



## A new genus and species of Cheyletidae (Acariformes: Prostigmata) from citrus trees in Florida

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### Abstract

A new genus and species, *Lanceacheyla whartoni* (Acariformes: Prostigmata: Cheyletidae) is described for the female, male, and teleonymph. All mites were collected from leaves of 'Hamlin' orange trees in Florida, U.S.A. Affinities of the new genus within Cheyletidae are discussed.

**Key words:** Cheyletidae, *Lanceacheyla*, new genus, new species

### Introduction

The family Cheyletidae Leach (Acariformes: Prostigmata) is quite diverse, both taxonomically and ecologically (including free living predators, parasites of vertebrates, and obligate associates of invertebrates). Volgin (1969, 1987) recognized 10 tribes and 54 genera, Summers and Price (1970) listed 50 genera and close to 190 species, and Gerson *et al.* (1999) listed a total of 76 genera and more than 400 species. Bochkov and Fain (2001) presented the first phylogenetic analysis of intrafamilial relationships, which largely confirmed Volgin's classification. These authors recognized 72 valid genera for the family. Currently, the Cheyletidae includes about 370 species belonging to 73 genera (Bochkov 2004).

A series of surveys and field assessments of soft pesticide programs intended to minimize pest mite populations and to optimize beneficial mites on Florida citrus were conducted between 1991 and 2004 (Childers *et al.*, unpublished data). As a result of these studies, we obtained a number of Cheyletidae that could not be assigned to any existing genus. The material included females, males, and nymphs, thus allowing description of multiple instars, and proper delineation of differences among instars. The goal of this study is to describe a new genus to accommodate these specimens. Affinities of this new genus are explored in the context of the Bochkov and Fain (2001) study.

### Material and methods

The nomenclature of the idiosomal and leg setae follows Grandjean (1939, 1944), as implemented by Bochkov *et al.* (2008).

Illustrations were prepared starting with pencil drawings using a drawing tube on a Zeiss Axioskop™ compound microscope. Final processing was done in Adobe Photoshop™ (Adobe Systems Incorporated, San Jose, California) based on scans of inked images. Measurements were taken using an ocular micrometer, and are presented in micrometers (µm) in the format holotype (average; range) for the female or average (range) for the nymphs.

The second nymphal instar in Cheyletidae may be homologous to the ancestral deutonymph but this point is still unclear. We therefore prefer to retain the term teleonymph to designate this instar.

Specimen depository abbreviations: FSCA: Florida State Collection of Arthropods, Gainesville; OSAL: Ohio State University Acarology Collection, Columbus; ZIN: Zoological Institute Russian Academy of Sciences, St. Petersburg.

## Taxonomic section

### *Lanceacheyla* Xia, Klompen and Childers, gen. nov.

**Type species:** *Lanceacheyla whartoni* Xia, Klompen and Childers, sp. n.

**Diagnosis.** Female: palp tarsus with 4 setae, 2 comb-like and 2 sickle-like. Palp claw with 5–6 teeth. Palp tibia with 3, genu with 2, and femur with 3 setae. Rostral shield with granulate texture. Peritremes arched, with 6–7 pairs of links. Eyes absent. Dorsum with an anterior and a posterior shield, both with similar squamiform setae; humeral setae (*c2*) lanceolate, elongate, almost twice as long as dorsal shield setae. Modest hypertrichy of “*c*” setae on anterior dorsal shield, posterior shield with 9 setae. Setae *ps1*–*ps3* and outer seta on coxal field III smooth, filiform. All legs shorter than idiosoma, all tarsi with smooth claws and well-developed empodia. Solenidion  $\phi$  on tibia II present, tibia I seta *v*” and femur III seta *v* absent.

Male: most characteristics as in female but humeral setae (*c2*) narrowly squamiform, not lanceolate; longer than dorsal setae. Posterior dorsal shield with 7, rather than 9, setae.

Teleonymph: most characteristics as in female but dorsum with one large anterior and five smaller posterior shields. All dorsal shield setae narrowly squamiform; humeral setae (*c2*) lanceolate, almost twice as long as other dorsal shield setae.

**Etymology.** The generic name is a combination of “*lancea*” (lance) to indicate the shape of the humeral setae and “*cheyletia*”, a common generic ending in Cheyletidae.

### *Lanceacheyla whartoni* Xia, Klompen and Childers, sp. n.

(Figs. 1–12)

**Diagnosis.** As for genus.

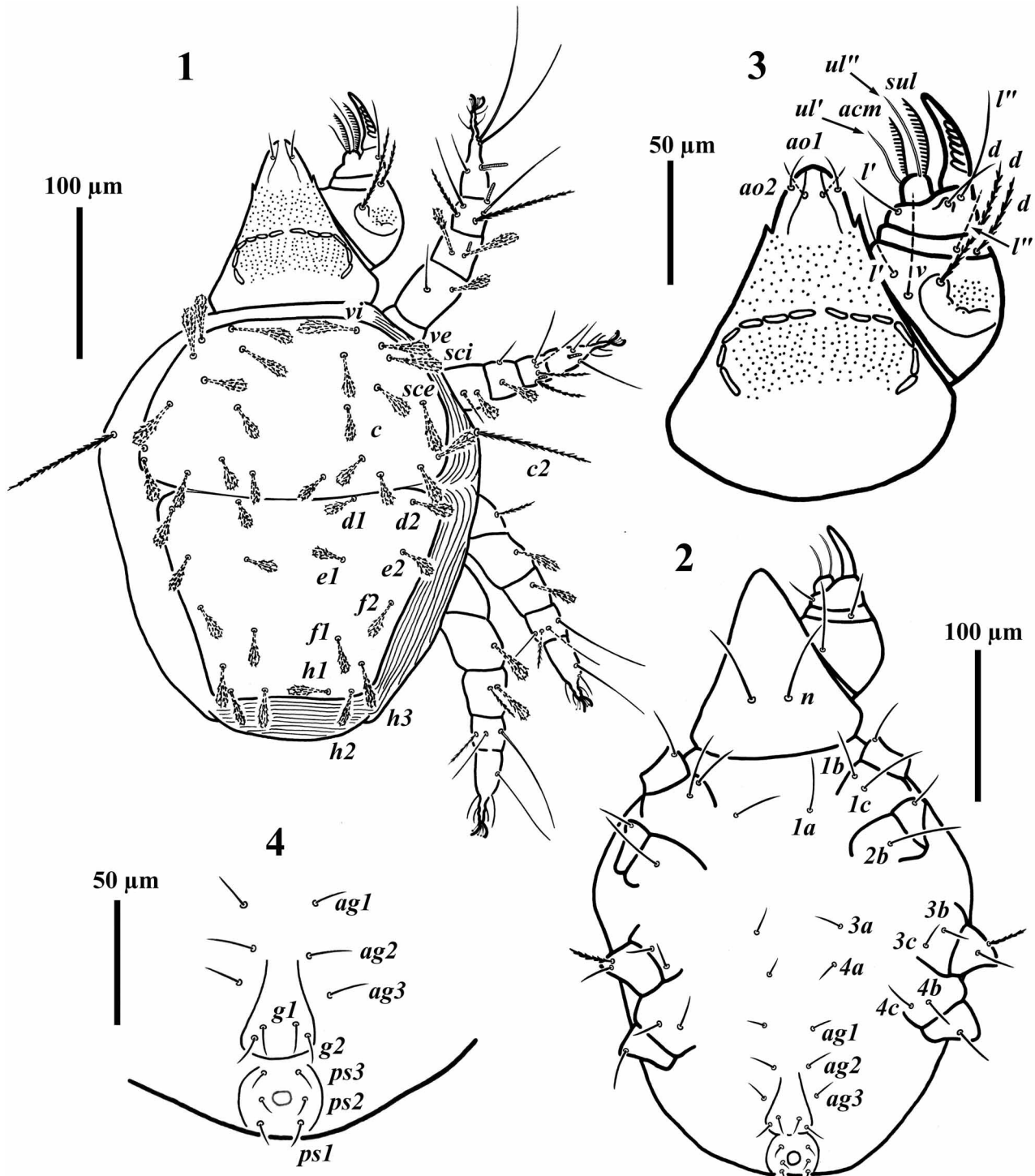
**Description.** Female (N=5) ( Figs. 1–8 ). Body length (including gnathosoma) 401 (390; 378–401), maximum width 253 (230; 207–253).

*Gnathosoma* (Fig. 3). Length 135 (136; 130–141), width 117 (117; 111–120). Rostrum broadly conical, with two pairs of apical (*ao1*, *ao2*) and one pair of ventral (*n*) setae. Rostral shield with granular surface. Peritremes arched, with 6–7 pairs of links. Palp femur length 52 (52; 49–55), width 62 (61; 57–64); with three setae, one lanceolate dorsal (*d*) 57 (51; 48–57) and two smooth and filiform ventral (*l'*, *v*). Palp genu with one lanceolate dorsal (*d*) [38 (38; 36–38)], and one filiform ventral (*l''*) seta. Palp tibia with three filiform setae (*d*, *l'*, *l''*). Palp tibial claw with 5–6 teeth. Palp tarsus wider than long, bearing 2 comb-like (*acm*, *sul*) and 2 sickle-like (*ul'*, *ul''*) setae; seta *acm* with about 12 teeth, *sul* with about 17.

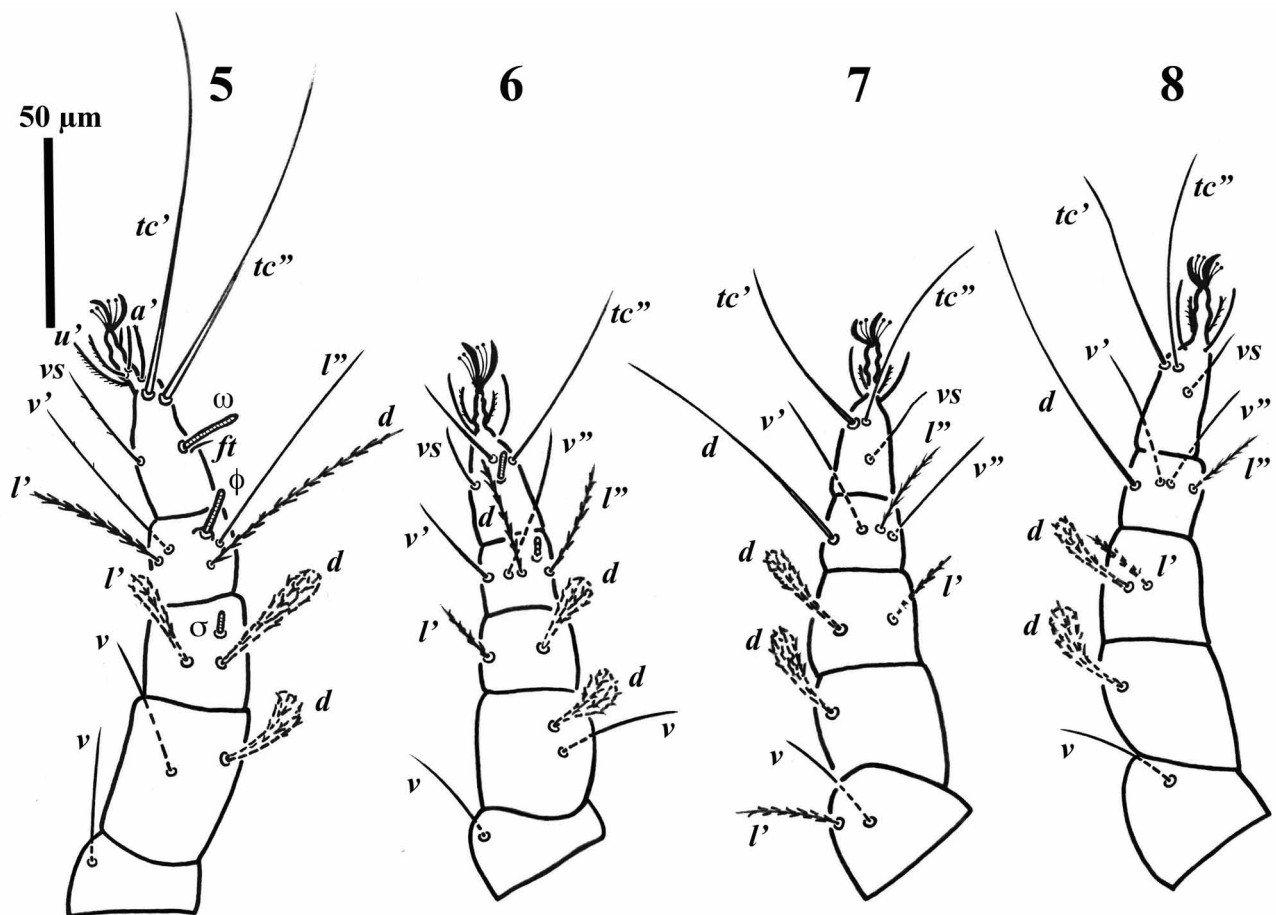
*Idiosoma* (Figs 1, 2, 4). Length 301 (296; 282–310). Dorsum largely covered by two well-sclerotized shields. Anterior dorsal shield length 122 (122; 117–129), maximum width 211 (200; 188–211); posterior dorsal shield with a straight anterior margin, abutting anterior shield; length 132 (137; 132–147) and width 199 (193; 179–199). Eyes absent. All dorsal shield setae squamiform. Anterior shield with 12 pairs of setae: 4 pairs of anterior-lateral setae, *vi*, *ve*, *sci*, and *sce* (length 33–41, width 8–12), and 8 pairs of “*c*” setae (length 25–28, width 8–10). Humeral setae (*c2*) situated off anterior shield, lanceolate, length 69 (71; 66–75); almost twice as long as anterior-lateral setae. Posterior shield with 9 pairs of setae (*d1*, *d2*, *e1*, *e2*, *f1*, *f2*, *h1*, *h2*, *h3*), slightly shorter than those on the anterior shield. Interscutal membrane striate, without additional ornamentation. Venter: without shields. Coxal field I–IV with, respectively, three (*1a*, *1b*, *1c*), one (*2b*), three (*3a*, *3b*, *3c*), and three (*4a*, *4b*, *4c*) setae. Genital and anal region adjoining. Anal region with three pairs of *ps* setae, genital area with two pairs of genital (*g*) setae; three pairs of aggenital (*ag*) setae anterior to the genital region. All ventral setae smooth, filiform.

*Legs* (Figs 5–8). All legs shorter than idiosoma. All tarsi with smooth claws and well developed empodia. Lengths of legs I–IV 202 (203; 197–207), 168 (164; 160–168), 175 (169; 166–175), and 201 (196; 188–201),

respectively. Chaetotaxy of legs I–IV (number of solenidia in brackets): tarsi 9(1)-7(1)-7-7, tibiae 4(1)-4(1)-4-4, genua 2(1)-2-2-2, femora 2-2-1-1, trochanters 1-1-2-1. Tibia I seta *v''* and femur III seta *v* absent. Tarsal setae *u'* and *u''* with very distinct barbs, *vs* I–II with few small barbs; *p'*, *p''* and *a'* I blunt tipped, slightly wider in middle than at base or tip, *a'* I with a few barbs near distal end. Other leg segments: *dG* I–IV, *l'G* I and *dF* I–IV squami-form, *dTi* I–II, *l'Ti* I, *l''Ti* II–IV, *l'G* II–IV and *l'Tr* III lanceolate, all other leg setae smooth, setiform. Tarsal solenidia located median on tarsi I–II, at level of seta *vs*.; solenidium  $\omega$  I of medium length, with a small guard seta *ft* (5);  $\omega$  II short. Tibial solenidium  $\phi$  I of median length,  $\phi$  II short. Genual solenidium  $\sigma$  I short. Empodia I–IV each with 4 (rarely 3–5) pairs of tenant hairs.



**FIGURES 1–4.** *Lanceacheylea whartoni* gen. nov., sp. nov., female. 1, Dorsal view; 2, Ventral view; 3, Gnathosoma, dorsal view; 4, Genito-anal region.



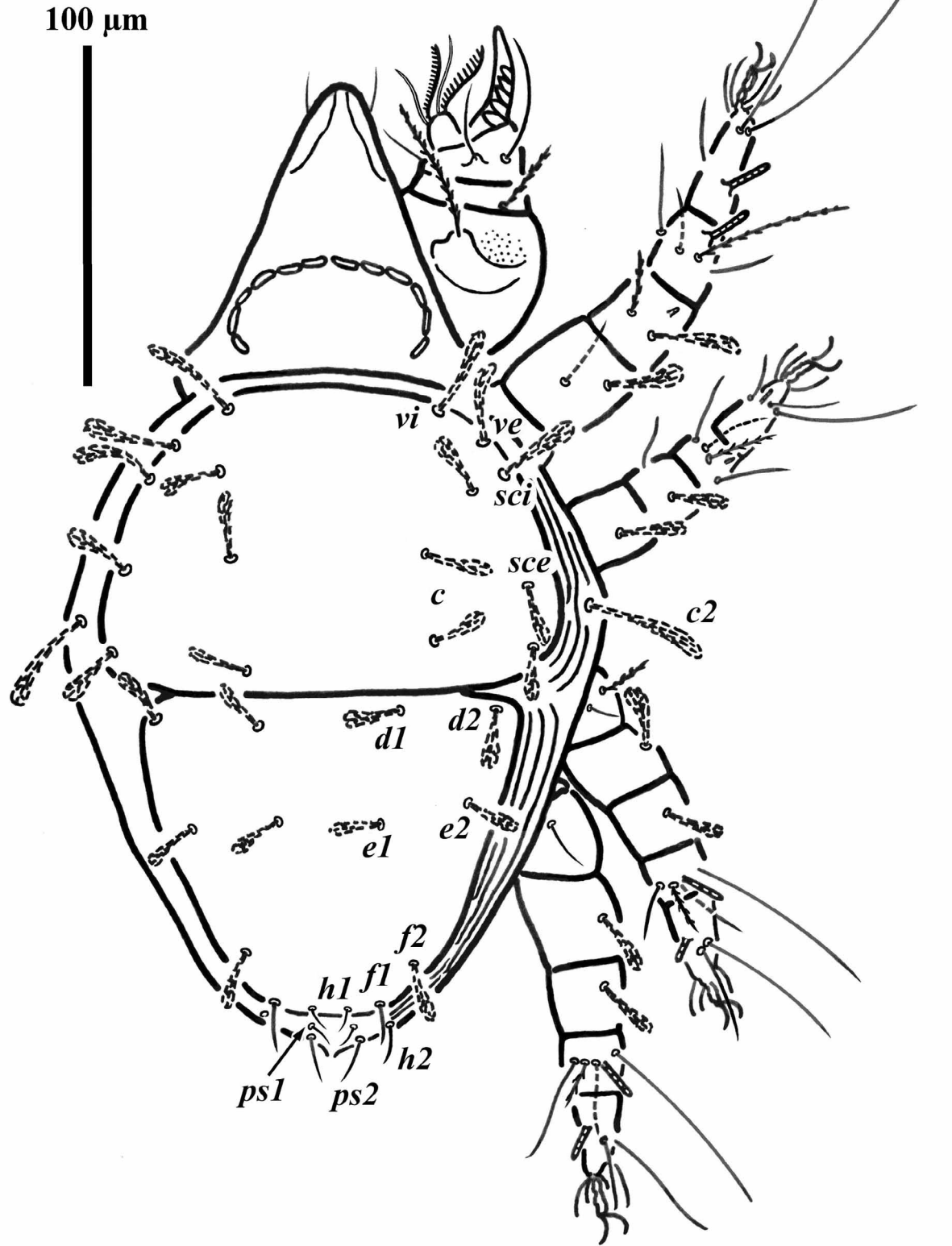
FIGURES 5–8. *Lanceacheylea whartoni* gen. nov., sp. nov., female. 5, Leg I; 6, Leg II; 7, Leg III; 8, Leg IV.

Male (N=1) (Fig 9). Body length (including gnathosoma) 311, maximum width 175. Gnathosoma as in female. Idiosomal length 228, with two dorsal shields. Anterior dorsal shield length 99, maximum width 137; bearing 8 pairs of narrowly squamiform setae (including 4 pairs of “c” setae). Humeral setae (c2) situated off dorsal shields, narrowly squamiform, 1/3 longer than anterior-lateral setae. Posterior dorsal shield length 102 and width 132, bearing 5 pairs of narrowly squamiform (d1, d2, e1, e2, f2) and 2 pairs of filiform (h1, f1) setae; setae h2, ps1 and ps2 inserted off the shields, filiform. Ventral setation reduced relative to female, setae g1, g2, and ag3 absent. Leg chaetotaxy as in female, but solenidiotaxy different. Relative to the female, solenidion ω added on tarsi III–IV and solenidion φ added on tibiae III–IV.

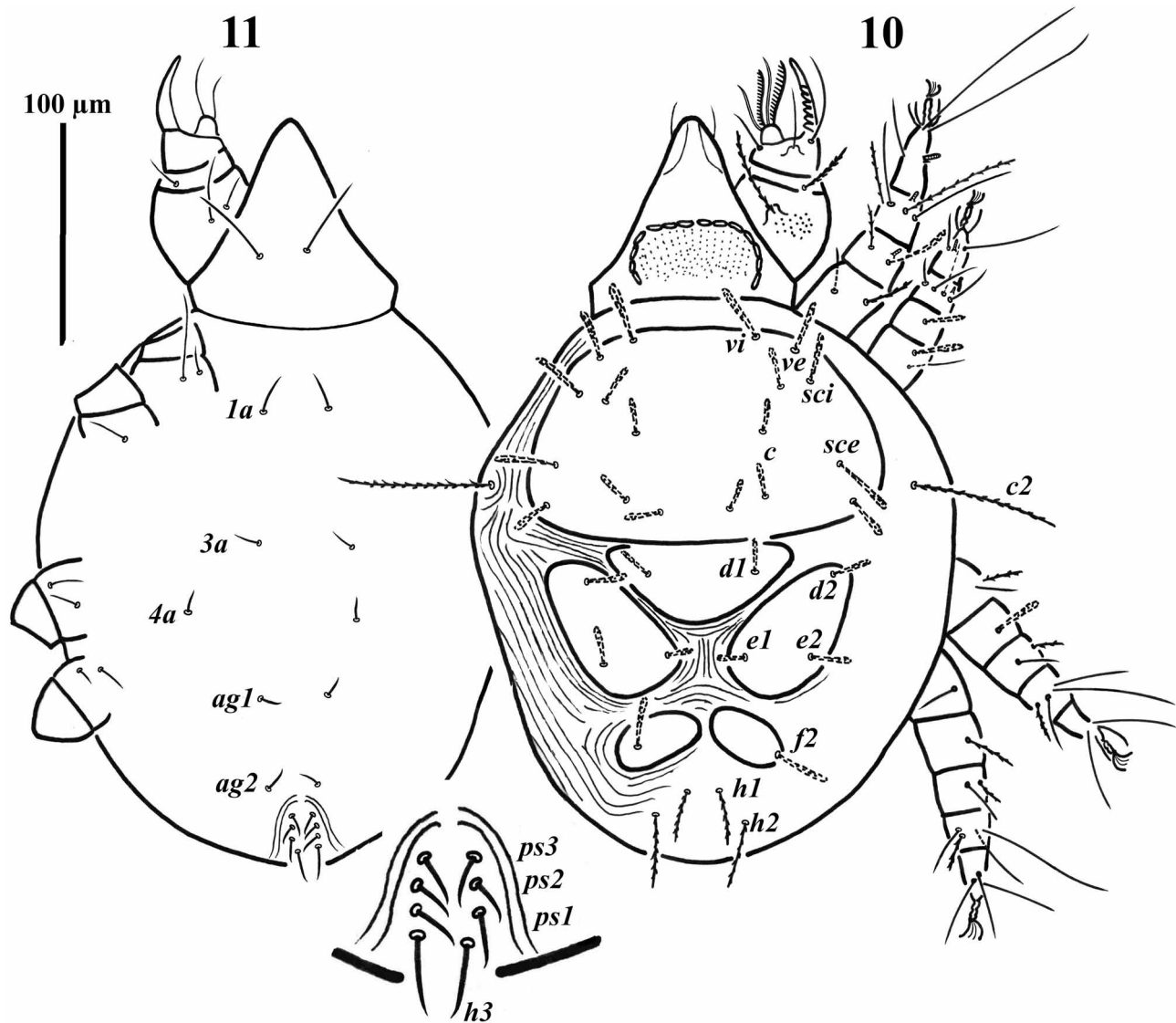
Teleonymph (N=3) (Figs. 10–12). Body length (including gnathosoma) 338 (327–352), maximum width 206 (197–217). Gnathosoma as in female. Idiosomal length 255 (248–263), with 6 dorsal shields: one large anterior and five smaller posterior shields. All dorsal shield setae narrowly squamiform. Anterior dorsal shield length 100 (98–102), maximum width 172 (169–179), bearing 9 pairs of setae (including 5 pairs of “c” setae). Humeral setae (c2) situated off dorsal shields, lanceolate, 70 long (70–71), almost twice as long as anterior lateral setae. Among the 5 posterior shields, the anterior median shield with setae d1, paired anterior lateral shields with setae d2, e1, and e2, and posterior lateral shields with setae f2; setae h1 and h2 inserted off the shields, lanceolate. The genito-anal regions are fused (not adjoining as in the female), and carry the h3, ps1, ps2 and ps3 setae, setae g1, g2 absent. As in the male, the nymph carries only 2 pairs of ag setae (ag3 absent). Leg chaetotaxy and solenidiotaxy as in female.

**Collection information.** Holotype female: U.S.A.: Florida, Hardee Co., 10 km S of Ona, Lilly, 27°21'59"N 81°57'56"W (test plot 98-5), coll. C. C. Childers, 1 Jun 1998. Paratypes female (same locality and collector), male, 18 Dec 1998, and two nymphs, 20 Jan 1999 (all lot E20098177-2); two paratype females and one nymph from Florida, Lake Co., vicinity of Monteverde, 28°35'53"N 81°40'19"W (test plot 98-6), coll. C. C. Childers, 19 Jan 1999 (OSAL106573–5); one paratype female, Florida, Highlands Co., 6 km SE of Avon Park (27°33'09"N 81°27'23"W) (test plot 2000-3), collector C. C. Childers, 10 Jul 2000 (OSAL106576). All specimens were collected in leaf samples from ‘Hamlin’ oranges.

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FIGURES 9. *Lanceacheylea whartoni* gen. nov., sp. nov., male. 9, Dorsal view.



**FIGURES 10–11.** *Lanceacheyla whartoni* gen. nov., sp. nov., teleonymph: 10, Dorsal view; 11, Ventral view. Detail view genito-anal region.

**Deposition types.** Holotype female (E2009-8177-1), paratype female (E2009-8177-2a), male (E2009-8177-2b), and 2 nymphs (E2009-8177-2c–d) in FSCA. Paratype female (OSAL0106573) and paratype nymph (OSAL0106575) in OSAL; paratype female (OSAL0106574) in ZIN.

**Etymology.** We are pleased to name this species in honor of Dr. George W. Wharton, founder of the Acarology Laboratory, Ohio State University, who made outstanding contributions to acarology.

### Affinities of the new taxon

Assessment of affiliation of the new taxon proved somewhat complicated, as it shows a mosaic of characters. To more accurately determine affinities we added the new taxon to the matrix for cheyletid genera generated by Bochkov and Fain (2001). Based on raw differences as expressed through this analysis, and using the latest classification for the family, we generated low numbers of differences (4 or less) with multiple lineages within the tribe Cheyletini (*Cheletacarus* group, *Cheyletus* group, *Cheletomimus* group, *Cheletonella*) and with members of the Acaropsellini. Notably, of the above taxa that include more than one genus only the *Cheletomimus* group and the Acaropsellini proved to be monophyletic in the Bochkov and Fain (2001) study.

*Lanceacheyla* shares the lack of eyes with the *Cheyletus* group and *Cheletonella* Womersley (no group assigned). The structure of the nervous system in eye-less Cheyletidae has not yet been studied and it is unclear whether absence of eyes represents anything more than absence of lenses, as in, for example, some ixodid ticks (Binnington 1972). *Cheletonella* has (1) no or only a few neutrichous setae on the anterior dorsal shield [vs. >6 in *Lanceacheyla*], (2) solenidion  $\phi$  on tibia II absent [vs. present], and (3) femur III seta  $v$  present [vs. absent]. Inclusion of the new taxon would force a substantial revision of the concept of *Cheletonella*, which seems ill advised. Ecologically, the match is also poor, given that previous records of *Cheletonella* are from bat guano, bird nests, and soil.

Within this *Cheyletus* group the genus *Camincheyletus* Smiley & Whitaker has the inner comb-like seta on the palp tarsus weakly developed [vs. well developed *Lanceacheyla*], while *Zakhvatkiniola* Volgin and most *Eucheyletia* Baker are characterized by fan-like *ps1* setae [vs. filiform; *ps1* also filiform in *E. hardyi* Baker]. Potentially the best match would be with the genus *Cheyletus* Latreille (4 differences in matrix). In fact *Lanceacheyla* keys to *Cheyletus* in the Gerson *et al.* (1999) key. But even given the very expansive view of *Cheyletus* as presented by Fain and Bochkov (2001) and Bochkov and OConnor (2003), the new taxon fits poorly. In the female, *Cheyletus* species have (1) at most 3 pairs of neutrichous setae on the anterior dorsal shield [vs. 6–7 pairs in *Lanceacheyla*], (2) outer coxal field III seta and *ps1*, *ps2* setae barbed [vs. smooth], (3) solenidion  $\phi$  on tibia II absent [vs. present], (4) length of setae *tc'* and *tc''* on tarsus I not, or barely, exceeding the length of tarsus I (vs. distinctly longer). In addition, in most *Cheyletus* species (5) tibiae I seta  $v$  is present [vs. absent in *Lanceacheyla*], (6) each palp tibial claw usually has 4 or less basal teeth (vs 5–6; 4 to 5 teeth in *C. zumpti* Fain). Finally in male *Cheyletus* solenidia  $\omega$  III–IV and  $\phi$  III–IV are absent (Fain *et al.* 1997) (vs. present). The ecology is once again quite different, with members of the *Cheyletus* group most commonly found in nests of vertebrates or, more rarely, in soil and stored products.

If the presence/absence of eyes has no special significance, affinities with several other taxa are possible. The Acaropsellini are characterized by a shift in position of the ventral palp genu seta (*l'*) to the junction of genu and femur (vs. clearly on the genu in *Lanceacheyla*). This shift is extended in *Cheletomimus* Oudemans (and others), where this seta appears inserted on the femur. Acaropsellini also feature a strong reduction of the inner comb seta on the palp tarsus (vs well developed with numerous tines). These two characters support the monophyly of Acaropsellini in the Bochkov and Fain (2001) analysis. In addition, tarsal setae *tc'* and *tc''* I are of modest size (vs. long in *Lanceacheyla*). Most Acaropsellini have reduced or fragmented posterior dorsal shields, but *Acaropsellina* Summers features a complete posterior dorsal shield as seen in *Lanceacheyla*. Some *Acaropsellina* have been collected from plants, providing an ecological match. Even so, the absence of the unique derived states characterizing Acaropsellini makes us hesitant to include *Lanceacheyla* in this lineage.

All remaining possibly related groups are in the tribe Cheyletini. An intriguing possibility is *Paracheyletiella* Kuznetsov (*Cheletacarus* group). Differences among characters included in the matrix are limited to presence of eyes (vs. absence in *Lanceacheyla*), the presence of only 3 pairs of “c” setae on the anterior dorsal shield (vs. 7–8 pairs), and short *tc'* and *tc''* on tarsus I (vs. long). *Paracheyletiella* also differs in the structure of the posterior dorsal shield: two small posterior dorsal shields (each with 2 setae) vs. a single, large shield in *Lanceacheyla* (with 9 pairs of setae). *Paracheyletiella* was collected from tree holes in the Crimea, a weak ecological match. A better ecological match would be with *Cheletomimus* (*Cheletomimus* group), a genus of short-legged plant inhabiting cheyletids (very similar to *Lanceacheyla*). But other than the 3 main differences noted for *Paracheyletiella* (eyes, neutrichy of “c” setae, and tectal setae) this genus also differs by the repositioning of ventral palp genu seta *l'* to the palpal femur (vs. retained on genu in *Lanceacheyla*), and the presence of a nipple-like protrusion on tarsus I (vs. absent).

In summary, the new genus appears most similar to various taxa in the tribe Cheyletini. However, barring an extensive additional, species-level, analysis of relationships in that lineage, we cannot assign it to any existing grouping, and leave it as unassigned within the tribe.

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