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A new eriophyoid mite species, *Diptilomiopus floridanus* (Acari: Eriophyoidea: Diptilomiopidae), from citrus in Florida, USA

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Abstract

A new eriophyoid mite species, *Diptilomiopus floridanus* **sp. nov.**, (Eriophyoidea: Diptilomiopidae) is described and illustrated from various *Citrus* spp. in Florida, USA. This is the second *Diptilomiopus* sp. known on citrus worldwide and the third on plants of Rutaceae. A key is provided for six *Diptilomiopus* spp. including the new species.

Key words: Prostigmata, Trombidiformes, taxonomy, plant pest, citrus rust mite, citrus pest

Introduction

The Eriophyoidea is a superfamily of microscopic, worm-like, obligatory phytophagous mites. Some eriophyoid species are economically important crop pests (Jeppson *et al.* 1975). Three eriophyoid pests are known on Florida citrus: *Phyllocoptruta oleivora* (Ashmead) (citrus rust mite), *Aculops pelekassi* (Keifer) (pink citrus rust mite), and *Aceria sheldoni* (Ewing) (citrus bud mite) (Childers & Achor 1999). These species all belong to the Eriophyidae. During a routine survey of citrus trees in the Hollywood, Florida area, K. M. Griffiths and M. E. Meadows, Pest Survey Specialists with USDA, APHIS, Bureau of Cooperative Agricultural Pest Survey (CAPS), discovered a slight infestation of an unusual looking mite on a sour orange (*Citrus aurantium* L.) tree in John Williams Park. The mite was tentatively identified as *Diptilomiopus assamica* Keifer (citrus leaf vagrant) (Welbourn 2008), a species belonging to the Diptilomiopidae. However, when multiple specimens were examined by the second author, some characteristics differed from the original description of *D. assamica*, and the mite was identified as a new, undescribed *Diptilomiopus* sp.

Diptilomiopus assamica is thus far the only *Diptilomiopus* sp. known from citrus. It was first described by Keifer (1959) from Jorhat, Assam, India. It has also been reported from Burniket, Assam (Keifer 1959) and West Bengal (Chakrabarti & Mondal 1983), India; and New Territories, Australia (Knihinicki & Boczek 2002). Welbourn (2008) reported *D. assamica* from the USA, but it was the new *Diptilomiopus* sp. described here, and not *D. assamica*.

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The type hosts of *D. assamica* were reported as "several varieties of oranges" and *Citrus limonia* Osbeck (lemandarin or Rangpur lime) (Rutaceae) (Keifer 1959). Other *Citrus* spp. specifically listed as its hosts were *Citrus limon* (L.) Burmann (lemon), *Citrus* x *paradisi* Macfad. (grapefruit) and *Citrus sinensis* (L.) Osbeck 'Valencia' (Valencia orange) (Keifer 1959; Knihinicki & Boczek 2002). *Diptilomiopus assamica* was reported as a rust mite, not causing serious damage (Keifer 1959). Gerson (2003) concluded that the pest status of *D. assamica* is largely unknown. On citrus in India, *D. assamica* is commonly associated with *P. oleivora* (Keifer 1959; Jeppson *et al.* 1975; Chakrabarti & Mondal 1983).

In this paper *Diptilomiopus floridanus* **sp. nov.** from citrus in Florida is described and illustrated. It is the second *Diptilomiopus* sp. found on citrus worldwide, the third on plants of Rutaceae, and the second *Diptilomiopus* sp. found in the USA. The other species in the USA, *Diptilomiopus panithus*[1] (Boczek & Chandrapatya), was found on *Mangifera indica* L. (mango) (Anacardiaceae) in Florida (Welbourn 2005). A key is provided to six *Diptilomiopus* spp.: *D. floridanus* **sp. nov.**, and five species relevant to this species, namely, *D. acronychia* Chen, Wei & Qin, *D. assamica*, *D. panithus*, *D. combreti* Wei & Lu and *D. euscaphiae* Wang, Wei & Yang.

Materials and Methods

Collection and preparation of mites. Eriophyoid mites were sampled from 526 dooryard and 18 varietal block citrus trees in Florida between May 2009 and April 2014 (Childers *et al.* 2017). Sampling of the individual citrus trees included removing from 5–12 clusters of leaves and associated twigs from each tree and washing them in approximately 250 ml of 80% ethanol (Childers & Ueckermann 2015). All mites were removed from each tree sample and representative numbers of eriophyoid mites were collectively slide-mounted on one or more slides using modified Berlese medium (Amrine & Manson 1996).

Scanning electron microscope technique. Mites were collected in 80% ethanol in the field. In the lab they were dehydrated further in ethanol (10% steps, 10 minute each step) from 80-100%. They were then dried using a Ladd Critical Point Dryer (Ladd Res. Ind., Burlington, VT), mounted on stubs, coated with gold/ palladium using a Ladd Sputter Coater (Ladd Res. Ind., Burlington, VT), viewed and photographed with an Hitachi S530 Scanning Electron Microscope (Hitachi High-Technologies Corporation, Japan).

Morphological study and description. The morphological terminology used herein follows Lindquist (1996) and the genus was identified using the generic key by Amrine *et al.* (2003). Slides were mounted and specimens were measured following de Lillo *et al.* (2010). Specimens were examined with a Zeiss Imager M2 research microscope with Phase Contrast Light Microscopy (PC LM) and Differential Interference Contrast Light Microscopy (DIC LM) using 100x oil objectives. Exact drawings of slide-mounted specimens were made with a drawing tube attached to the research microscope. All measurements are in µm. Type and identified specimens are deposited as slide-mounted specimens in the Florida State Collection of Arthropods (FSCA) in Gainesville, USA, and some in the mite collection of the National Collection of Arachnida (NCA) in Pretoria, South Africa. Duplicate slides of many of these are deposited in the collection of the second author.

1. Species name spelled *pamithus* in literature, emended to *panithus* by Chandrapatya *et al.* (2016a, p. 100), named after Mr. Panithan Chandrapatya.

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Description of new species

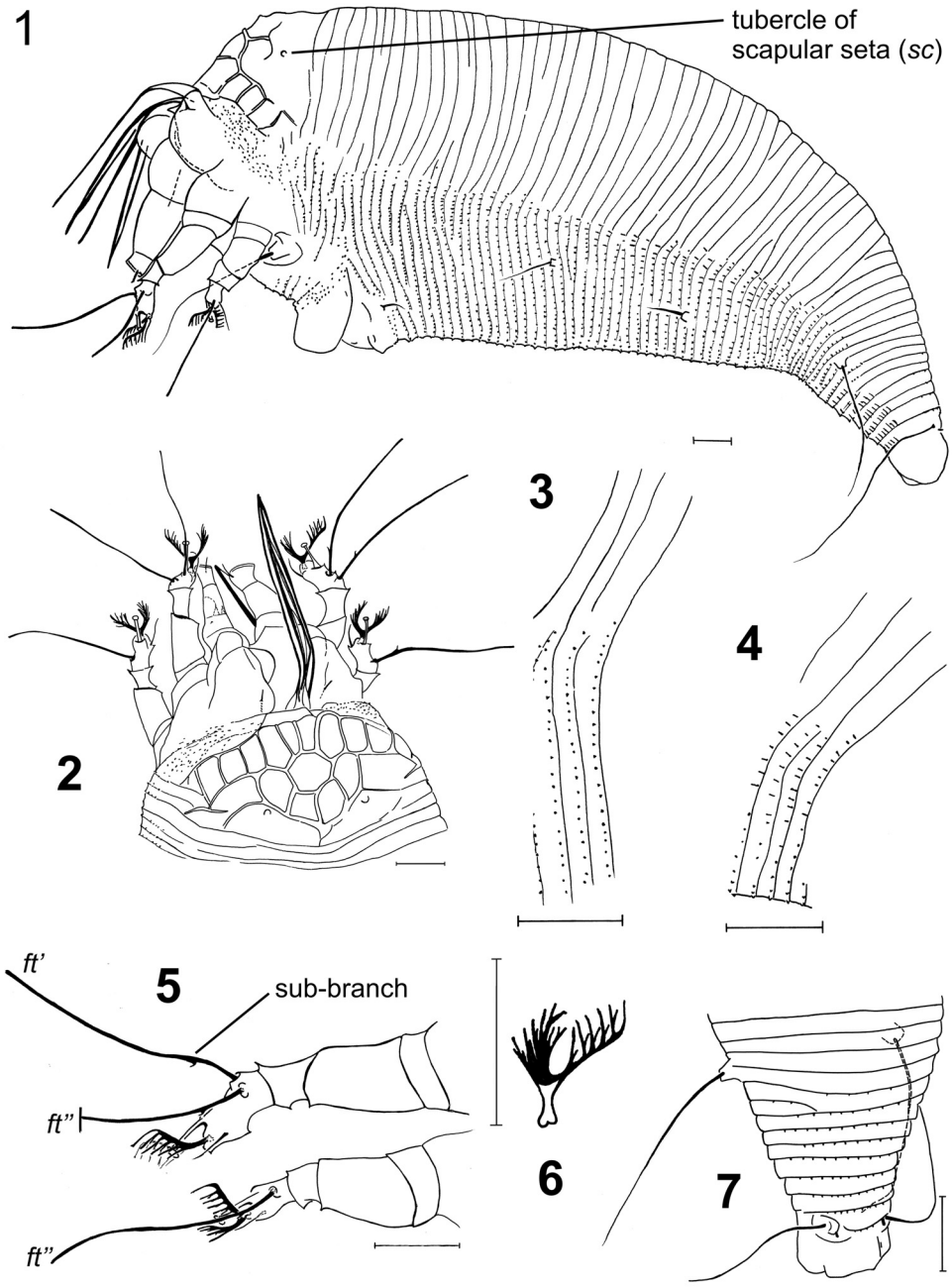
Diptilomiopus floridanus Craemer and Amrine **sp. nov.** (Figs 1–27, measurements and counts in Table 1)

Female (n = 90 for qualitative characteristics) (Figs 1–9, 15–22, 24–27). **Idiosoma**—Fusiform to somewhat elongate fusiform. **Gnathosoma**—Palp setae *ep* and *v* present; presence of palp setae *d* uncertain: the second author thought he could detect these setae, obscure and inserted on the medial surfaces of the palpi, and the first author could not detect them unambiguously among the other electron dense structures. **Prodorsal shield**—Similar to other *Diptilomiopus* spp., broadly oval and short, with a characteristic convex shape and posterior declivity; ornamentation on prodorsal shield consisting of ridges forming a cell-like pattern. Shield ornamentation includes parts of the median line, on the first and third quarter of the shield from the anterior shield margin; the cell-like pattern can be interpreted to be four rows of cells: 12 cells (six on each side of the median line) in anterior row (the sixth cell on either side is smaller and more obscure than the other cells), one cell in second row, visually in the center of pattern, and six cells in third row from anterior; two open cell-like areas formed by slight ridges present on basal declivity of shield could be vaguely determined in some specimens, forming the fourth, basal row. Area largely lateral to the shield and above the leg coxae (the second author regards this area as the lateral shield) with granules, sometimes forming vague circular patterns, and three incomplete annuli. Frontal lobe present, broader than long, apparently thin and flexible with anterior margin about straight; not overhanging basal parts of chelicerae entirely; usually inconspicuous in the slide-mounted specimens and difficult to detect. Tubercles of scapular setae (*sc*) present, small, rounded, anterior of posterior shield margin; setae *sc* absent. **Opisthosoma**—Evenly rounded; with middorsal longitudinal ridge on either side flanked by shallow furrow and subdorsal ridge, all declining posteriad, absent from about annulus 40 posteriad. Dorsal annuli without microtubercles; except about six posteriormost dorsal annuli with tiny triangular, pointed microtubercles extending from posterior annulus margins. Microtubercles on ventral annuli relatively small, rounded, sometimes slightly pointed, close to posterior margins of annuli, becoming progressively more elongate ridges from about level of *f* (on posteriormost *ca* 10 ventral annuli). Setae *h1* present, minute, largely shorter than one micron; setae *d*, *e*, *f* and *h2* relatively long and finely tapered. **Legs**—Setal complement of *Diptilomiopus*, and legs II with *ft'* absent; all setae *ft* on legs I and II relatively long and strong, not tapering to very thin apical ends, rather ending relatively bluntly, and each with a very short sub-branch with very thin thread-like apical end at about basal third; solenidion ω straight or slightly curved, noticeably knobbed. Empodium (*em*) with rays at angle against each branch, especially at base of *em*; therefore, rays could not be accurately counted on slide-mounted specimens or most SEM images, particularly in dorsal view. Empodium in lateral view usually clearly 6-rayed, but could possibly sometimes be 5-rayed. **Coxigenital region**—Suboral plate with some granules and tubercles similar to those on the coxisternal plates; coxisternal plates I and II with rounded (granules) to elongate tubercles almost entirely covering coxisternal plates I, sparser and in small area anteriad to *2a* on coxisternal plates II; coxisternal plates I separated from each other by a relatively weak, forked sternal apodeme for most of medial margin. Setae *1a* and *2a* "as usual" within Eriophyoidea (simple and tapering), relatively long, frequently convoluted, with well-developed setal tubercles; *1a* anterior of imaginary line through tubercles of *2a*. Setae *3a* tapering and relatively short. **Genitalia**—Internal genitalia illustrated in Figs 9 and 21; external genital coverflap with slightly raised basal areas, vaguely in the shape of two contiguous, transverse ellipses, covered with granules and elongate tubercles that vary in shape and clarity between specimens, distally smooth.

Male (n = 26 for qualitative characteristics) (Figs 10, 23). Morphology, including measurements and counts, similar to that of female, except for genitalia; most setal lengths similar to shorter

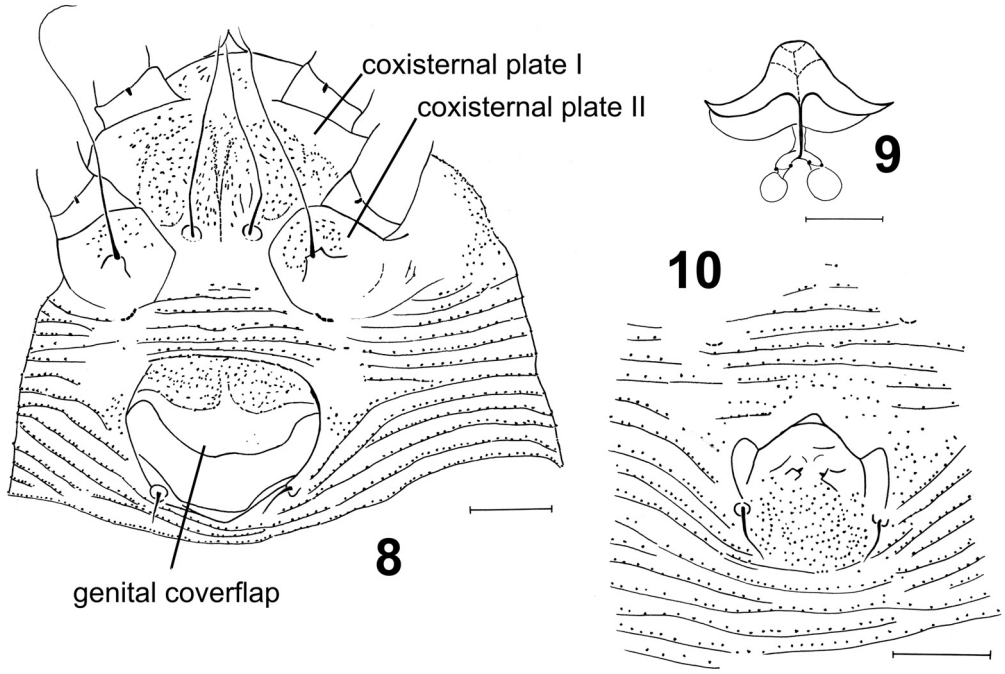
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corresponding setae in females (Table 2); opisthosoma with 59 dorsal and 71 ventral annuli. Genitalia with scattered microtubercles immediately posterior to eugenital setae, similar to many other eriophyoid species; eugenital setae unambiguously present, with well-developed setal tubercles.



FIGURES 1–7. *Diptilomiopus floridanus* **sp. nov**. female. 1. Lateral view; 2. Prodorsum and legs, note minute sub-branch visible on *ft*-setae on right hand side, and the sub-branch is present, but not visible on *ft*-setae on the left due to orientation of setae; 3, 4. Enlargement of annuli and microtubercles as seen in lateral view; 5. Leg I above, leg II below; 6. Empodium on leg I; 7. Dorsal view of caudal part of opisthosoma. All scale bars = 10 µm.

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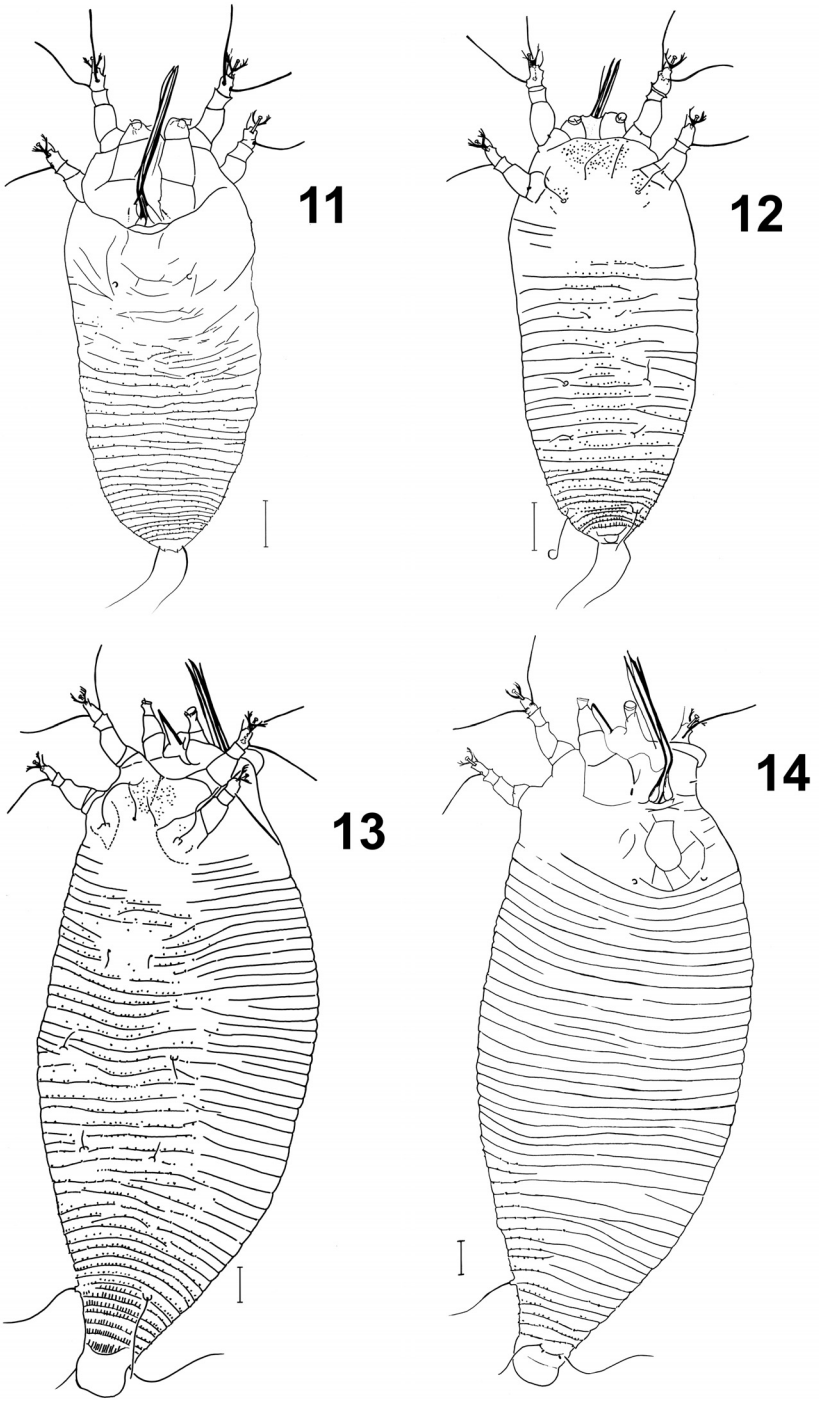
FIGURES 8–10. *Diptilomiopus floridanus* **sp. nov**.: 8. Female coxigenital region; 9. Female internal genitalia. 10. Male external genitalia. All scale bars = 10 µm.

Larva (n = 1 for qualitative characteristics) (Figs 11, 12). Only one, somewhat distorted and vague specimen was available for study. Prodorsal shield with striae or ridges forming mainly basal part of the cell-pattern of ridges found in the adult; tubercles of setae *sc* similar to those of adult; setae *sc* absent. Dorsal, irregular annuli or largely smooth area immediately posterior of prodorsal shield; remainder of dorsal annuli with tiny rounded microtubercles near posterior annulus margins, microtubercles posteriad progressively more pointed and progressively closer to posterior annulus margins, situated on posterior annulus margin beyond about level of setae *f*. Ventral annuli with tiny, pointed microtubercles generally further away from posterior annulus margins than dorsal microtubercles, largely present from first annulus beyond coxisternal plates, in a band corresponding in width with the mid-area between setae *d* and *e*; present on entire length of ventral annuli from *e* posteriad; elongate on ventral annuli beyond *f*. Setal complements as in adult, including *h1* present, however setae generally much shorter (Table 1). Legs: presence of short sub-branch, found on all setae *ft* in adult, not visible in specimen, possibly due to their orientation; *em* with fewer rays than adult, but impossible to count rays accurately. Coxisternal plates I and II with granules similar in shape and area covered than those in adult. Without external genitalia, but *3a* present.

Nymph (n = 7 for qualitative characteristics) (Figs 13, 14). Prodorsal shield with striae or ridges forming mainly central part of the cell-pattern of ridges found in the adult; tubercles of setae *sc* similar to those of adult; setae *sc* absent. Dorsal annuli just behind posterior margin of prodorsal shield regular. Dorsal annuli smooth (without microtubercles), with pointed microtubercles on the rear margins of the posterior-most annuli, largely beyond *f* (similar to adult). Ventral annuli with microtubercles similar in shape, size and area covered as adult, but clearly pointed, and possibly slightly further anterior to posterior annulus margins, progressively more elongate, with elongate ridges on about 7 posterior-most annuli. Setal complements as in adult, however setae generally

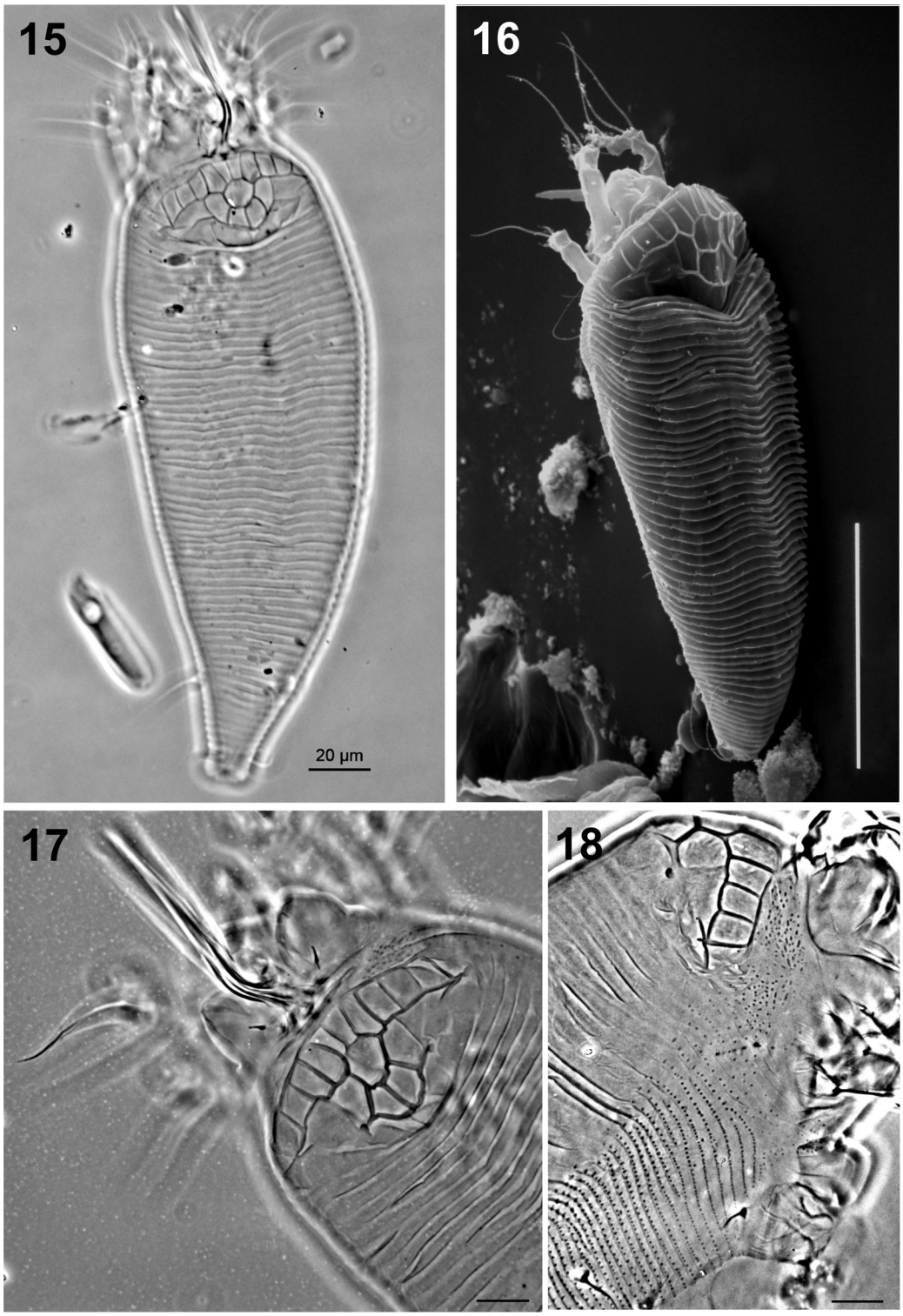
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shorter than in adult and longer than in larva (Table 2); coxisternal plates I and II with granules similar in shape and area covered as adult; presence of short sub-branch on setae *ft* uncertain, *em* possibly 4- or 5-rayed (difficult to count). Without external genitalia, ventral annuli interrupted where external genitalia would be present in adult, *3a* present.



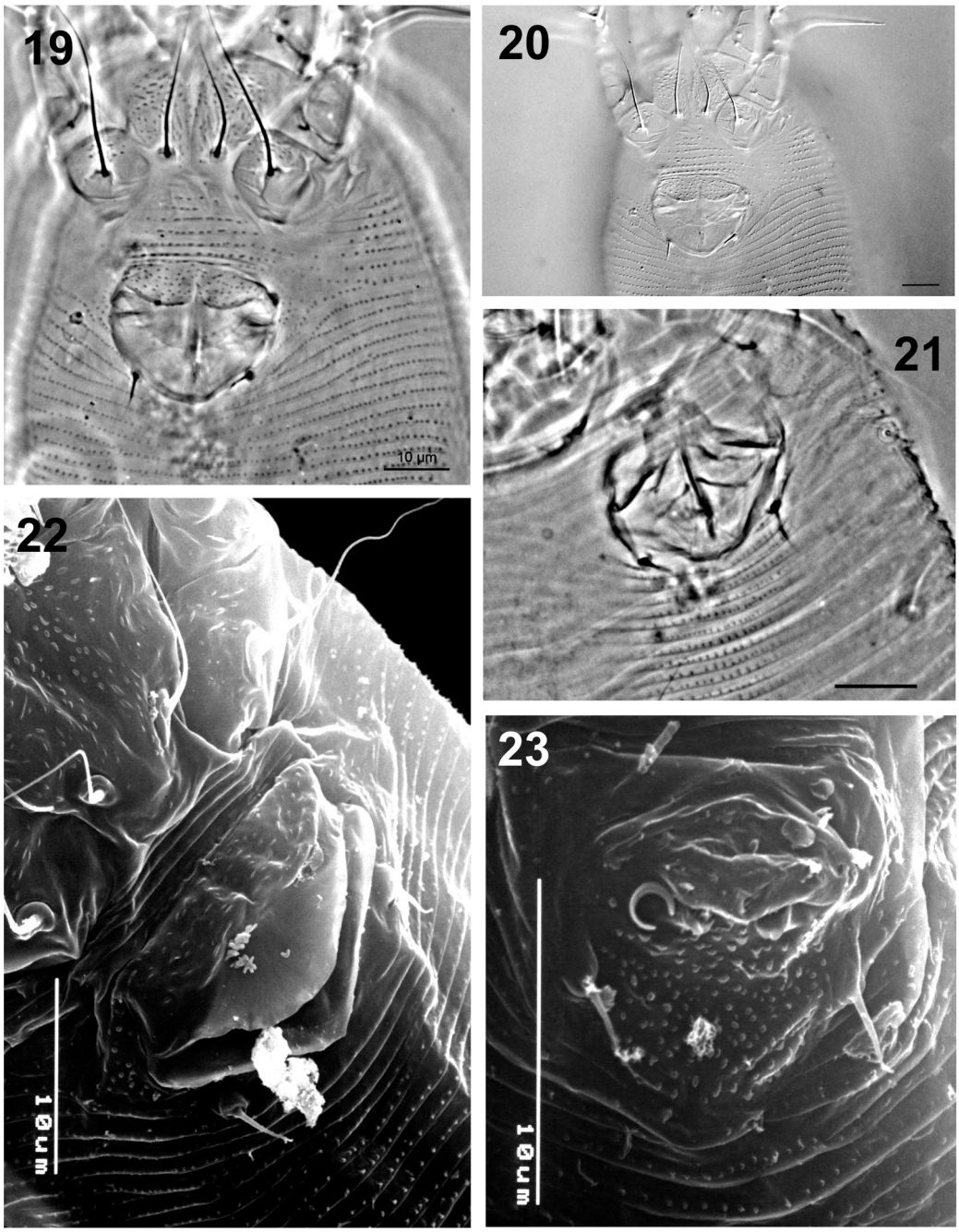
FIGURES 11–14. *Diptilomiopus floridanus* **sp. nov**. immatures. 11. Dorsal view of larva; 12. Ventral view of larva; 13. Ventral view of nymph; 14. Dorsal view of nymph. All scale bars = 10 µm.

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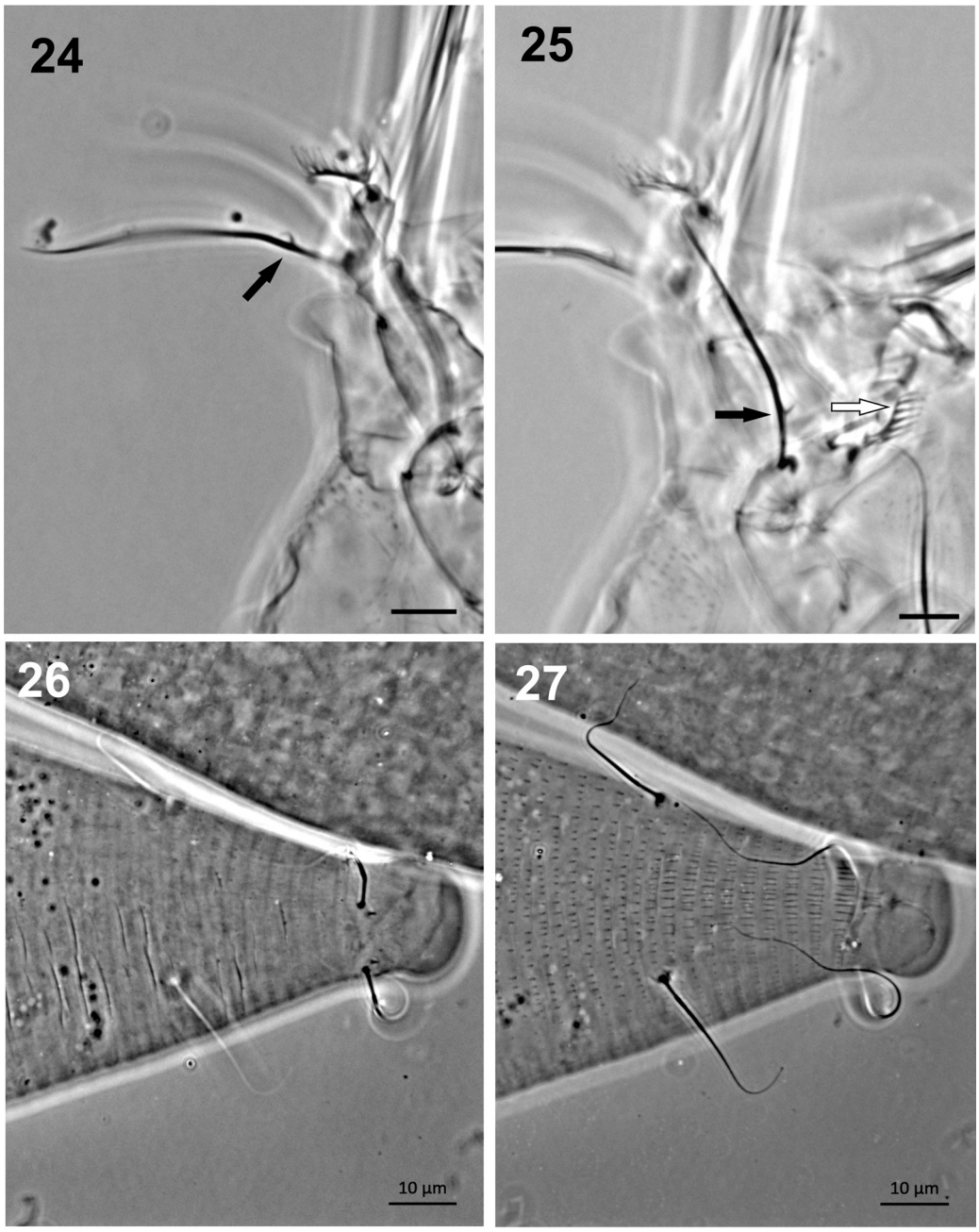
FIGURES 15–18. Conventional PC LM (15,17,18) and SEM (16) images of *Diptilomiopus floridanus* **sp. nov**. female. 15–17. Dorsal view; 18. Lateral view. Scale bars: Fig. 15 = 20 µm, Fig. 16 = 50 µm, Figs 17, 18 = 10 µm.

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FIGURES 19–23. Conventional PC LM (19, 21), DIC LM (20) and SEM (22, 23) images of *Diptilomiopus floridanus* **sp. nov**. female: 19–20, 22. Coxigenital region; 21. Internal genitalia. 23. Male external genitalia. All scale bars = 10 µm.

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FIGURES 24–27. *Diptilomiopus floridanus* **sp. nov**. female. Legs: 24. Black arrow, sub-branch on Leg I seta *ft''*; 25. Black arrow, sub-branch on seta *ft'* on leg II, white arrow, empodium 6-rayed. Caudal area: 26. Dorsal view; 27. Ventral view. All scale bars = 10 µm.

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Host plants and relation to hosts. Type specimens were collected from *Citrus aurantiifolia* (Christm.) Swingle 'Key' (Key lime), *C.* x *aurantium* L. (sour orange), *C.* x *latifolia* (Yu. Tanaka) Yu. Tanaka (lime or Tahiti lime), *C. limon* (L.) Burmann 'Eureka' and 'Meyer' (Eureka and Meyer lemon), *C. reticulata* Blanco x *C.* x *paradisi* Macfad. (tangelo), *C. sinensis* (L.) Osbeck (orange or sweet orange) (Rutaceae). A complete list of all Rutaceae spp. whereon *D. floridanus* was collected is reported by Childers *et al*. (2017). The exact niche of *D. floridanus* was not determined, because plant material (largely leaves and twigs) were directly washed in alcohol. However, it probably lives exposed on the leaf surfaces, similar to *D. assamica*.

Type material. All specimens were collected in Florida, USA by Carl C. Childers. **Holotype.** female (the holotype female can be distinguished by being the specimen imaged in Fig. 15 and depicted in Figs 2 and 8); together on one slide with 18 paratypes of *D. floridanus* **sp. nov.** (12 females, 4 males and 2 immatures), West Palm Beach, 240 Wenonah Place, 21-V-2012, from Key lime (FSCA). **Paratypes.** 2 females, 1 male and 1 immature on two slides, Naples, 1147 Palmatta Ridge Road, 10-VI-2013, from Eureka lemon (FSCA and NCA); 5 females on one slide, Boca Raton, 7801 Cloverfield Circle, 19-VI-2012, from lime (variety unknown) (NCA); 2 females and 3 males on one slide, Palm City, 4042 St. Lucie Lane, 14-VI-2014, from Key lime (FSCA); 10 females and 4 males on two slides, Palm City, 602 Pine Tree Lane, 14-VI-2014, from Meyer lemon (FSCA); 5 females on one slide, West Palm Beach, 240 Wenonah Place, 21-VI-2012, from Key lime (FSCA); 11 females, 4 males and 1 immature on four slides, Pine Island, 7648 Helen Rd., Bokeelia, FL, 12-VI-2013, from Meyer lemon (FSCA and NCA); 2 males and 2 immatures on one slide, Hollywood, 1910 Bahama Drive, 2-VI-2011, from lime (variety unknown) (FSCA); 6 females, 1 male and 2 immatures on two slides, Ft. Pierce, 6902 Sebastian Road, 12-VI-2012, from sour orange and tangelo (FSCA and NCA); 18 females and 1 male on three slides, Hollywood, John Williams Park, 23-VIII-2011, from sour orange (FSCA and NCA); 3 females on one slide, Ft. Lauderdale, 2725 NE 27th Court, 18-VI-2012, from sweet orange (variety unknown) (FSCA); 15 females and 6 males on one slide, Green Acres, 1288 Olympic Circle, 20-VI-2012, from Key lime (FSCA).

Note. *Diptilomiopus floridanus* **sp. nov.** usually occurred mixed, on the same slides, with largely *P. oleivora*, single specimens of other mite families (not Eriophyoidea), and on two paratype slides, *Aceria* sp. *cf. A. sheldoni.*

Etymology. The species name *floridanus* is derived from "Florida", the USA state where it was found the first time, and grammatically the species name is an adjective, singular, masculine and nominative.

Differential diagnosis. *Diptilomiopus floridanus* **sp. nov.** is morphologically similar to *D. assamica*, *D. combreti* and *D. euscaphiae*, and occurs on broadly the same hosts (*Citrus* spp.) as *D. assamica*. These four species differ largely in the ornamentation of the prodorsal shield and female genital coverflap, and presence of a small sub-branch on tarsal setae *ft* (Table 2). Some characters differentiating *Diptilomiopus* spp., including these four species, might be ambiguous due to wrong morphological observations, or lack of adequate description of intraspecific variation, or due to inadequate slide preparation. For example, setae *h1* has been described as being absent in *D. assamica* by Keifer (1959), but was found to be present in Australian specimens of the same species (Knihinicki & Boczek 2002), and differences were also found between the measurements of structures of the Australian (Knihinicki & Boczek 2002) and Indian specimens (Keifer 1959) of this species, providing that the Australian specimens were indeed *D. assamica*. The ornamentation of the female genital coverflap is one of the major characteristics differentiating the four species. The coverflap of *D. assamica* might have had ornamentation which was, as in the new species, very vague and unclear in slide-mounted specimens and might have been missed, but in this case, apart from Keifer (1959) describing the coverflap as smooth, this was corroborated in his differentiation of *D. assamica* from *Diptilomiopus knorri* Keifer (Keifer 1974).

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TABLE 1. Measurements and counts (single measurement or count when n=1; mean ± SD and range when n>1) of *Diptilomiopus floridanus* **sp. nov.** Measurements and counts are rounded to the nearest integer, except length of *h1*, which was usually clearly less than 1 μm; SD is rounded to the first decimal place. Abbreviations: L = length, W = width, D = distance between setae or setal tubercles, MT = microtubercles, SD = Standard Deviation; n = number; only acronyms of setal names used, in italics. Measurements are all in μm.

character	♀ holotype	♀♀ (dorsal/ventral view) (n = 12, incl. holotype)		♂♂ (n=3)		nymph (n=1)	larva (n=1)
		mean ± SD	min–max	mean	min-max		
BODY SIZE							
idiosoma L (excl. gnathosoma)	195	202 ± 28.3	143–251	186	175–202	223	76
body W just behind prodorsal shield	69	74 ± 6.1	65–88	59	57–60	39	43
body W at level of *f*	28	33 ± 2.4	28–36	26	24–28	27	20
GNATHOSOMA							
dorsal excl. stylets L	36	34 ± 4.2	29–43	36	34–39	36	25
ep L	3	3 ± 0	3–3	2	2–2	2	2
v L	4	4 ± 0.5	3–4	3	3–3	4	1
chelicerae L	57	56 ± 3.4	51–62	44	42–48	44	37
PRODORSUM							
prodorsal shield L	31	30 ± 2.1	26–33	28	25–32	27	19
prodorsal shield W	70	58 ± 5.5	52–70	45	45–46	35	35
sc setal tubercles D	19	21 ± 1.1	19–23	18	17–19	19	18
sc setal tubercles distance ahead of rear shield margin	7	7 ± 1.2	5–9	6	4–9	5	5
OPISTHOSOMA							
d L	20	15 ± 2.2	11–20	13	12–14	8	5
e L	15	11 ± 1.9	9–15	9	9–9	7	5
f L	37	29 ± 4.4	23–37	28	27–30	19	13
h2 L	58	46 ± 7.0	38–58	47	37–54	26	17
h1 L	0.5	1 ± 0.3	0.5–1	0.5	0.5–0.5	0.5	0.5
ventral annulus position of *d*	22	25 ± 2.3	22–28	24	22–26	22	12
n ventral annuli *d–e*	19	17 ± 1.4	15–19	14	13–15	8	4
ventral annulus position of *e*	41	42 ± 2.7	37–45	38	35–41	30	16
n ventral annuli *e–f*	19	18 ± 1.7	16–21	18	17–18	13	9
ventral annulus position of *f*	60	60 ± 3.5	54–65	56	53–58	43	25
ventral annulus position of *f* from rear	9	9 ± 0.5	9–10	9	9–10	7	5
d–d D	40	40 ± 3.1	35–44	32	31–34	32	20
e–e D	24	24 ± 1.4	22–27	22	20–23	20	15
f–f D	24	24 ± 2.4	20–28	18	17–19	20	16
n of MT between *d*	28	28 ± 2.9	25–36	18	17–18	8	11
n of MT between *e*	12	14 ± 1.3	12–17	14	11–16	7	7
n of MT between *f*	17	19 ± 2.0	17–22	16	14–17	14	13
n of ventral MT / 20 μm (/ 11 μm in larva) level of *d*	16	17 ± 1.3	15–19	14	13–16	8	11
n of dorsal annuli lateral to shield	3	3 ± 0.0	3–3	3	2–3	3	not clear

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character	♀ holotype	♀♀ (dorsal/ventral view) (n = 12, incl. holotype)		♂♂ (n=3)		nymph (n=1)	larva (n=1)
		mean ± SD	min–max	mean	min-max		
n of dorsal annuli from rear shield margin	55	58 ± 4.1	51–65	52	51–53	46	*ca 35
n of dorsal annuli with central ridge	33	35 ± 2.7	32–39	28	28–28	no ridge visible	no ridge visible
total n of dorsal annuli	58	61 ± 4.1	54–68	55	53–56	49	*ca 35
total n of ventral annuli	68	68 ± 3.4	62–73	64	53–67	49	29
COXISTERNAL REGION							
coxisternal apodeme L	16	16 ± 2.7	14–19	12	11–12	12	no line visible
1a L	26	27 ± 4.8	20–35	22	19–24	15	10
2a L	41	39 ± 3.5	33–44	29	28–31	19	16
1a–1a D	7	7 ± 0.8	6–9	7	6–7	7	6
2a–2a D	24	27 ± 1.9	24–31	23	22–24	23	18
1a–2a D (perpendicular)	3	3 ± 0.9	2–5	3	3–4	3	4
n complete annuli in coxigenital region	4	4 ± 0.5	3–4	5	5–5	10	not clear
n half annuli in coxigenital region	4	2 ± 0.7	2–4	2	2–2	none visible	none visible
total n of annuli in coxigenital region	8	6 ± 0.8	5–8	7	7–7	10 or more	not clear
LEGS I							
L incl. coxa and extremities	56	56 ± 2.4	52–60	50	47–52	45	ca 35
L incl. coxa, excl. extremities	49	49 ± 2.2	45–52	44	41–47	41	ca 30
L from base of trochanter, excl. extremities	29	30 ± 1.6	27–33	28	26–29	22	17
trochanter L	4	5 ± 0.8	4–6	5	5–5	4	3
femoro-genu L	15	13 ± 1.6	11–15	11	10–12	8	6
tibia L	6	5 ± 1.0	3–6	4	4–5	4	4
tarsus L excl. extremities	8	7 ± 0.8	6–9	7	7–8	6	5
ft" L	33	31 ± 1.3	29–33	27	26–29	23	15
ft' L	30	30 ± 1.1	29–32	27	26–29	21	16
u' L	5	6 ± 0.5	5–6	5	4–6	7	3
ω (tarsal solenidion) L	6	6 ± 0.5	5–6	5	5–5	5	4
em (tarsal empodium) L	8	8 ± 1.0	6–9	7	6–7	6	4
n *em* rays each branch	5		5–6?		5–6?	4	cannot count
LEGS II							
L incl. coxa and extremities	48	46 ± 1.6	44–48	41	40–42	35	29
L incl. coxa, excl. extremities	38	39 ± 1.2	37–42	35	34–36	30	25
L from trochanter base, excl. extremities	25	26 ± 1.1	24–27	22	22–22	18	13
trochanter L	6	5 ± 1.1	4–7	4	4–5	3	2
femoro-genu L	12	10 ± 1.3	8–12	9	8–10	7	5
tibia L	5	5 ± 0.5	4–5	4	4–4	3	3
tarsus L excl. extremities	9	8 ± 0.7	7–9	6	6–6	5	5
ft" L	27	26 ± 0.7	25–27	23	21–25	18	11

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character	♀ holotype	♀♀ (dorsal/ventral view) (n = 12, incl. holotype)		♂♂ (n=3)		nymph (n=1)	larva (n=1)
		mean ± SD	min–max	mean	min-max		
u' L	5	5 ± 0.8	5–7	5	5–6	4	3
ω L	6	5 ± 0.4	5–6	5	5–5	4	4
em L	8	7 ± 0.7	6–8	7	6–7	4	4
n *em* rays each branch	5?					4?	cannot count
EXTERNAL GENITALIA							
female genital coverflap L	13	13 ± 0.8	12–14				
female genital coverflap W	25	24 ± 1.2	21–25				
male genitalia L				15	11–17		
male genital area W				17	14–20		
3a L	7	7 ± 1.0	6–8	6	5–8	5	6
3a D	16	18 ± 1.8	16–22	15	14–15	13	19

*smooth area behind shield margin

TABLE 2. Some morphological differences between *Diptilomiopus floridanus* **sp. nov.**, *Diptilomiopus assamica* Keifer, 1959, *Diptilomiopus combreti* and *Diptilomiopus euscaphiae*. Data obtained from original descriptions of these species.

Character	*Diptilomiopus* spp.			
	D. floridanus **sp. nov.**	*D. assamica*	*D. combreti*	*D. euscaphiae*
Anterior third of prodorsal shield median line	present	absent	present	present
Scapular setal tubercles	present	present	absent	absent
Ornamentation of female genital coverflap	basally granulate; distally smooth	entirely smooth	basally granulate and with short, wavy striations; distally smooth	entirely granulate
ft setae of legs I and II	with short sub-branch	simple, without short sub-branch	simple, without short sub-branch	with short sub-branch

Key to *Diptilomiopus* spp.: on Rutaceae, in the USA, and two species morphologically similar to *D. floridanus* sp. nov.

Regional keys are available to *Diptilomiopus* spp. of China (incl. Huang & Wang 2009; Wang *et al.* 2009; Wei *et al.* 2009; Cheng *et al.* 2012), India (Chakrabarti & Mondal 1983) and Thailand (Chandrapatya & Boczek 1991b). This key is to six *Diptilomiopus* spp.: *D. floridanus* **sp. nov.** and five species relevant to this new species, namely, *D. acronychia* Chen, Wei & Qin, and *D. assamica* the other *Diptilomiopus* spp. known from Rutaceae; *D. panithus* present in the USA; and two species morphologically similar to the new species, namely *D. combreti* Wei & Lu and *D. euscaphiae* Wang, Wei & Yang.

1. Prodorsal shield ornamentation with anterior quarter of median line absent; occurs on *Citrus* spp. (Rutaceae) in India and Australia . . . . . *D. assamica* Keifer 1959
– Prodorsal shield ornamentation with anterior quarter of median line present; occurs on various host plants, including *Citrus* spp. 2
2. Genital coverflap entirely smooth (without ornamentation); coxisternal plates I smooth (without granules or other ornamentation) (note: the line along posterolateral margin of coxisternal plates

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II described by Chen, Wei & Qin (2004) might be the internal apodeme usually present in this region); occurs on *Acronychia pedunculata* (L.) Mig. (Rutaceae) in China . . . . . *D. acronychia* Chen, Wei & Qin 2004

– Genital coverflap and coxisternal plates I with ornamentation (Fig. 8) 3

3. Female genital coverflap entirely ornamented with granules; tarsal setae *ft* with short sub-branch; occurs on *Euscaphis japonica* (Thunb.) Dipp. (Staphyleaceae) in China . . . . . *D. euscaphiae* Wang, Wei & Yang 2009

– Female genital coverflap ornamented basally, with distal area smooth; tarsal setae *ft* simple, or with short sub-branch 4

4. Prodorsal shield ornamental pattern different from all other species dealt with in this key: with admedian lines on the transverse level of the scapular tubercles absent, thus without the two smaller cells below central cell in second row of cells from anterior, and relatively long transverse cells next to central cell of second row from front, not divided into two by part of a submedian line; occurs on *Mangifera indica* L. (Anacardiaceae); . . . . . *D. panithus* (Boczek & Chandrapatya 1989)

– Prodorsal shield ornamentation pattern different from that of *D. panithus* 5

5. Coverflap basally with granules and short wavy striations; scapular tubercles absent; tarsal setae *ft* simple, without short sub-branch; occurs on *Combretum alfredii* Hance and *Quisqualis indica* L. (Combretaceae) in China . . . . . *D. combreti* Wei & Lu 2001

– Coverflap basally with granules (Fig. 8); scapular tubercles present (Fig. 1); tarsal setae *ft* with short sub-branch at about basal third (Figs 5, 24–25); occurs on *Citrus* spp., presently known only from the USA, but is probably not indigenous here . . . . . *D. floridanus* **sp. nov.**

Discussion

Regarding the morphology of *D. floridanus* **sp. nov.** the following is noteworthy. Setae *ft* of legs I and II are usually simple and tapering in *Diptilomiopus* spp. In *D. floridanus* **sp. nov.** a short sub-branch is present on all its *ft* setae. This characteristic is present in only a few previously described *Diptilomiopus* spp: *D. ficifolius* (Boczek & Oleczek) (Boczek & Oleczek 1988); *D. sandorici* (Chandrapatya) (Chandrapatya & Boczek 1991a); *D. musae* (Chandrapatya) (Chandrapatya & Boczek 1998); *D. eucalypti* (Boczek) (Chandrapatya & Boczek 1991b); *D. euscaphiae* Wang *et al.* (Wang *et al.* 2009); *D. retusus* Cheng *et al.* (Cheng *et al.* 2012). Chandrapatya & Boczek (2002), in their differentiation of *D. aglaiae* (Chandrapatya & Boczek, 2002) from *D. benjaminae*, stated the latter species has *ft*-setae with short sub-branches, but this was not recorded in the original description of *D. benjaminae* by Boczek & Chandrapatya (2002). It is possible that the tiny sub-branches on *ft*-setae may be present in more of the described *Diptilomiopus* spp., but that they were not seen by the descriptors.

The majority of the 107 *Diptilomiopus* spp. presently known worldwide were described from the Oriental Region (Hong & Zhang 1997; Craemer *et al.* 2005; Chakrabarti *et al.* 2008a, b; Wei *et al.* 2009; Hong *et al.* 2010; Cheng *et al.* 2012; Tan *et al.* 2013; Xue *et al.* 2013; Konvipasruang & Chandrapatya 2015; Chandrapatya *et al.* 2016b), one species from the Australian Region (Keifer 1969), and three species from the Afrotropical Region (Sub-Saharan Africa) (Keifer 1960; Boczek & Oleczek 1988; Abou-Awad & El-Banhawy 1992). Only two species were described from the Palearctic Region, but these are probably not indigenous to this region, but could have originated with their hosts in the Oriental Region. *Diptilomiopus ficus* Attiah was described from "fig trees" in Egypt (Attiah 1967), presumably the cultivated fig, *Ficus carica* L. (Moraceae), which is believed

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to have originated in western Asia and later spread to the Mediterranean (Tous & Ferguson 1996). The other species, *D. buxusis* Song, Xue and Hong was collected from a "*Buxus* sp." (Buxaceae) (Song *et al.* 2008). This is the only Chinese *Diptilomiopus* sp. described from the Palearctic part of China (Mengchao Tan of Guangxi University, China, pers. comm.). Although some *Buxus* spp. are indigenous to Asia and Eurasia in general (Van Laere *et al.* 2011), it is plausible that the host was one of the *Buxus* spp. indigenous to the Oriental Region of Asia, and not an exceptional indigenous occurrence of *Diptilomiopus* in the Palearctic region. Therefore, collecting records thus far indicate that *Diptilomiopus* may have originated in the Oriental Region, and may be largely indigenous to the Oriental, Australian and Afrotropical Zoogeographical Regions.

Diptilomiopus panithus and *D. floridanus* **sp. nov.** are similarly, most likely not indigenous to the Nearctic Region, and have probably been introduced to North America with plant material of their respective hosts, *Mangifera indica* and *Citrus* spp. All *Mangifera* spp. are indigenous to Indomalaysia (Van Wyk 2005), *Citrus* spp. originated from south-eastern Asia (Nicolosi 2007) and additionally *D. panithus* was originally described from Thailand (Boczek & Chandrapatya 1989). The likely origin of these two *Diptilomiopus* spp. are in agreement with the proposed origin of *Diptilomiopus* spp. and areas where it might be indigenous. The introduction of *D. floridanus* to the USA might have been relatively recent; in particular, it was not found during a previous comprehensive survey of citrus grove sites throughout Florida (Childers & Achor 1999).

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