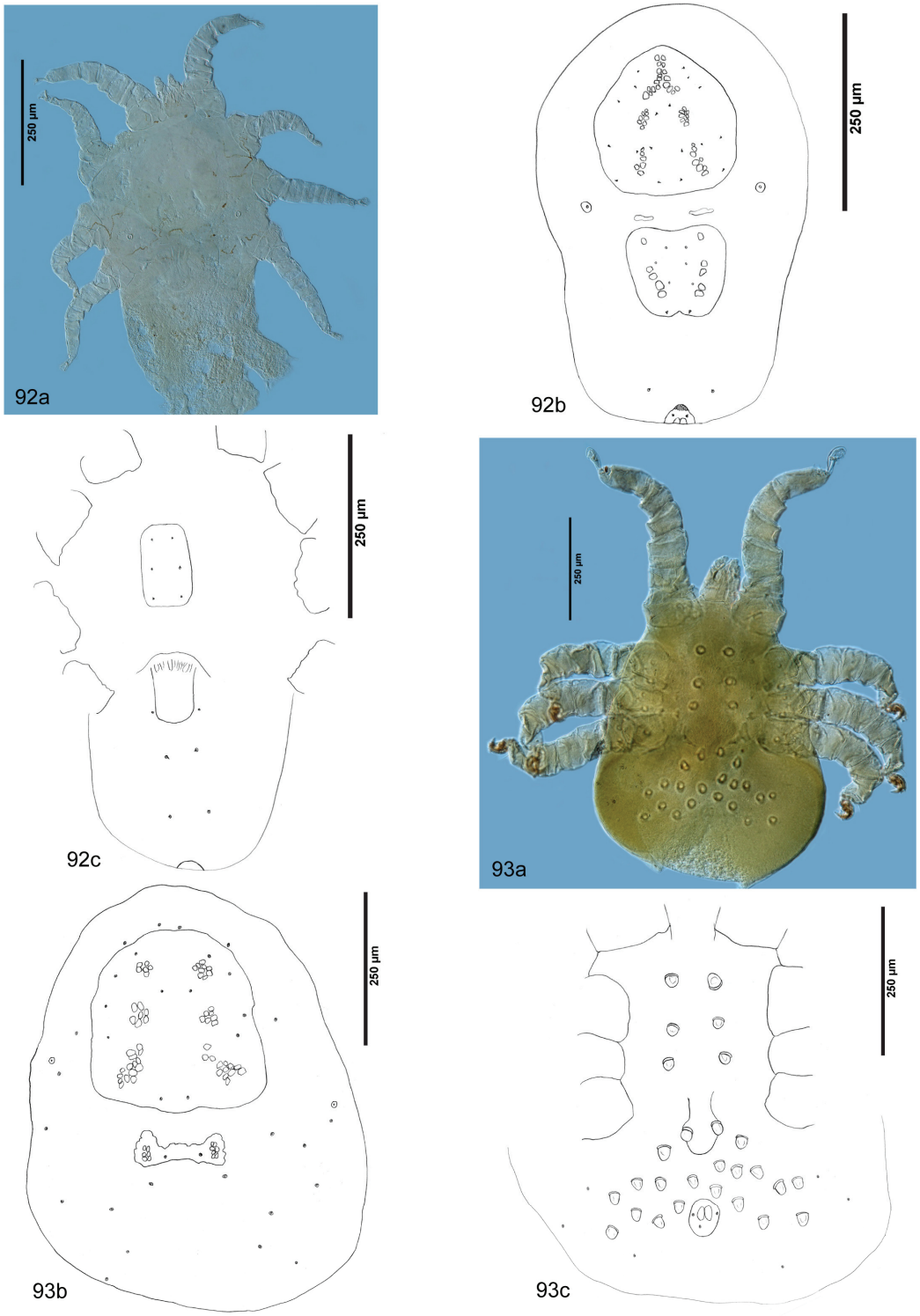

Figures 92-93. 92, *Sternostoma sialiphilus* female, a. dorsal habitus, b. dorsum, c. venter. 93, *Ptilonyssus angrensis* female, a. dorsal habitus, b. dorsum, c. venter.

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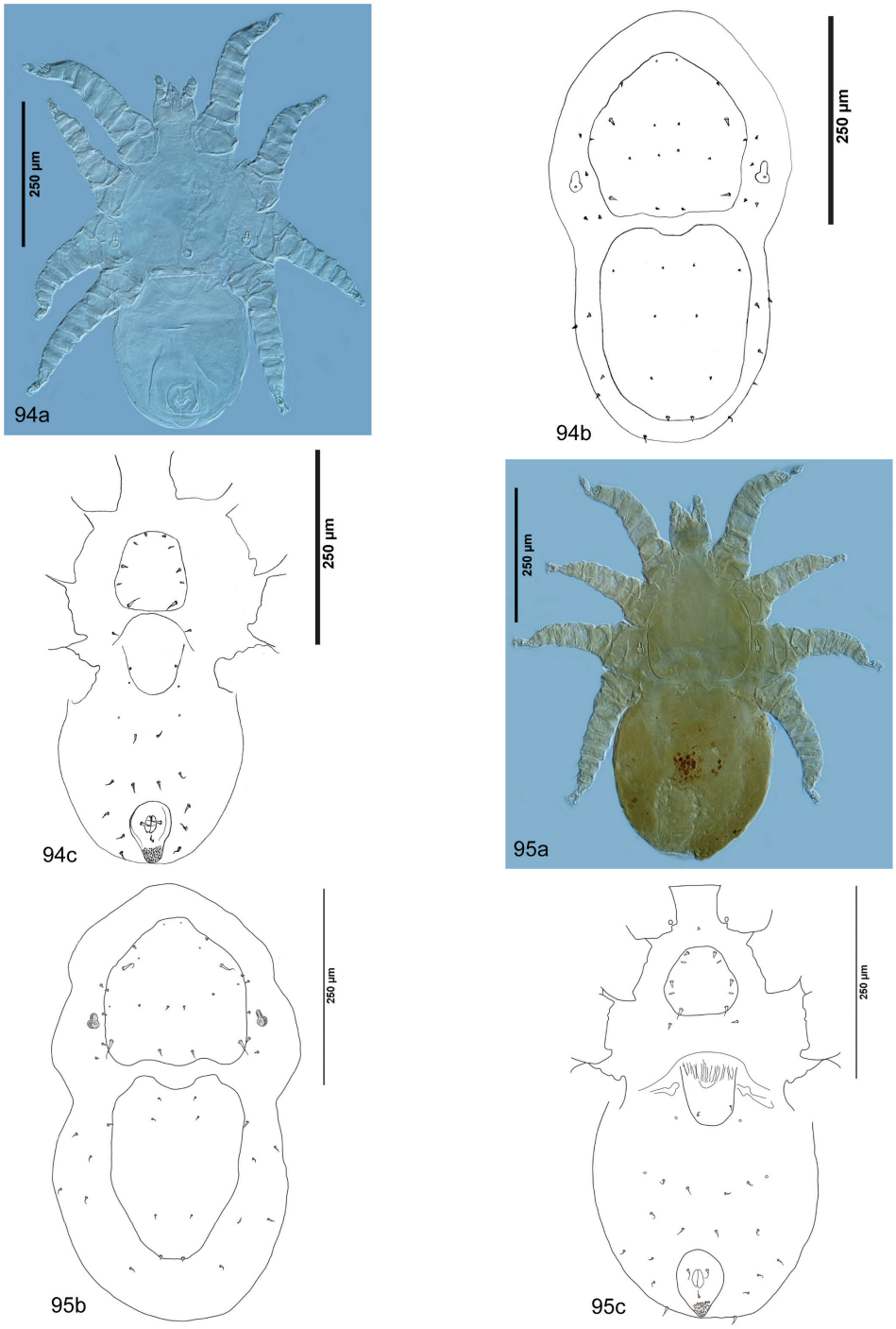

Figures 94-95. 94, *Ptilonyssus coccothraustis* female, a. dorsal habitus, b. dorsum, c. venter. 95, *P. plesiotypicus* female, a. dorsal habitus, b. dorsum, c. venter.

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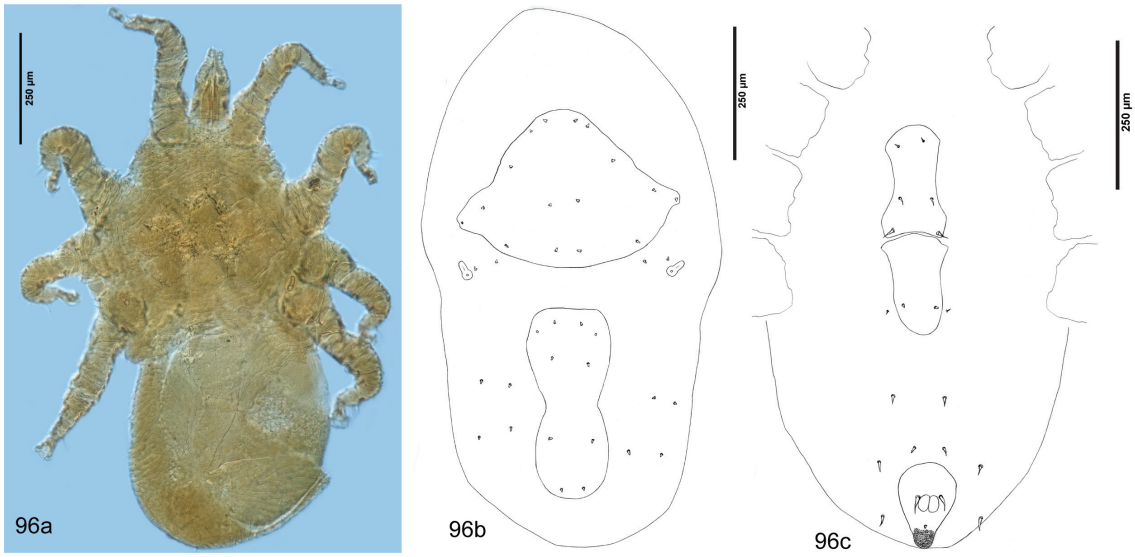

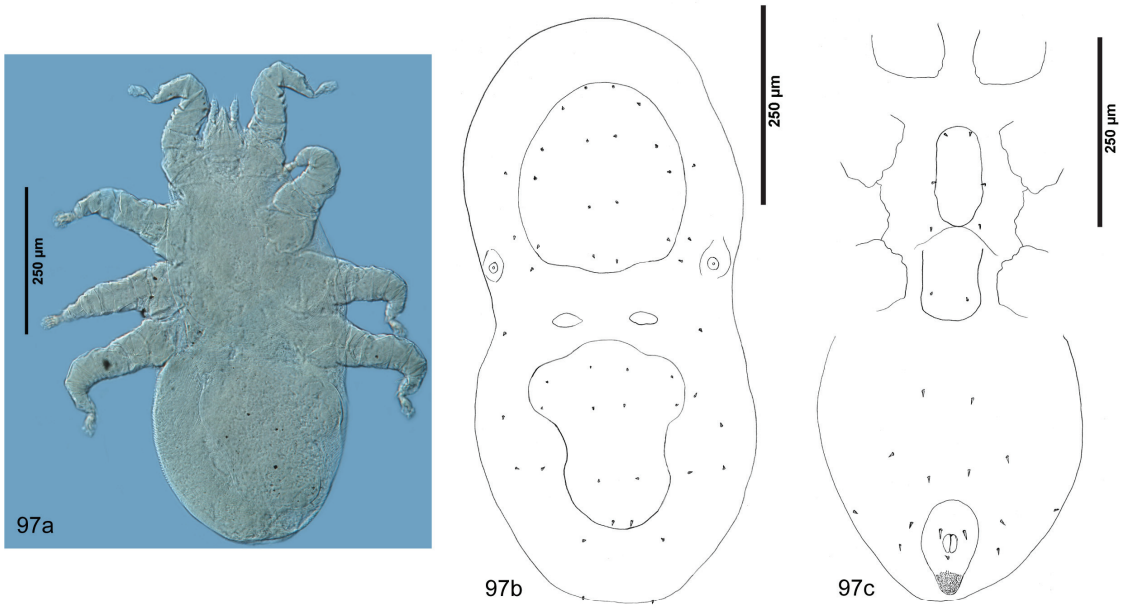

Figures 96-97. 96, *Ptilonyssus callinectoides* female, a. dorsal habitus, b. dorsum, c. venter. 97, *P. vireonis* female, a. dorsal habitus, b. dorsum, c. venter.

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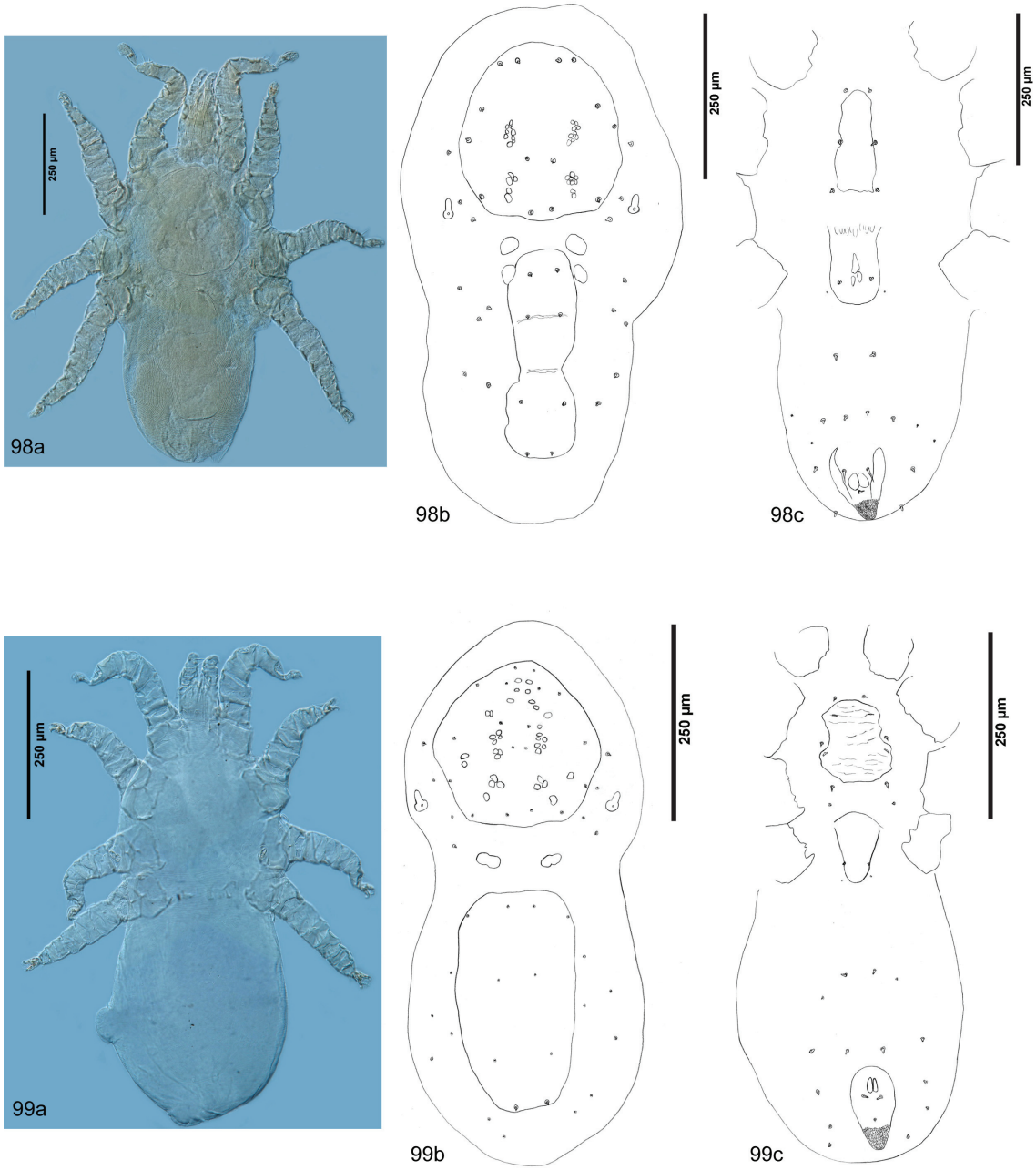

Figures 98-99. 98, *Ptilonyssus tyrannus* female, a. dorsal habitus, b. dorsum, c. venter. 99, *P. hirsti* female, a. dorsal habitus, b. dorsum, c. venter.

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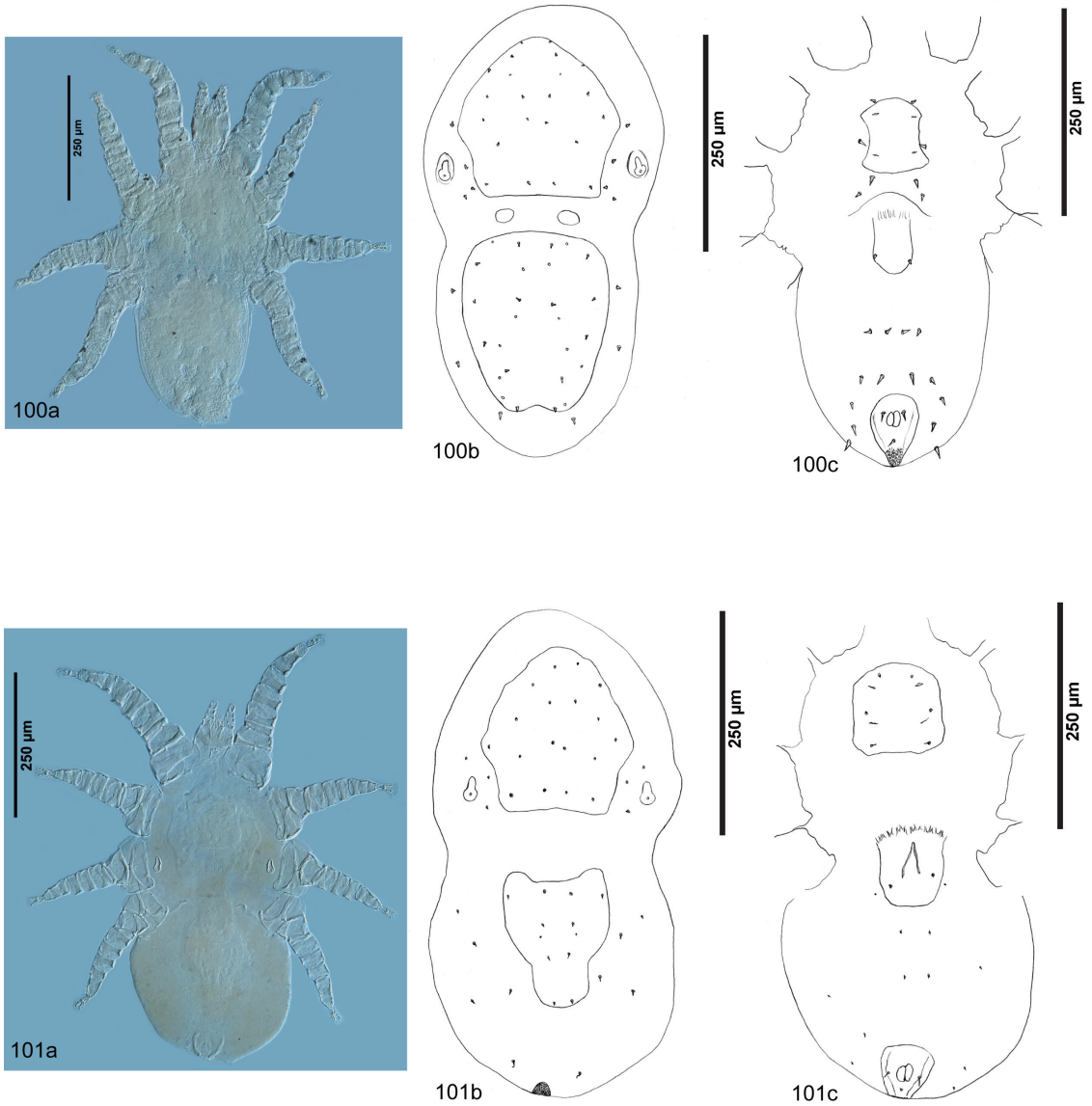

Figures 100-101. 100, *Ptilonyssus icteridius* female, a. dorsal habitus, b. dorsum, c. venter. 101, *P. morofskyi* female, a. dorsal habitus, b. dorsum, c. venter.

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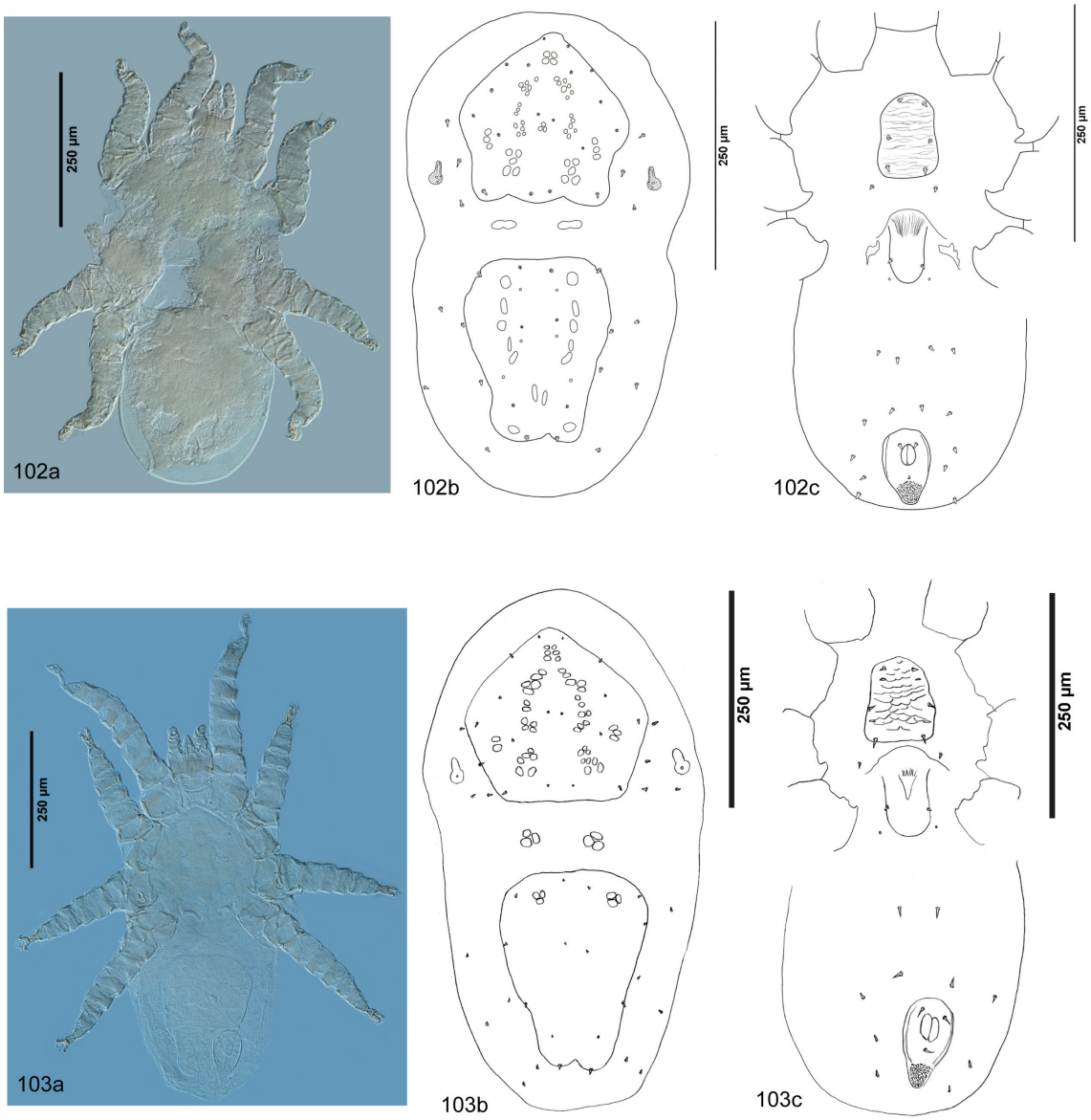

Figures 102-103. 102, *Ptilonyssus nivalis* female, a. dorsal habitus, b. dorsum, c. venter. 103, *P. pirangae* female, a. dorsal habitus, b. dorsum, c. venter.

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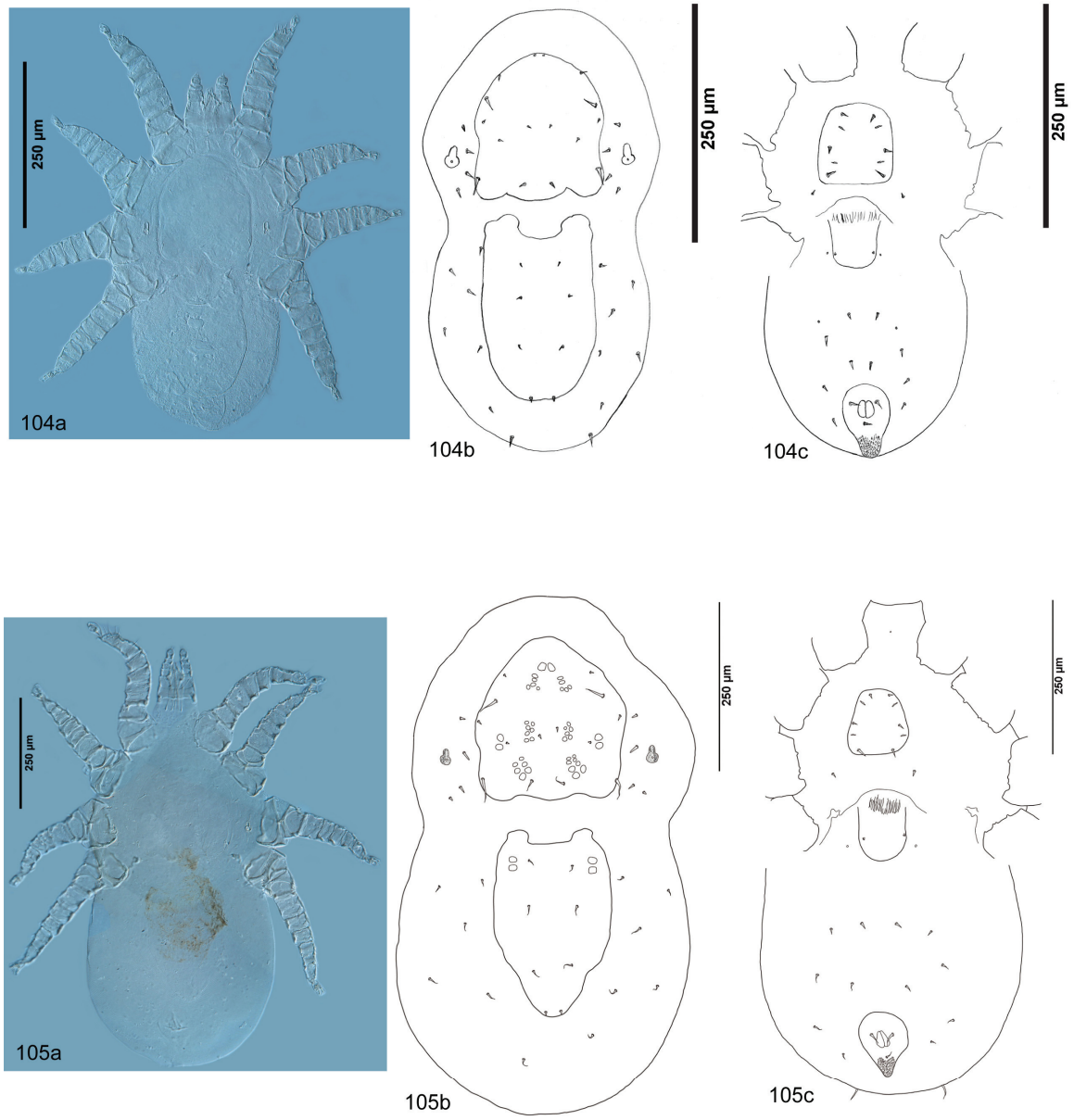

Figures 104-105. 104, *Ptilonyssus carduelis* female, a. dorsal habitus, b. dorsum, c. venter. 105, *P. pinicola* female, a. dorsal habitus, b. dorsum, c. venter.

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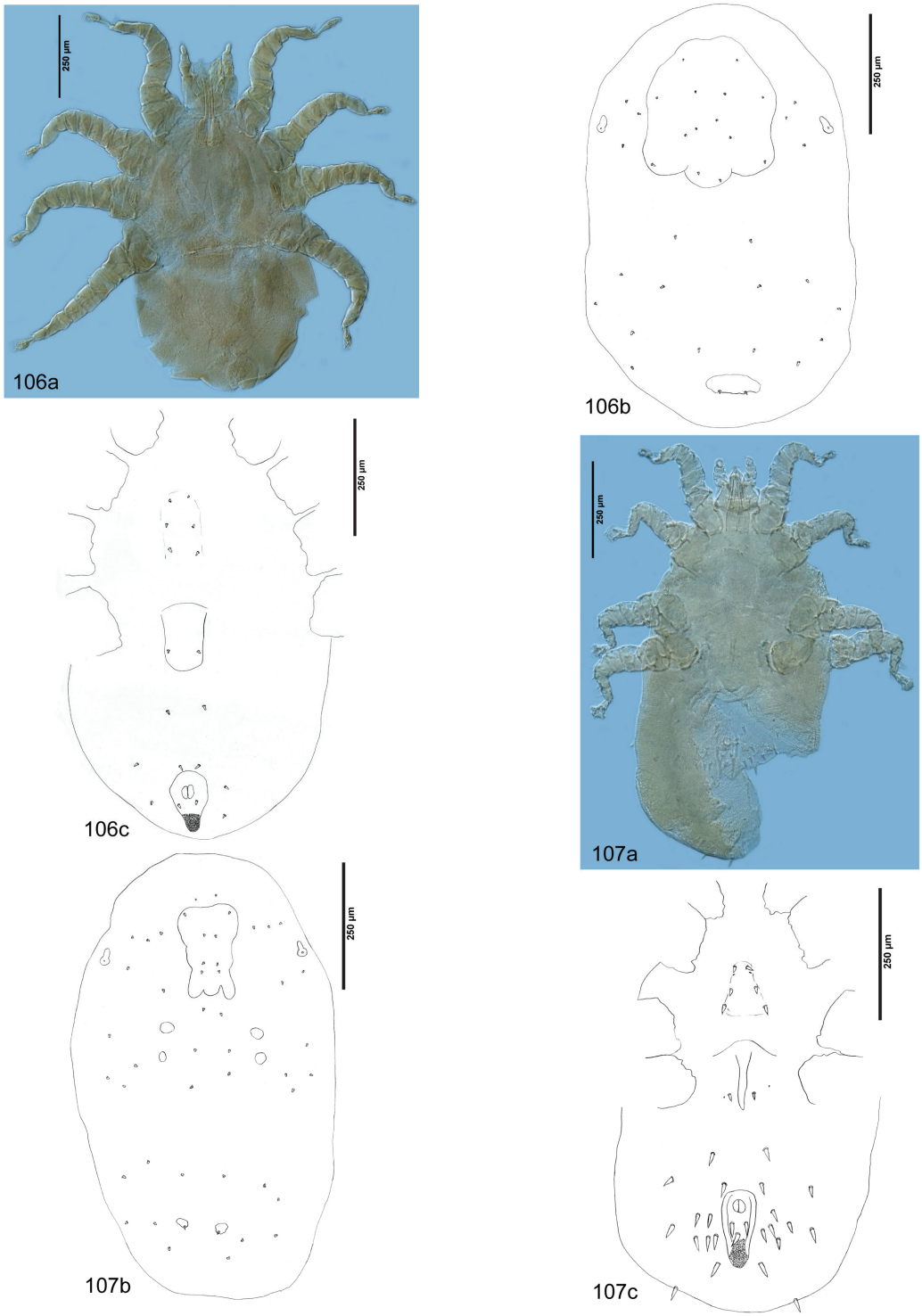

Figures 106-107. 106, *Ptilonyssus perisorei* female, a. dorsal habitus, b. dorsum, c. venter. 107, *P. echinatus* female, a. dorsal habitus, b. dorsum, c. venter.

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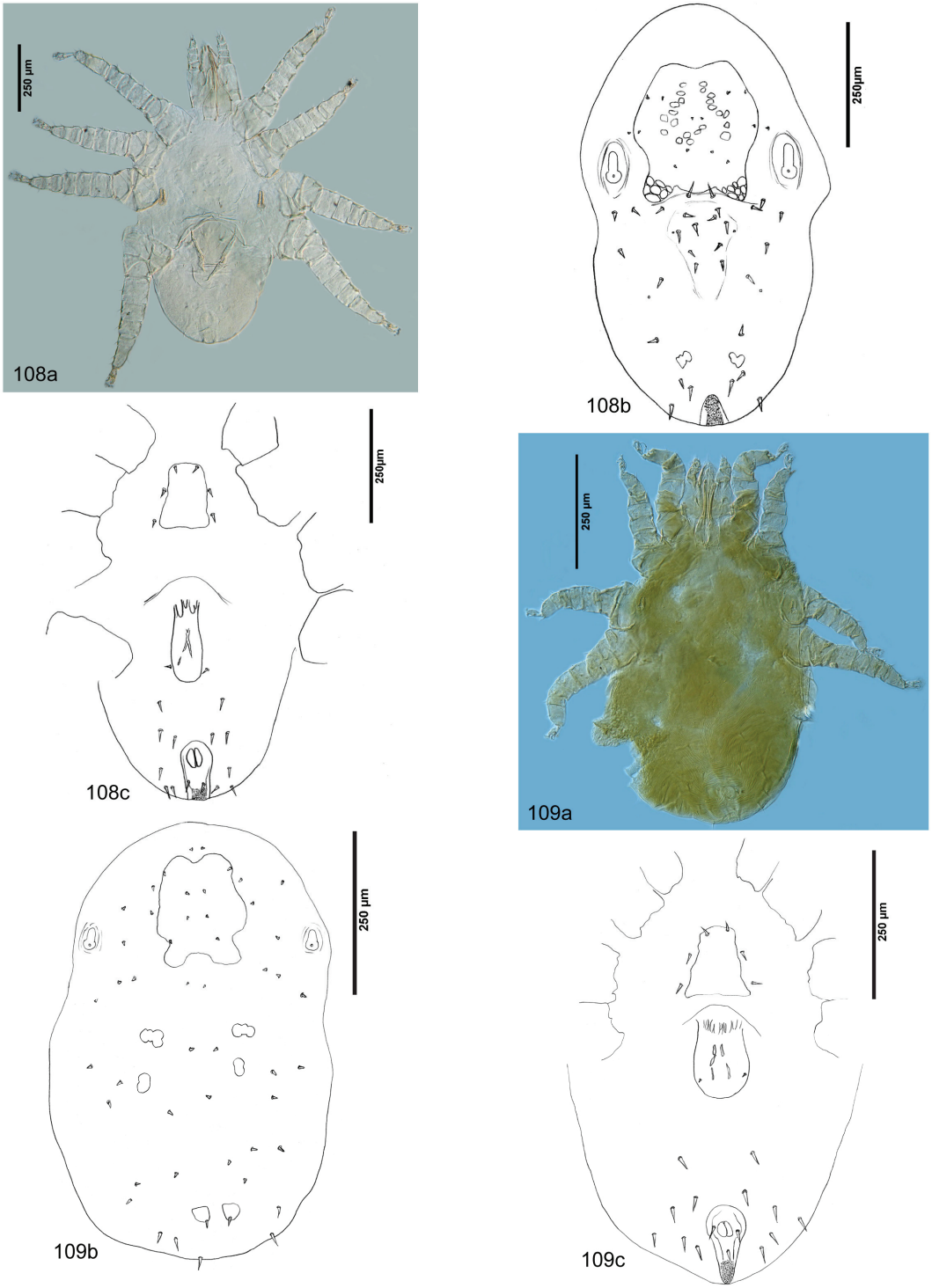

Figures 108-109. 108, *Ptilonyssus cerchneis* female, a. dorsal habitus, b. dorsum, c. venter. 109, *P. troglodytis* female, a. dorsal habitus, b. dorsum, c. venter.

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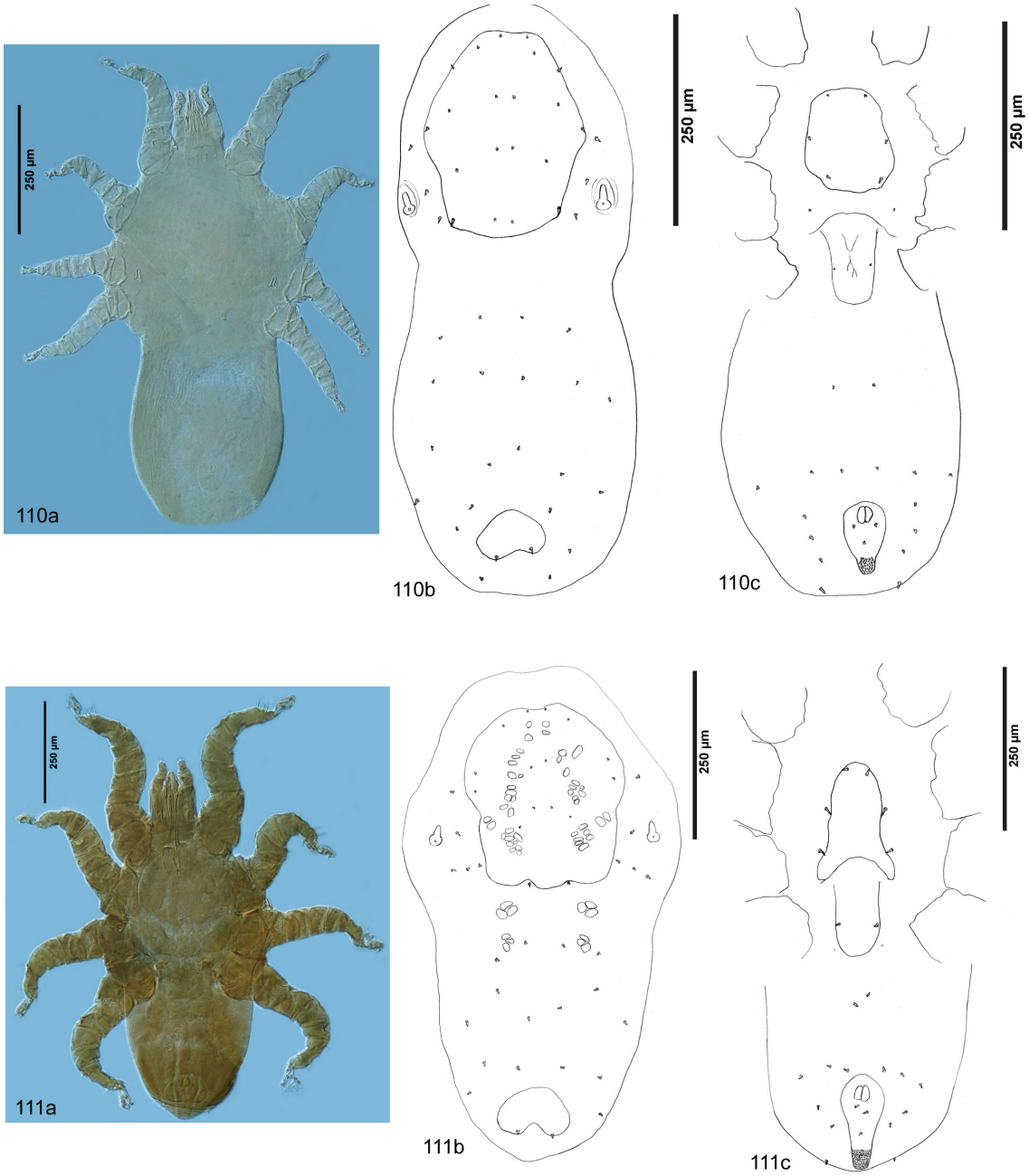

Figures 110-111. 110, *Ptilonyssus nudus* female, a. dorsal habitus, b. dorsum, c. venter. 111, *P. bombycillae* female, a. dorsal habitus, b. dorsum, c. venter.

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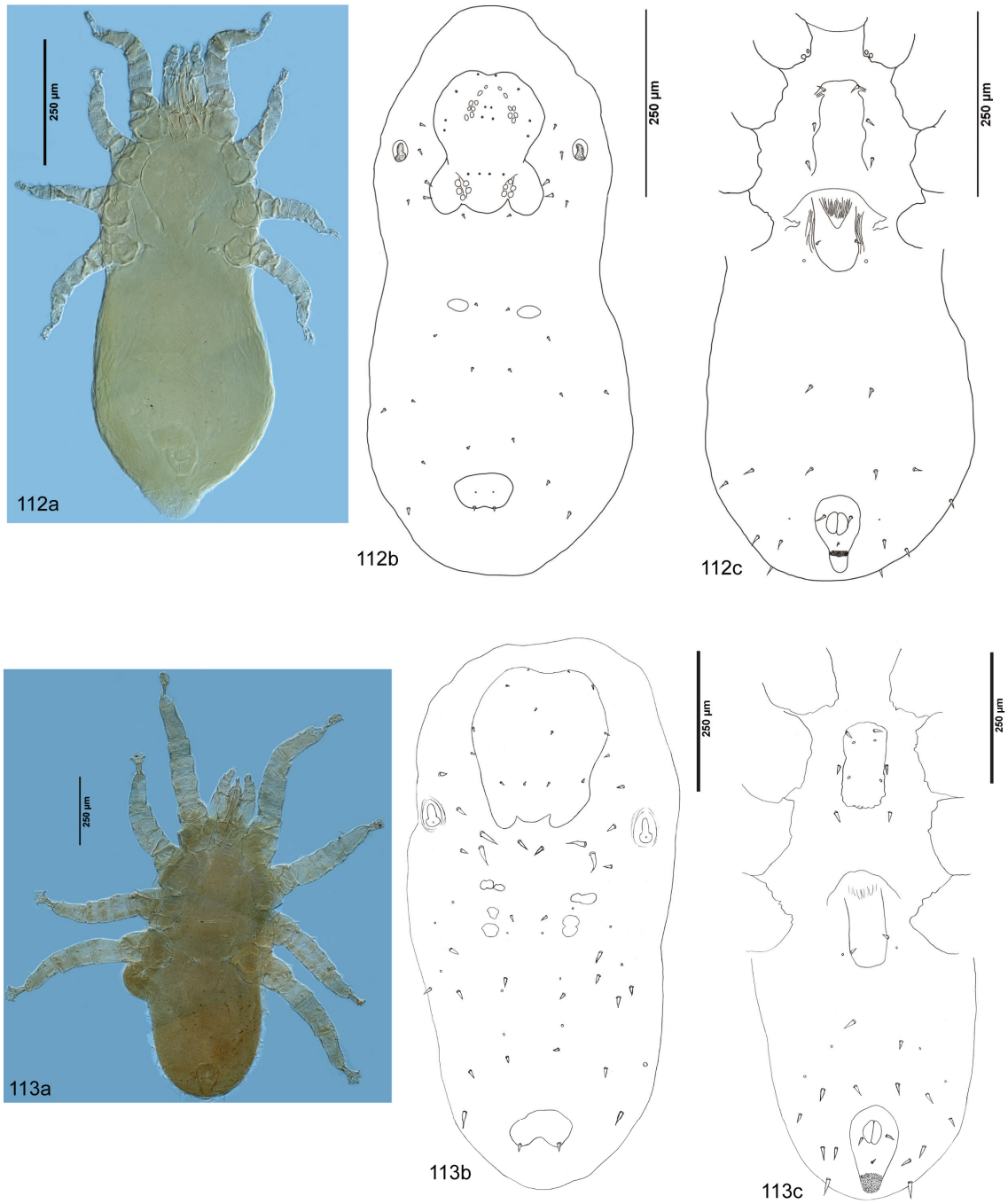

Figures 112-113. 112, *Ptilonyssus calvaria* female, a. dorsal habitus, b. dorsum, c. venter. 113, *P. euroturdi* female, a. dorsal habitus, b. dorsum, c. venter.

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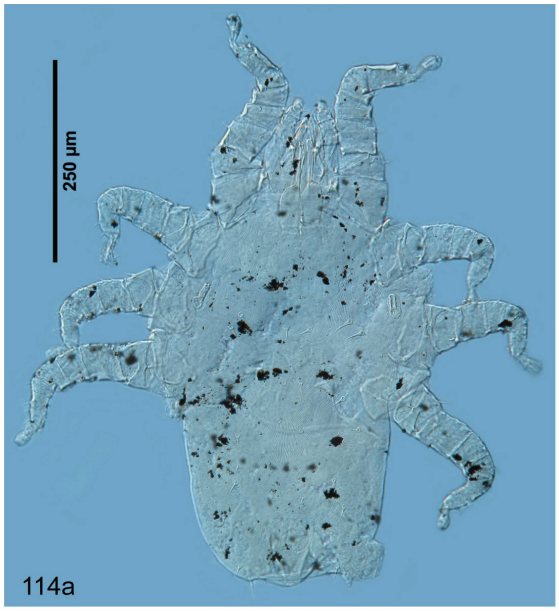

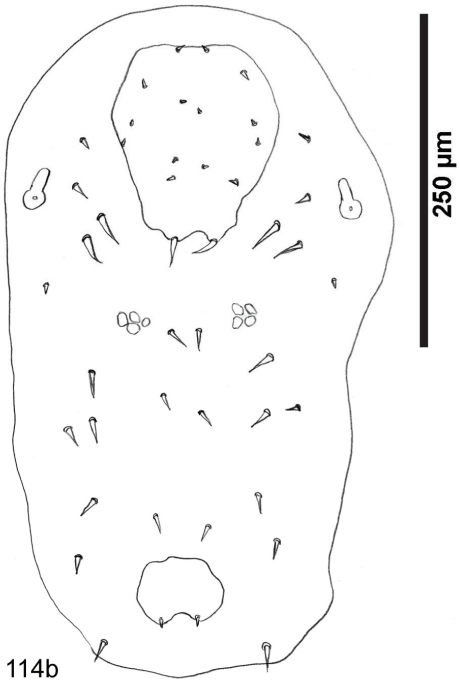

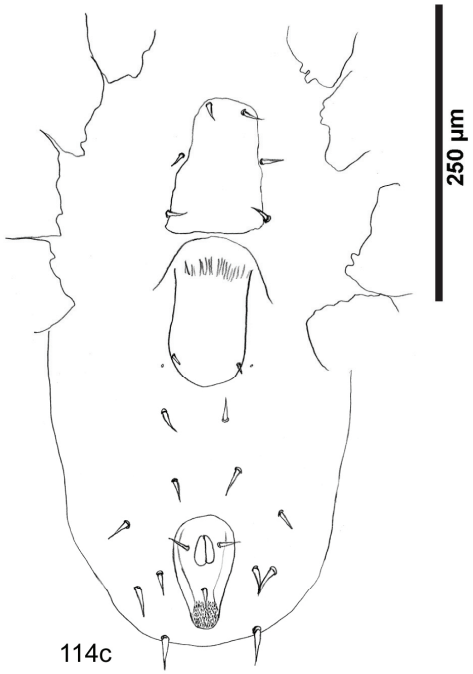

Figure 114, *Ptilonyssus acrocephali* female, a. dorsal habitus, b. dorsum, c. venter.

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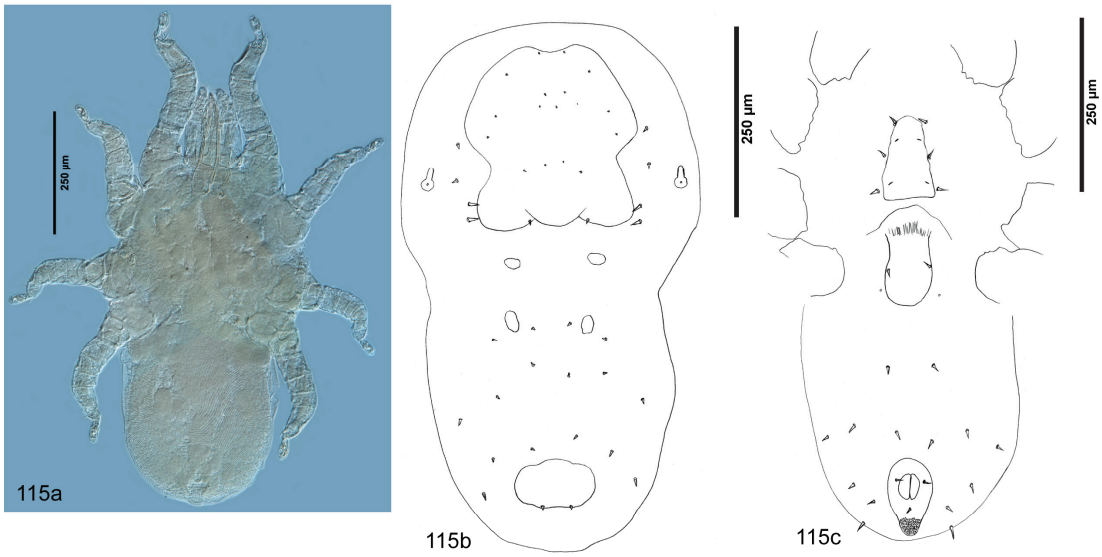

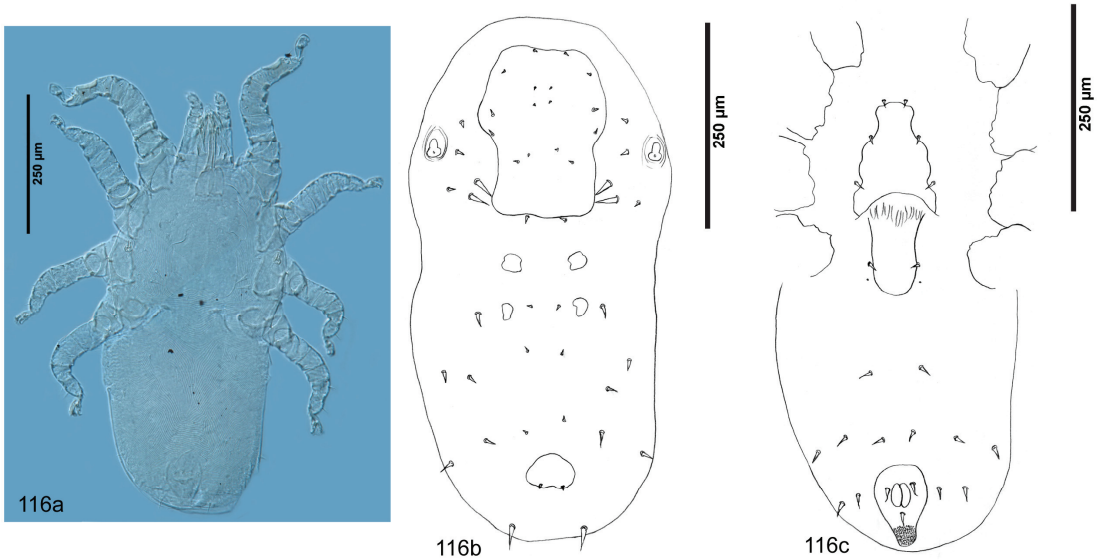

Figures 115-116. 115, *Ptilonyssus japuibensis* female, a. dorsal habitus, b. dorsum, c. venter. 116, *P. sairae* female, a. dorsal habitus, b. dorsum, c. venter.

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Table 1. Rhinonyssid species associated with Canadian birds.

Mite species	Author
Ptilonyssus acrocephali	Fain, 1964
Ptilonyssus angrensis	(Castro, 1948)
Ptilonyssus bombycillae	Fain, 1972
Ptilonyssus callinectoides	(Brooks and Strandtmann, 1960)
Ptilonyssus calvaria	Knee, 2008
Ptilonyssus carduelis	Fain, 1962
Ptilonyssus cerchneis	Fain, 1957
Ptilonyssus coccothraustis	Fain and Bafort, 1963
Ptilonyssus echinatus	Berlese & Trouessart, 1889b
Ptilonyssus euroturdi	Fain & Hyland, 1963
Ptilonyssus hirsti	(Castro & Periera, 1947)
Ptilonyssus icteridius	(Strandtmann and Furman, 1956)
Ptilonyssus japuibensis	Castro, 1948
Ptilonyssus morofskyi	Hyland, 1962
Ptilonyssus nivalis	Knee, 2008
Ptilonyssus nudus	Berlese & Trouessart, 1889a
Ptilonyssus perisorei	George, 1961
Ptilonyssus pinicola	Knee, 2008
Ptilonyssus pirangae	(Cerny, 1969)
Ptilonyssus plesiotypicus	Knee, 2008
Ptilonyssus sairae	Castro, 1948
Ptilonyssus troglodytis	Fain, 1964
Ptilonyssus tyrannus	(Brooks and Strandtmann, 1960)
Ptilonyssus vireonis	(Dusbabek, 1969)
Rallinyssus caudistigmus	Strandtmann, 1948
Rhinoecius aegolii	Butenko, 1971
Rhinoecius alifanovi	Butenko, 1976
Rhinoecius brikinboricus	Butenko, 1976
Rhinoecius cooremani	Strandtmann, 1952

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Table 1 cont...

Mite species	Author
Rhinoecius grandis	Strandtmann, 1952
Rhinoecius nycteae	Butenko, 1976
Rhinonyssus coniventris	Trouessart, 1894
Rhinonyssus rhinolethrum	(Trouessart, 1895)
Sternostoma boydi	Strandtmann, 1951
Sternostoma cryptorhynchum	Berlese and Trouessart, 1889a
Sternostoma hylandi	Fain and Johnston, 1966
Sternostoma laniorum	Fain 1956
Sternostoma longisetosae	Hyland, 1961
Sternostoma loxiae	Fain, 1965
Sternostoma porteri	Hyland, 1962
Sternostoma sialiphilus	Hyland and Ford, 1961
Sternostoma technaui	(Vitzthum, 1935)
Sternostoma tracheacolum	Lawrence, 1948
Sternostoma setifer	Knee, 2008
Tinaminyssus columbae	(Crossley, 1950)
Tinaminyssus melloi	(Castro, 1948)
Tinaminyssus zenaidurae	(Crossley, 1952)

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