

Article

Morphological and molecular diversity among pin nematodes of the genus *Paratylenchus* (Nematoda: Paratylenchidae) from Florida and other localities, and molecular phylogeny of the genus

Sergio Álvarez-Ortega ^{1,*}, Sergei A. Subbotin ^{2,3}, Koon-Hui Wang ⁴, Jason D. Stanley ⁵, Silvia Vau ⁵, William Crow ⁶ and Renato N. Inserra ⁵

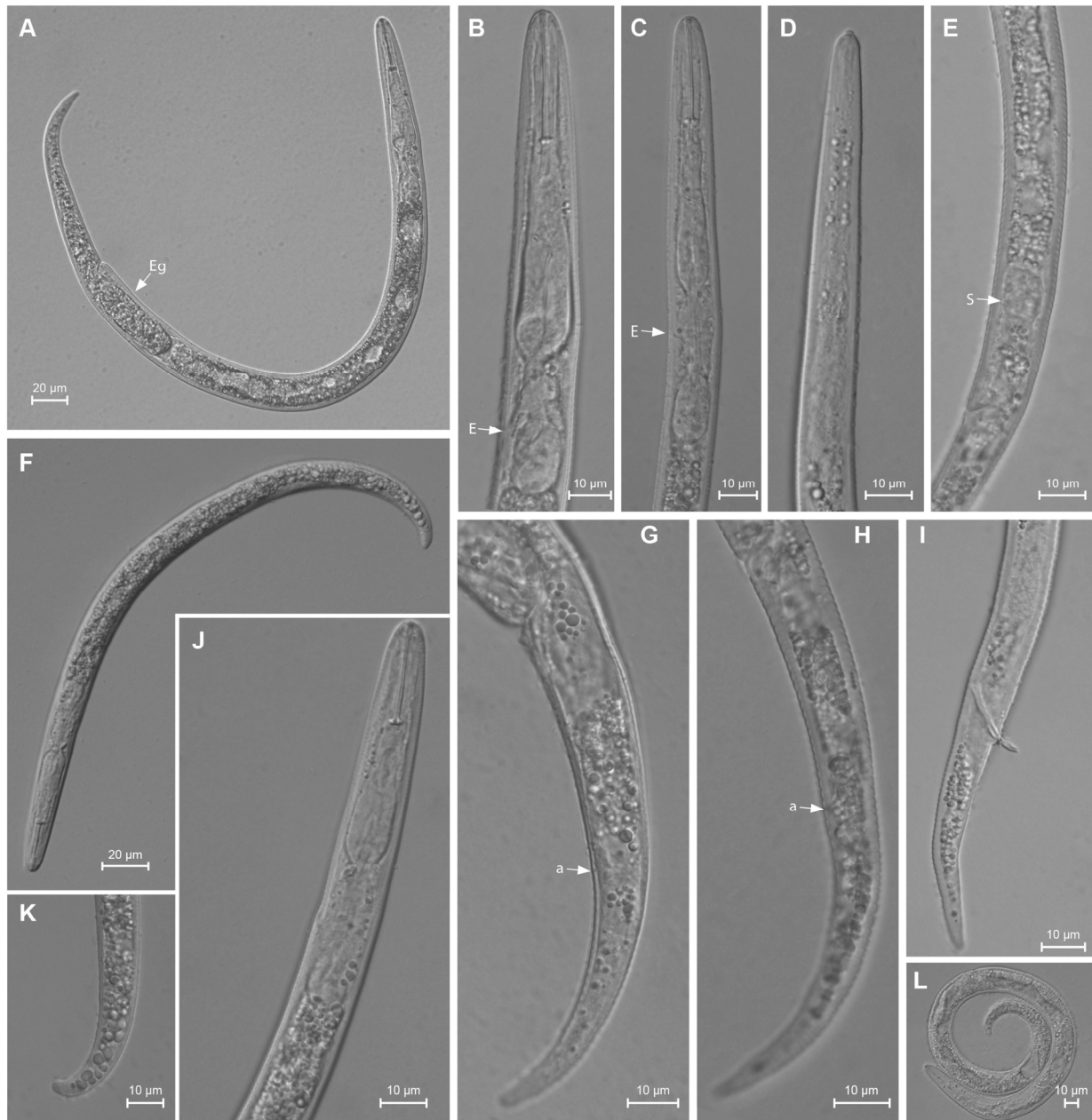


Figure S1. Light microscopic photos of *Paratylenchus* from *Zoysia* sp. in Florida (CD3651). A: Entire body of an egg-laying female. Note egg (arrowed); B, C: Anterior bodies of an egg-laying and immature female, respectively. Note excretory pore (arrowed); D: Anterior body of male; E: Vulvar region showing a prominent spermatheca (arrowed); F: Second stage juvenile entire body; G, H: Posterior bodies of egg-laying and immature female. Note anus (arrowed); I: posterior body of male; J: Anterior and posterior body of J2; K: Coiled fourth stage juvenile entire body.

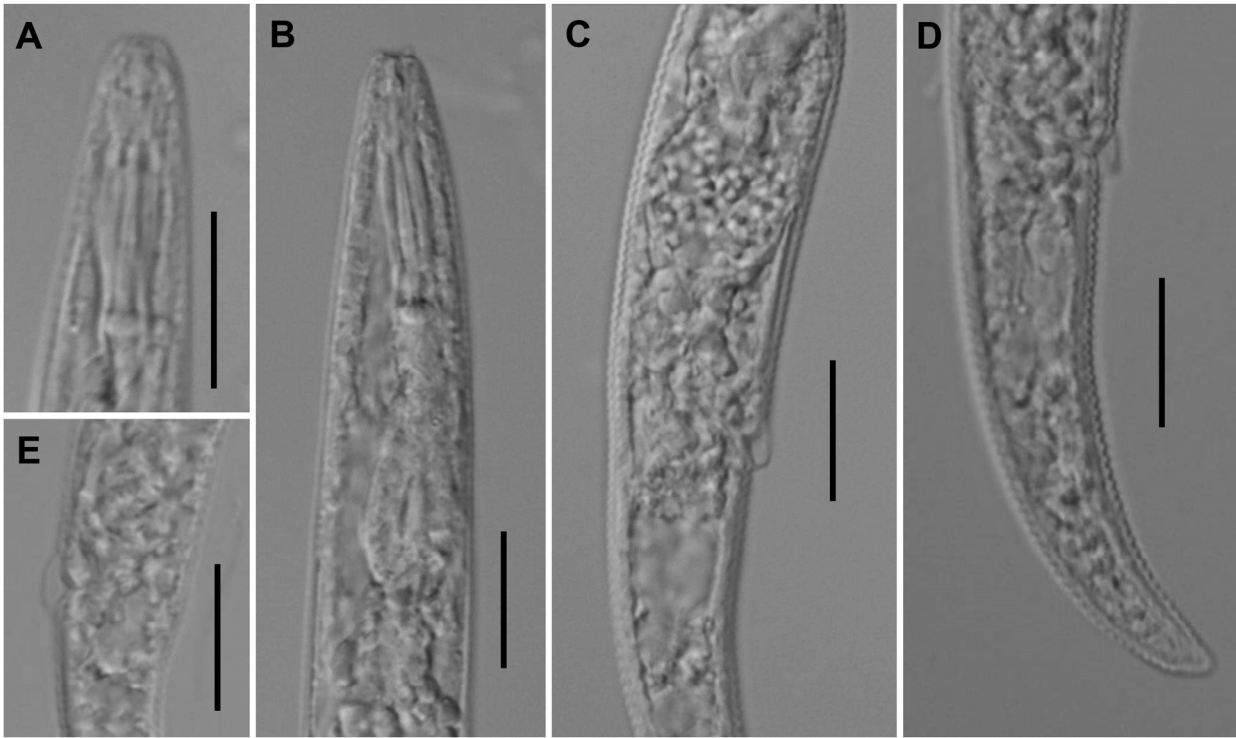


Figure S2. Light microscopic photos of *Paratylenchus minutus* (*P. shenzhenensis* syn. n.) female from *Coffea* sp. in Hawaii. A: Truncate lip region and stylet; B: Pharyngeal region; C: Posterior genital tract with large spermatheca; D: Posterior body; E: Vulvar region. (Scale bars = 10 μm).

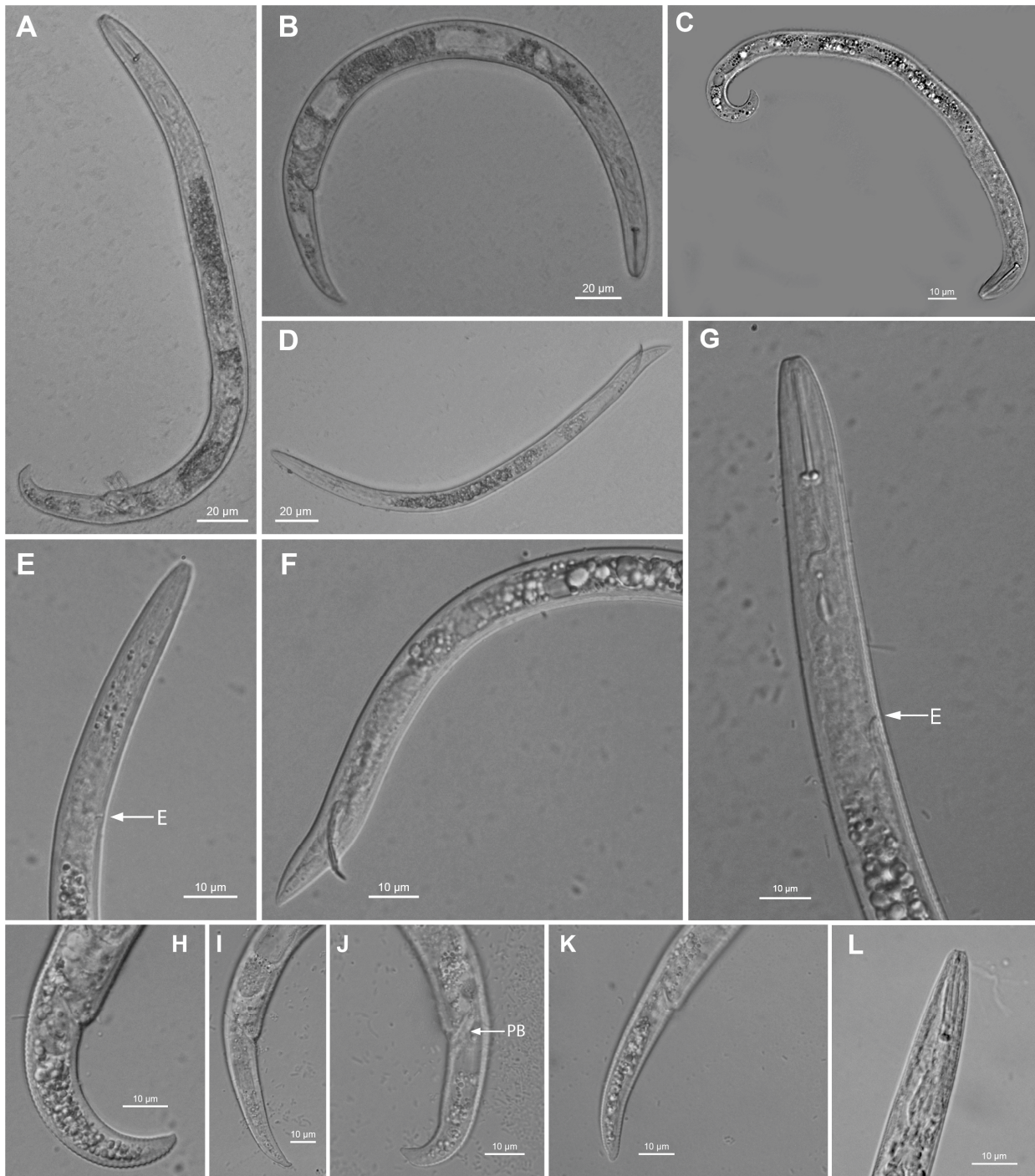


Figure S3. Light microscopic photos of *Paratylenchus minutus* (*P. shenzhenensis* syn. n.) female, male and fourth stage juvenile from *Hemerocallis* sp. in Florida. A, B: Entire body of female; C: Entire body of fourth stage juvenile; D: Entire body of male; E, F: Anterior and posterior body of male. Note excretory pore (arrowed); G: Pharyngeal region of female showing a truncate lip region and excretory pore (arrowed); H-K: Shape variations of female posterior body. Note large spermatheca and rudimentary post-vulvar branch (PB); L: Anterior body with truncate lip region of a female *P. minutus* from *Coffea* sp. in Hawaii is included for comparison.

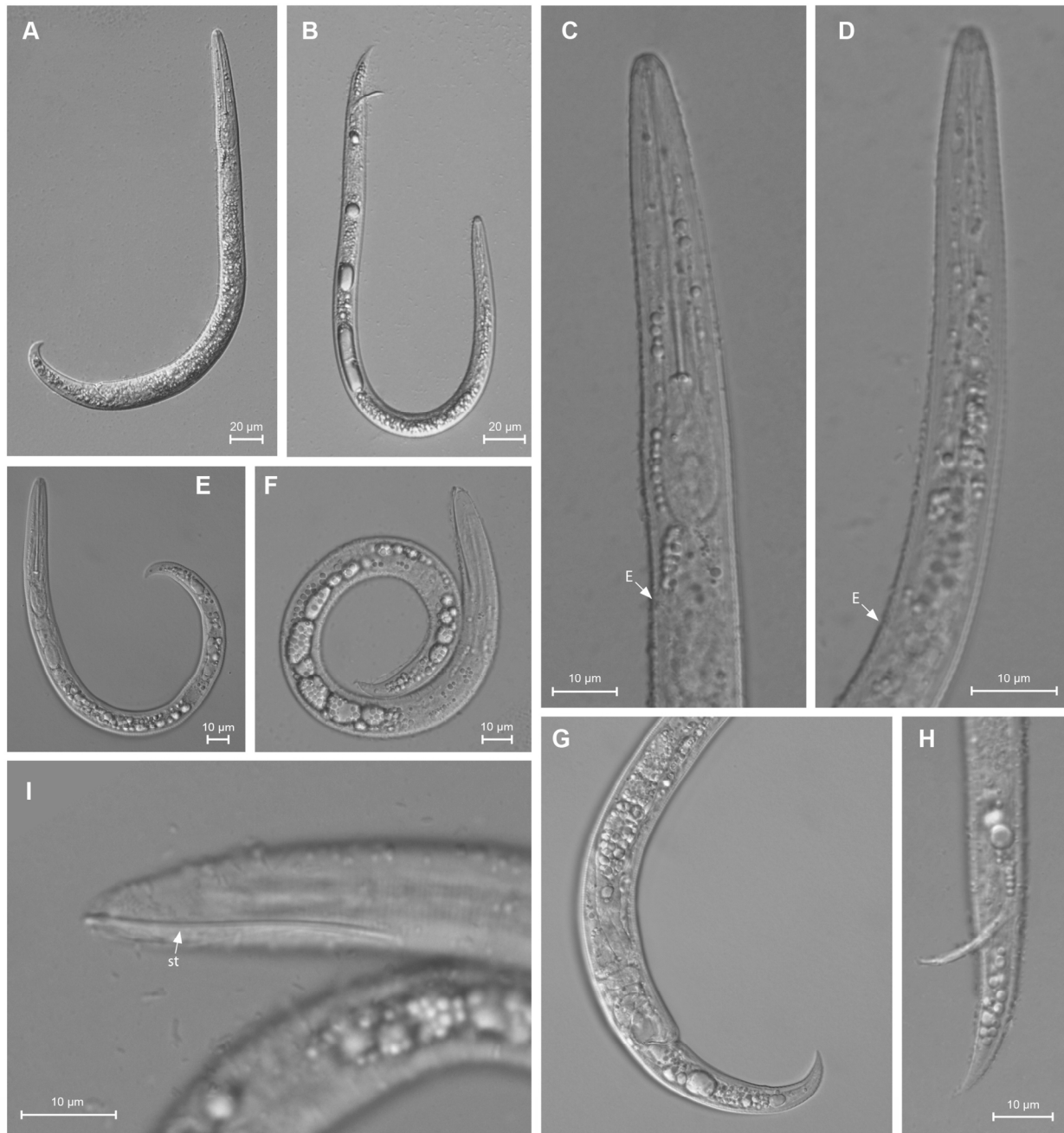


Figure S4. Light microscopic photos of *Paratylenchus straeleni* from *Quercus virginiana* in Florida. A, B: Female and male entire bodies, respectively; C, D: Female and male anterior bodies, respectively. Note excretory pore (arrowed); E: Second stage juvenile entire body; F: Fourth stage encased in the molted cuticles of J2 and J3; G: Posterior body of female showing oocytes and crustaformeria; H: Posterior body of male; I: Magnified figure F showing the molted stylet (arrowed) of J2 adhering to the molted cuticle.

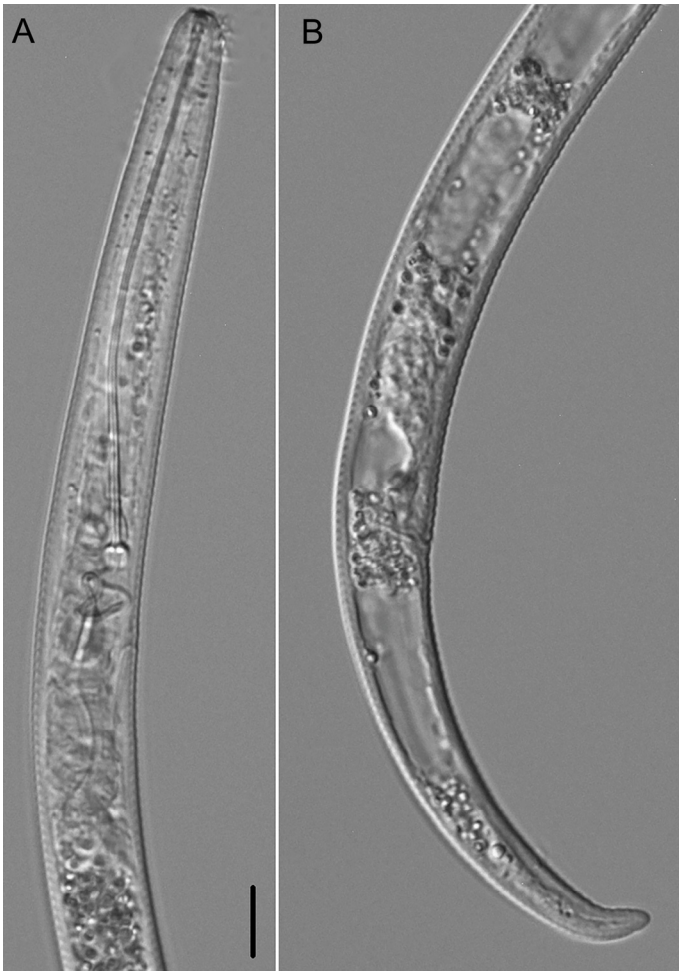


Figure S5. Light microscopic photos of *Paratylenchus* sp. FL2 female from palm in Florida. A: Anterior body region; B: Posterior body region (Scale bars = 10 μ m).

Table S1. Species of the pin nematodes reported in Florida.

| Species | Morphological or morphometrical characterization | Molecular characterization | Identification without any published morphological datasets | Reference |
|--|---|-------------------------------|---|---|
| <i>P. aciculus</i> | - | - | + | Raski (1976); Esser (1992); Lehman (2002) |
| <i>P. acti</i> | + | + | - | This study |
| <i>P. aculentus</i> | - | - | + | Esser (1992); Lehman (2002) |
| <i>P. alleni</i> | - | - | + | Esser (1992); Lehman (2002) |
| <i>P. aquaticus</i> | + | + | - | This study |
| | - | - | + | Esser (1992); Lehman (2002) |
| <i>P. audriellus</i> | - | - | + | Esser (1992) |
| <i>P. besoeckianus</i> | - | - | + | Lehman (2002) |
| <i>P. breviculus</i> | - | - | + | Esser (1992); Lehman (2002) |
| <i>P. colbrani</i> | - | - | + | Esser (1992); Lehman (2002) |
| <i>P. costatus</i> | - | - | + | Lehman (2002) |
| <i>P. curvitatulus</i> | - | - | + | Esser (1992); Lehman (2002) |
| <i>P. dianthus</i> | - | - | + | Esser (1992); Lehman (2002) |
| <i>P. elachistus</i> | + | - | - | Steiner (1949); Raski (1975a) |
| <i>P. elegans</i> | + | - | - | Raski (1962) |
| <i>P. enatus</i> | - | - | + | Lehman (2002) |
| <i>P. goldeni</i> | + | + | - | This study |
| | - | - | + | Esser (1992); Lehman (2002) |
| <i>P. goodeyi</i> | - | - | + | Esser (1992); Lehman (2002) |
| <i>P. hamatus</i> | - | - | + | Esser (1992); Lehman (2002) |
| <i>P. hawaiiensis</i> sp. n. | + | + | - | This study |
| | - | + | + | Singh <i>et al.</i> (2021) |
| <i>P. holdemani</i> | - | - | + | Lehman (2002) |
| <i>P. leioderms</i> | - | - | + | Esser (1992); Lehman (2002) |
| <i>P. leptos</i> | - | - | + | Esser (1992); Lehman (2002) |
| <i>P. marylandicus</i> | - | - | + | Esser (1992); Lehman (2002) |
| <i>P. microdorus</i> | - | - | + | Esser (1992); Lehman (2002) |
| <i>P. mimulus</i> | - | - | + | Esser (1992); Lehman (2002) |
| <i>P. minor</i> | - | - | + | Lehman (2002) |
| <i>P. minusculus</i> | + | - | - | Tarjan (1960) |
| <i>P. minutus</i> | + | + | - | This study |
| | - | - | + | Esser (1992); Lehman (2002) |
| | - | + | + | Singh <i>et al.</i> (2021) |
| <i>P. nainianus</i> | - | - | + | Raski (1975b) |
| | | | | |
| <i>P. nanus</i> | - | - | + | Lehman (2002) |
| <i>P. nawadus</i> | - | - | + | Lehman (2002) |
| <i>P. oostenbrinki</i> | - | - | + | Lehman (2002) |
| <i>P. paralatescens</i> (in Troccoli <i>et al.</i> (2002) as <i>P. latescens</i>) | + | + | - | Troccoli <i>et al.</i> (2002) |
| | + | + | - | This study |
| <i>P. peperpotti</i> | - | - | + | Esser (1992); Lehman (2002) |
| <i>P. peraticus</i> | - | - | + | Esser (1992); Lehman (2002) |
| <i>P. perlatus</i> | - | - | + | Lehman (2002) |
| <i>P. pesticus</i> | - | - | + | Esser (1992); Lehman (2002) |
| <i>P. projectus</i> (= <i>P. amblycephalus</i>) | - | - | + | Esser (1992); Lehman (2002) |
| <i>P. roboris</i> sp. n. | + | + | - | This study |

| | | | | |
|-------------------------|---|---|---|-----------------------------|
| <i>P. robustus</i> | - | - | + | Lehman (2002) |
| <i>P. salubris</i> | - | - | + | Lehman (2002) |
| <i>P. sarissus</i> | + | - | - | Tarjan (1960) |
| | - | - | + | Esser (1992) |
| <i>P. sheri</i> | - | - | + | Lehman (2002) |
| <i>P. straeleni</i> | + | + | - | This study |
| | - | - | + | Lehman (2002) |
| <i>P. vandenbrandei</i> | - | - | + | Esser (1992); Lehman (2002) |
| <i>P. yokooi</i> | - | - | + | Lehman (2002) |

Table S2. Morphometrics of *Paratylenchus aquaticus* from the original description in Ivory Coast, compared to those of a population of *P. aquaticus sensu lato* from Mexico (Brzeski, 1995) and another from Kansas (classified as type B in Van den Berg *et al.*, 2014).

| Population | Paratypes Ivory Coast | | <i>P. aquaticus</i> Mexico | | <i>P. aquaticus</i> type B Kansas |
|---|--------------------------|------------------|-------------------------------|-----------|--------------------------------------|
| Character | ♀ (fixed) | ♂ (fixed) | ♀ (fixed) | ♂ (fixed) | ♀ (fixed) |
| <i>n</i> | 22 | 4 | 31 | ? | 7 |
| L | 340 (270-370) | 300 (290-310) | 331.0 ± 213.4 (303-390) | - | 301.0 ± 36.5 (272-378) |
| Stylet length (St) | 16.0-20.0 | - | 15.8 ± 0.6 (14.5-17.5) | - | 17.0 ± 1.0 (16.0-18.5) |
| Conus length | - | - | - | - | 10.0 ± 0.7 (9.0-11.0) |
| Stylet shaft + knob height | - | - | - | - | 7.0 ± 0.8 (6.0-8) |
| Knob width | - | - | - | - | 3.0 ± 0.5 (3.0-3.5) |
| Knob height | - | - | - | - | 2.0 ± 0.3 (1.5-2.0) |
| DGO | 4.0-8.0 | - | - | - | 3.5 ± 0.3 (3.0-3.5) |
| Median bulb valve length | - | - | - | - | - |
| Median bulb width | - | - | - | - | - |
| Isthmus length | - | - | - | - | - |
| Pharynx length | 85.4 | 62.0 | - | - | 71.0 ± 4.4 (66.0-78.0) |
| Anterior end to excretory pore (Ep) | - | - | 71.0 ± 4.2 (64.0-81.0) | - | 62.5 ± 4.7 (58.0-72.0) |
| Max body width | 12.1 | 11.1 | - | - | 14.5 ± 2.2 (11.0-17.0) |
| Body width at vulva | - | - | - | - | - |
| Body width at anus | - | - | - | - | - |
| Anterior end to median bulb base | - | - | - | - | - |
| Lateral field width | - | - | - | - | 2.5 ± 0.2 (2.0-2.5) |
| Anterior end-vulva distance | - | - | - | - | - |
| Vulva-tail terminus distance | - | - | - | - | - |
| Genital tract length | - | - | - | - | - |
| Vulva-anus distance | - | - | - | - | 30.5 ± 11.3 (29.5-35.5) |
| Tail length | 20.0-24.0 | 21.0-23.0 | - | - | 23.5 ± 1.9 (22.0-26.5) |
| Stylet base (Stb) to median bulb valve base (v) | - | - | - | - | - |
| Spicule length | - | 21.0-22.0 | - | 16.0-18.0 | - |
| Gubernaculum length | - | - | - | 3.0-4.0 | - |
| PERCENTAGES | | | | | |
| V | 79.0-84.0 | - | 81.3 ± 0.9 (79.0-84.0) | - | 80.5 ± 1.1 (79.5-82.5) |
| G or T | 23.0-31.0 | - | - | - | - |
| Stb-v/St | - | - | - | - | - |
| St/L | - | - | - | - | - |
| Ep/L | - | - | 21.5 ± 0.8 (18.5-23.5) | - | 20.9 ± 1.2 (19.1-22.2) |
| RATIOS | | | | | |
| <i>a</i> | 30.0 (26.0-39.0) | 28.0 (26.0-30.0) | 32.1 ± 2.0 (27-35) | - | 20.9 ± 2.5 (18.5-35.7) |
| <i>b</i> | 4.1 (3.5-4.7) | 4.9 (4.8-5.0) | 3.9 ± 0.3 (3.5-4.8) | - | 4.2 ± 0.5 (3.6-4.8) |
| <i>c</i> | 15.0 (14.0-18.0) | 14.0 (13.0-15.0) | 15.3 ± 1.3 (13.2-18.0) | - | 12.8 ± 0.9 (11.3-14.3) |
| <i>c'</i> | - | - | 3.1 ± 0.3 (2.6-3.7) | - | 2.8 ± 0.3 (2.4-3.1) |

Table S3. Morphometrics of males and J2 of *Paratylenchus goldeni* associated with *Zoysia* sp. in Florida.

| Population | Madison, Madison County (CD3651 – N21-01426-4) | | |
|---|--|-----------|----------------------------|
| Character | ♂ (live) | ♂ (fixed) | J2 (live) |
| <i>n</i> | 5 | 1 | 3 |
| L | 405 ± 34.1 (341.5-439.5) | 356.5 | 316.1 ± 16.9 (279.9-338.6) |
| Stylet length (St) | - | - | 21.1 ± 0.4 (20.7-21.7) |
| Conus length | - | - | 13.2 ± 0.5 (12.8-13.9) |
| Stylet shaft + knob height | - | - | 7.9 ± 0.0 (7.9-7.8) |
| Knob width | - | - | 3.7 ± 0.9 (3.5-3.8) |
| Knob height | - | - | 1.7 ± 0.1 (1.6-1.8) |
| DGO | - | - | 5.4 ± 0.3 (5.0-7.8) |
| Median bulb valve length | - | - | 5.8 ± 0.3 (5.4-6.1) |
| Median bulb width | - | - | 9.9 ± 0.0 (9.9-9.9) |
| Isthmus length | - | - | 15.4 ± 0.6 (15.0-16.3) |
| Pharynx length | 95.0 ± 5.5 (85.1-102.0) | ? | 94.7 ± 6.1 (89-103.2) |
| Anterior end to excretory pore (Ep) | 83.3 ± 7.3 (72.0-91.5) | ? | 73.7 ± 1.5 (72.2-75.2) |
| Max body width | 13.9 ± 0.7 (12.8-14.7) | 12.0 | 16.0 ± 0.6 (15.5-16.8) |
| Body width at anus | 10.4 ± 0.5 (9.9-10.8) | 8.5 | 10.5 ± 0.2 (10.3-10.7) |
| Anterior end to median bulb base | - | - | 57.6 ± 3.5 (54.0-62.3) |
| Genital tract length | 121.4 ± 12.4 (105.0-142.5) | 73.0 | - |
| Tail length | 44.4 ± 5.4 (38.0-50.4) | 43.0 | 30.6 ± 0.1 (30.5-30.6) |
| Stylet base (Stb) to median bulb valve base (v) | - | - | 27.5 ± 2.2 (24.7-30.2) |
| Spicule length | 20.4 ± 0.7 (19.5-21.2) | 19.5 | - |
| Gubernaculum length | 4.0 ± 0.3 (3.5-4.5) | 3.5 | - |
| PERCENTAGES | | | |
| G or T | 30.1 ± 3.3 (24.5-33.9) | 20.5 | - |
| St/L | - | - | 1.3 ± 0.1 (1.2-1.4) |
| Ep/L | 21.6 ± 1.1 (20.7-23.8) | ? | 24.2 ± 0.0 (24.1-24.2) |
| RATIOS | | | |
| <i>a</i> | 29.1 ± 1.3 (26.6-30.3) | 29.7 | 19.7 ± 1.7 (17.7-21.8) |
| <i>b</i> | 4.2 ± 0.1 (4.0-4.3) | ? | 3.3 ± 0.1 (3.2-3.5) |
| <i>c</i> | 9.1 ± 0.7 (8.5-10.6) | 8.3 | 9.9 ± 0.2 (9.7-10.1) |
| <i>c'</i> | 4.1 ± 0.3 (3.8-4.6) | 5.1 | 2.9 ± 0.1 (2.8-2.9) |

Table S4. Morphometrics of *Paratylenchus minutus* (paratypes) and paratypes of the closely related species *P. shenzhenensis* Wang, Xie, LI, Xu Yu & Wang, 2013 from China.

| Population | Linford <i>et al.</i> (1949). Values in bold from Raski (1975) | | Paratypes of <i>Paratylenchus shenzhenensis</i> Wang <i>et al.</i> (2013) China | |
|-------------------------------------|--|-------------------------|--|--------------------------|
| Character | ♀ (fixed) | ♂ (fixed) | ♀ (fixed) | ♂ (fixed) |
| <i>n</i> | 17 | 3 | 41 | 22 |
| L | 267.0 (240.0-310.0) | 258.0 (220.0-270.0) | 275.0 ± 11.9 (249.0-302.0) | 262 ± 12.2 (236.0-280.0) |
| Stylet length (St) | (16.0-21.0) | - | 19.0 ± 0.7 (17.0-21.0) | - |
| Conus length | - | - | 12.0 ± 0.6 (11.0-14.0) | - |
| Stylet shaft + knob height | 11.0 (10.0-12.0) | - | 6.0 ± 0.4 (5.0-7.0) | - |
| Knob width | - | - | 2.0 ± 0.3 (2.0-3.0) | - |
| Knob height | - | - | 1.5 ± 0.2 (1.0-2.0) | - |
| DGO | - | - | 3.0 ± 0.6 (2.0-4.0) | - |
| Median bulb valve length | - | - | 5.0 ± 0.7 (4.0-7.0) | - |
| Isthmus length | - | - | 11.0 ± 1.3 (8.0-16.0) | - |
| Pharynx length | 64 | - | 68.0 ± 0.3 (60.0-72.0) | - |
| Anterior end to excretory pore (Ep) | 56.0 (49.0-59.0) | 54.0 (49.0-59.0) | 63.0 ± 2.3 (59.0-68.0) | 58.0 ± 2.7 (53.0-63.0) |
| Max body width | 15 | - | 13.0 ± 1.3 (10.0-15.0) | 9.0 ± 0.5 (8.0-10.0) |
| Lateral field width | - | - | 2.0 ± 0.1 (1.5-2.0) | - |
| Anterior end-vulva distance | 224 | - | 226.0 ± 9.7 (207.0-250.0) | - |
| Vulva-tail terminus distance | 46 | - | - | - |
| Genital tract length | 127 | - | - | - |
| Vulva-anus distance | 29 | - | - | - |
| Tail length | 17 | (14.0-19.0) | 18.0 ± 2.0 (15.0-24.0) | 16.0 ± 1.1 (15.0-19.0) |
| Spicule length | - | (16.0-19.0) | - | 17.0 ± 0.7 (16.0-19.0) |
| Gubernaculum length | - | 3.0 (2.0-4.0) | - | 3.0 ± 0.4 (2.0-4.0) |
| PERCENTAGES | | | | |
| <i>V</i> | (80.0-84.0) | - | 82.2 ± 0.8 (79.6-84.2) | - |
| G or T | - | 30.0 (24.0-33.0) | - | 29.1 ± 3.3 (20.7 -34.0) |
| St/L | - | - | 6.8 ± 0.3 (6.1-7.9) | - |
| Ep/L | - | - | 22.8 ± 0.8 (21.4-24.6) | 22.1 ± 0.8 (20.5-23.4) |
| RATIOS | | | | |
| <i>a</i> | 19.1 (16.0-24.0) | 24.4 (22.0-27.0) | 22.2 ± 2.6 (17.4-28.1) | 29.0 ± 2.1 (25.0-33.9) |
| <i>b</i> | 3.7 (3.4-4.1) | 3.8 (3.5-4.1) | 4.0 ± 0.2 (3.7-4.4) | - |
| <i>c</i> | (12.0-18.0) | 14.4 (12.0-19.0) | 15.5 ± 1.5 (11.5-18.8) | 16.1 ± 0.8 (14.8-17.7) |
| <i>c'</i> | - | - | 2.5 ± 0.3 (2.0-3.2) | 2.3 ± 0.2 (2.0 -2.7) |

Table S5. Morphometrics of females of *Paratylenchus paralatescens* paratypes Munawar *et al.* (2018) from an undefined bamboo from China compared to those reported for *P. latescens* Raski (1976) from mesquite in Texas.

| Population | Unspecified bamboo (as <i>P. paralatescens</i>) Munawar <i>et al.</i> (2018) China | <i>Prosopis</i> sp. (as <i>P. latescens</i>) Raski (1976) Texas |
|-------------------------------------|--|--|
| Character | ♀ (fixed) | ♀ (fixed) |
| <i>n</i> | 26 | 19 |
| L | 290.4 ± 11.8 (271.1-308.1) | 270.0 ± 16.9 (220.0-290.0) |
| Stylet length (St) | 74.8 ± 2.4 (71.5-78.8) | 75.0 (63.0-80.0) |
| Conus length | - | 67.0 (58.0-74.0) |
| Stylet shaft + knob height | - | 7.0 (5-10) |
| Median bulb valve length | - | 9.0 |
| Median bulb width | 7.5 ± 0.6 (6.2-8.6) | - |
| Isthmus length | - | 11.0 |
| Pharynx length | 125.6 ± 4.6 (118.7-133.5) | - |
| Anterior end to excretory pore (Ep) | 68.8 ± 2.8 (62.7-73.4) | 71.0 (64.0-82.0) |
| Max body width | 11.5 ± 0.7 (10.3-12.7) | - |
| Body width at vulva | 10.9 ± 0.6 (9.7-12.5) | - |
| Body width at anus | 5.9 ± 0.5 (5.0-6.8) | - |
| Vulva-tail terminus distance | 80.5 ± 3.4 (55.5-109.0) | - |
| Tail length | 26.2 ± 2.5 (21.3-30.5) | - |
| PERCENTAGES | | |
| <i>V</i> | 70.1 ± 1.2 (68.2-72.9) | 71.0 (68.0-73.0) |
| RATIOS | | |
| <i>a</i> | 25.3 ± 1.7 (22.4 -29.0) | 19.0 (14.0-23.0) |
| <i>b</i> | 2.3 ± 0.1 (2.2-2.5) | 2.2 (1.7-2.5) |
| <i>c</i> | 11.2 ± 1.1 (9.3-13.8) | 13.0 (10-13) |
| <i>c'</i> | 4.5 ± 0.4 (3.2-5.4) | - |

Table S6. Morphometrics of males of *Paratylenchus paralatescens* populations from *Phyllostachys nigra* (Florida), *Phyllostachys bambusoides* (Florida) Troccoli *et al.* (2002) and *P. paralatescens* paratypes Munawar *et al.* (2018) from an undefined bamboo from China compared to those reported for *P. latescens* Raski (1976) from mesquite in Texas.

| Population | <i>Phyllostachys nigra</i> (CD3396 – N20-01262-1) Florida | | <i>Phyllostachys bambusoides</i> (as <i>P. latescens</i>) Troccoli <i>et al.</i> (2002) Florida | Unspecified bamboo (as <i>P. paralatescens</i>) Munawar <i>et al.</i> (2018) China | <i>Prosopis</i> sp. (as <i>P. latescens</i>) Raski (1976) Texas |
|-------------------------------------|---|--------------|---|--|---|
| Character | ♂ (live) | ♂ (fixed) | ♂ (fixed) | ♂ (fixed) | ♂ (fixed) |
| <i>n</i> | 4 | 2 | 7 | 4 | 8 |
| L | 305.1 ± 13.2 (287.0-318.7) | 293.0, 322.0 | 298.0 ± 24.9 (278.0-348.0) | 312.8 ± 12.4 (300.3-324.3) | 290.0 (230.0-250.0) |
| Pharynx length | 79.3 ± 0.16 (71.0-86.1) | 65.0, 82.1 | - | 90.4 ± 2.4 (87.8-93.4) | 97.2 |
| Anterior end to excretory pore (Ep) | 66.0 ± 2.9 (63.3-70.2) | 66.3, 69.8 | 65.0 ± 6.9 (56.0-76.0) | 66.3 ± 1.9 (63.6-67.8) | 65.0 (58.0-77.0) |
| Max body width | 11.9 ± 0.7 (10.8-12.6) | 10.3, 12.4 | 10.5 ± 0.5 (10.0-11.5) | 10.4 ± 0.4 (10.1-10.9) | 12.0 |
| Body width at anus | 9.1 ± 0.5 (8.5-9.9) | 8.4, 8.4 | 7.5 ± 0.3 (7.5-8.0) | 8.0 ± 0.7 (7.4-8.8) | - |
| Lateral field width | 1.9 ± 0.0 (1.8-1.9) | 1.9, 1.8 | - | - | - |
| Genital tract length | 112.4 ± 4.0 (108.0-116.8) | 136.6, 136.6 | 118.0 ± 1.9 (111.0-124.0) | - | (40.0-49.0) |
| Tail length | 25.8 ± 1.9 (23.2-27.7) | 22.7, 27.0 | 26.5 ± 2.2 (24.0-30.5) | 28.2 ± 1.5 (26.7-29.5) | 26.9 |
| Gubernaculum length | 4.1 ± 0.2 (4.0-4.4) | 4.2, 4.0 | 4.5 ± 0.2 (4.5-5.0) | 4.5 ± 0.6 (4.0-5.3) | 4.0 |
| Spicule length | 18.4 ± 0.4 (18.0-18.8) | 18.0, 17.9 | 18.5 ± 0.7 (18.0-19.5) | 18.1 ± 0.7 (17.5-18.9) | (40.0-49.0) |
| PERCENTAGES | | | | | |
| G or T | 36.8 ± 1.7 (34.3-38.8) | 47.3, 42.4 | 39.3 ± 2.8 (35.6-42.8) | 31.5 ± 5.3 (23.8-35.7) | 37.0 (27.0-47.0) |
| Ep/L | 21.6 ± 1.0 (20.0-22.5) | 22.6, 21.0 | - | - | - |
| RATIOS | | | | | |
| <i>a</i> | 25.7 ± 0.7 (24.8-26.5) | 28.4, 25.9 | 28.6 ± 0.9 (27.6-30.3) | 30.2 ± 2.0 (27.6 -32.1) | 26.0 (20.0-29.0) |
| <i>b</i> | 3.8 ± 0.1 (3.7-4.0) | 4.5, 3.9 | - | 3.5 ± 5.3 (3.3-3.7) | 3.5 (3.3-3.7) |
| <i>c</i> | 11.8 ± 0.4 (11.4-12.3) | 12.5, 11.1 | 11.5 ± 0.7 (10.5-12.6) | 11.1 ± 0.8 (10.3-12.1) | 12.0 (11.0-13.0) |
| <i>c'</i> | 3.8 ± 0.1 (3.7-4.0) | 2.7, 3.4 | 3.4 ± 0.3 (3.0-3.8) | 3.6 ± 0.3 (3.3-4.0) | - |

Table S7. Reference sequences of *Paratylenchus* species used in the present study.

| Species | Original species description reference | Type locality / host | Accession number of reference sequences | | | Comments |
|--------------------------|--|---|---|-------------------|---------------------------------------|---|
| | | | D2-D3 of 28S rRNA gene | ITS rRNA gene | COI gene | |
| <i>P. aciculus</i> | Brown (1959) | Canada, Ontario, Blackburn / fowl bluegrass | MZ265071 | MZ265008 | MZ262212 | Specimens collected from Jaén, Spain in <i>Pinus halepensis</i> , identified as <i>P. aciculus</i> were morphologically and molecularly characterized by Clavero-Camacho <i>et al.</i> (2021). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. acti</i> | Eroshenko (1978) | Russia, Sakhalin Island / pine | OQ749957 | OQ749711 | OQ755146 | Specimens collected from Florida, USA in <i>Andropogon virginicus</i> , identified as <i>P. acti</i> were morphologically and molecularly characterized in this study. Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. aculentus</i> | Brown (1959) | Canada, Saskatchewan, Lake Lenore / grass sod | MW413626 | MW413588 | MW421639 | Specimens collected from Belgium in grasses, identified as <i>P. aculentus</i> were morphologically and molecularly characterized by Singh <i>et al.</i> (2021). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. audriellus</i> | Brown (1959) | Canada, Ontario, Orleans / white birch | KU291238 | - | - | Specimens collected Kermanshah province, Iran, identified as <i>P. audriellus</i> were morphologically and molecularly characterized by Esmaeili <i>et al.</i> (2016). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. amundseni</i> | Bernard (1982) | USA, Alaska, Adak Island, Shagak Bay / <i>Elymus mollis</i> | MZ265076 | MZ265012 | MZ262215 | Specimens collected from Jaén, Spain in <i>Pinus halepensis</i> , identified as <i>P. amundseni</i> were morphologically and molecularly characterized by Clavero-Camacho <i>et al.</i> (2021). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. aquaticus</i> | Merny (1966) | Ivory Coast, Béoumi / rice | KF242241 (type B) / OQ749952 (type C) | OQ749709 (type C) | MW411838 (type B) / OQ755157 (type C) | Specimens collected from Manhattan, Kansas identified as <i>P. aquaticus</i> type B and from Florida, USA identified as <i>P. aquaticus</i> type C were morphologically and molecularly characterized by Van den Berg <i>et al.</i> (2014) and by this study, respectively. Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. baldaccii</i> | Raski (1975) | Italy, Sicily / grape | MW798290 | MW798335 | MW797012 | Specimens collected from Sevilla, Spain in peach, identified as <i>P. baldaccii</i> were morphologically and molecularly characterized by Clavero-Camacho <i>et al.</i> (2021). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. beltsvillensis</i> | Kantor <i>et al.</i> (2021) | USA, Maryland, Beltsville / Virginia pine | MW413581 | MW413587 | - | Specimens collected from the type host and locality were morphologically and molecularly characterized by Kantor <i>et al.</i> (2021). Molecular characterization of COI gene of specimens collected from type host and locality is required. |
| <i>P. bilineatus</i> | Brzeski (1995) | Taiwan, Shuang Hai / bamboo | - | EU247525 | - | Specimens collected from the type host in Taiwan were morphologically and molecularly characterized by Chen <i>et al.</i> (2008). Molecular characterization of 28S rRNA and COI genes of specimens collected from type host and locality is required. |

| | | | | | | |
|---------------------------|--------------------------------------|---|----------|----------|----------|--|
| <i>P. borealis</i> sp. n. | This study | USA, Alaska, Anchorage / unknown plants | OQ749978 | OQ749710 | MW421700 | Specimens collected from the type host and locality were molecularly characterized in this study. Molecular characterization of COI gene of specimens collected from type host and locality is required. |
| <i>P. canchicus</i> | Mohilal & Dhanachand (2004) | India, Uttar Pradesh | ON873212 | - | ON873964 | Specimens collected from Málaga, Spain in maritimus pine, identified as <i>P. canchicus</i> were morphologically and molecularly characterized by Palomares-Rius <i>et al.</i> (2022b). Molecular characterization of ITS rRNA gene of specimens collected from type host and locality is required. |
| <i>P. capitatus</i> | Adams & Eichenmuller (1962) | USA, West Virginia / scarlet oak | - | - | MN710982 | Specimens collected North Carolina, USA, identified as <i>P. capitatus</i> were molecularly characterized by Powers <i>et al.</i> (2021). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. caravaquenus</i> | Clavero-Camacho <i>et al.</i> (2021) | Spain, Murcia, Caravaca / pine | MW798270 | MW798316 | MW797003 | Specimens collected from the type host and locality were morphologically and molecularly characterized by Clavero-Camacho <i>et al.</i> (2021). |
| <i>P. chongqingensis</i> | Li <i>et al.</i> (2019) | China, Chongqing / <i>Ophiopogon japonicus</i> | - | MK024368 | - | Specimens collected from the type host and locality were morphologically and molecularly characterized by Li <i>et al.</i> (2019). Molecular characterization of 28S rRNA and COI genes of specimens collected from type host and locality is required. |
| <i>P. coronatus</i> | Colbran (1965) | Australia, Queensland / <i>Baloghia lucida</i> | MK506808 | MK506795 | - | Specimens collected from East Azerbaijan, Iran in <i>Crataegus</i> sp., identified as <i>P. coronatus</i> were morphologically and molecularly characterized by Mokaram Hesar <i>et al.</i> (2019). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. dianthus</i> | Jenkins & Taylor (1956) | USA, Maryland / <i>Dianthus caryophyllus</i> | KF242226 | KF242271 | MW411837 | Specimens collected from Gauteng, South Africa in <i>Chrysanthemum</i> , identified as <i>P. dianthus</i> were morphologically and molecularly characterized by Van den Berg <i>et al.</i> (2014). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. elachistus</i> | Steiner (1949) | USA, Florida. Clewiston/ <i>Boehmeria nivea</i> | MW413629 | MW413590 | MW421643 | Specimens collected from Belgium in grasses, identified as <i>P. elachistus</i> were morphologically and molecularly characterized by Singh <i>et al.</i> (2021). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. enigmaticus</i> | Munawar <i>et al.</i> (2021) | Canada, Alberta, Taber / potato field | MW282760 | MW282772 | MZ262222 | Specimens collected from the type host and locality were morphologically and molecularly characterized by Munawar <i>et al.</i> (2021). Molecular characterization of COI gene of specimens collected from type host and locality is required. |
| <i>P. goldeni</i> | Raski (1975) | USA, North Carolina / <i>Buxus</i> sp. | OQ749969 | OQ749700 | OQ755152 | Specimens collected from Florida, USA in <i>Ilex</i> sp, identified as <i>P. goldeni</i> were morphologically and molecularly characterized in this study. Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. goodeyi</i> | Ostenbrink (1953) | The Netherlands, Arnhem / grasses | MW413631 | MW413594 | MW421647 | Specimens collected from Belgium in grasses, identified as <i>P. goodeyi</i> were morphologically and molecularly characterized by Singh <i>et al.</i> (2021). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. guangzhouensis</i> | Wang <i>et al.</i> (2016) | China, Guangdong Province, Guangzhou / <i>Bambusa multiplex</i> | - | KT725625 | - | Specimens collected from the type host and locality were morphologically and molecularly characterized by Wang <i>et al.</i> (2016). Molecular characterization of 28S rRNA and COI genes of specimens collected from type host and locality is required. |
| <i>P. hamatus</i> | Thorne & Allen (1950) | USA, California / fig tree | KF242212 | KF242244 | MW411821 | Specimens collected from the type host and locality were morphologically and molecularly characterized by Van den Berg <i>et al.</i> (2014). |
| <i>P. hamicaudatus</i> | Cid del Prado Vera & Maggenti (1988) | USA, California, Marin County / Sequoia sempervirens | OQ749973 | OQ749705 | OQ755158 | Specimens collected from the type host and locality were molecularly characterized in this study. |

| | | | | | | |
|------------------------------|--------------------------------------|--|----------|----------|----------|--|
| <i>P. hawaiiensis</i> sp. n. | This study | USA, Florida, Miami-Dade County / <i>Aechmea</i> sp. | OQ749977 | KF242277 | MW411845 | Specimens collected from the type host and locality were molecularly characterized in this study. Molecular characterization of ITS rRNA and COI genes of specimens collected from type host and locality is required. |
| <i>P. holdemani</i> | Raski (1975) | El Salvador, Santa Anna / coffee | MW413639 | MW413596 | MW421653 | Specimens collected from Belgium, grasses, identified as <i>P. holdemani</i> were morphologically and molecularly characterized by Singh <i>et al.</i> (2021). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. idalimus</i> | Raski (1962) | USA, California / <i>Ericameria palmeri</i> | KF242237 | KF242275 | MW411839 | Specimens collected from Belgium, grasses, identified as <i>P. idalimus</i> were morphologically and molecularly characterized by Singh <i>et al.</i> (2021). Specimens collected from California, USA in grape were molecularly characterized by Van den Berg <i>et al.</i> (2014). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. ilicis</i> | Singh <i>et al.</i> (2022) | The Netherlands, Hilversum / <i>Ilex aquifolium</i> | MW413683 | ON668073 | MW421706 | Specimens collected from the type host and locality were morphologically and molecularly characterized by Singh <i>et al.</i> (2022). |
| <i>P. indalus</i> | Clavero-Camacho <i>et al.</i> (2021) | Spain, Almería, Santa María de Nieva / almond | MW798273 | MW798319 | MW797005 | Specimens collected from the type host and locality were morphologically and molecularly characterized by Clavero-Camacho <i>et al.</i> (2021). |
| <i>P. israelensis</i> | Raski (1973) | Israel, Shiller / plum | MW798301 | MW798343 | MW797019 | Specimens collected from Cordoba, Spain in almond, identified as <i>P. israelensis</i> were morphologically and molecularly characterized by Clavero-Camacho <i>et al.</i> (2021). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. jasmineae</i> | Phani <i>et al.</i> (2019) | India, New Delhi / <i>Jasminum sambac</i> | MH588059 | MH588060 | - | Specimens collected from the type host and locality were morphologically and molecularly characterized by Phani <i>et al.</i> (2019). Molecular characterization of COI gene of specimens collected from type host and locality is required. |
| <i>P. labiosus</i> | Anderson & Kimpinski (1977) | Canada, Prince Edward Island, Souris / potato | MK506809 | MK506796 | - | Specimens collected from East Azerbaijan, Iran in <i>Malus</i> sp., identified as <i>P. labiosus</i> were morphologically and molecularly characterized by Mokaram Hesar <i>et al.</i> (2019). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. lepidus</i> | Raski (1975) | Sri Lanka / <i>Thea sinensis</i> | MK886692 | MK886695 | MT828831 | Specimens collected from Zhejiang Province, China in <i>Elaeocarpus</i> sp. identified as <i>P. lepidus</i> were morphologically and molecularly characterized by Munawar <i>et al.</i> (2019). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. leptos</i> | Raski (1975) | Brazil, Nova Teutonia / <i>Piper</i> sp. | MW413645 | - | MW421663 | Specimens collected from Gera district, Ethiopia in coffee, identified as <i>P. leptos</i> were molecularly characterized by Singh <i>et al.</i> (2021). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. macrodorus</i> | Brzeski (1963) | Poland, Skierniewice / <i>Cichorium intybus</i> | MZ265108 | MZ265034 | MZ262239 | Specimens collected from Córdoba, Spain in wild olive, identified as <i>P. macrodorus</i> were morphologically and molecularly characterized by Clavero-Camacho <i>et al.</i> (2021). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. microdorus</i> | Andrássy (1959) | Montenegro, Durmitor mountains / grasses | MW413654 | MW413598 | MW421666 | Specimens collected from Belgium in grasses identified as <i>P. microdorus</i> were morphologically and molecularly characterized by Singh <i>et al.</i> (2021). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. minor</i> | Sharma <i>et al.</i> (1986) | India, Himachal Pradesh, Juneo / <i>Prunus persica</i> | MK660188 | MK660189 | - | Specimens collected from Zhejiang Province, China in <i>Pinus tabulaeformis</i> identified as <i>P. minor</i> were morphologically and molecularly characterized by Munawar <i>et al.</i> (2019). Molecular characterization of specimens collected from type host and locality is required. |

| | | | | | | |
|----------------------------|--------------------------------------|--|----------|----------|----------|--|
| <i>P. minutus</i> | Linford <i>et al.</i> (1949) | USA, Hawaii, Oahu, Wahiawa / <i>Ananas comosus</i> | OQ749976 | OQ749706 | - | Specimens collected from Hawaii, USA in <i>Coffea</i> sp., identified as <i>P. minutus</i> were morphologically and molecularly characterized in this study. Molecular characterization of COI gene of specimens collected from type host and locality is required. |
| <i>P. nainianus</i> | Edward & Misra (1963) | India, Uttar Pradesh / <i>Psidium cattleianum</i> | ON873217 | ON873186 | ON873966 | Specimens collected from Málaga, Spain in green heather, identified as <i>P. nainianus</i> were morphologically and molecularly characterized by Palomares-Rius <i>et al.</i> (2022b) |
| <i>P. nanjingensis</i> | Wang <i>et al.</i> (2016) | China, Jiangsu Province, Nanjing / <i>Pinus massoniana</i> | KR232932 | KM366101 | - | Specimens collected from the type host and locality were morphologically and molecularly characterized by Wang <i>et al.</i> (2016). Molecular characterization of COI gene of specimens collected from type host and locality is required. |
| <i>P. nanus</i> | Cobb (1923) | USA, Virginia / grasses | MW234450 | MW234452 | MW238474 | Specimens collected from the type host and locality were morphologically and molecularly characterized by Subbotin <i>et al.</i> (2020). |
| <i>P. nawadus</i> | Khan <i>et al.</i> (1967) | India, Bihar / <i>Carissa</i> sp. | MN088373 | - | - | Specimens collected from Behbahan, Khuzestan, Iran in <i>Gundelia tournefortii</i> identified as <i>P. nawadys</i> were morphologically and molecularly characterized by Mirbabaie <i>et al.</i> (2019). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. neoamblycephalus</i> | Geraert (1965) | Germany, Frauweiler / <i>Malus</i> | MW413660 | MW413606 | MW421675 | Specimens collected from Belgium in cypress tree identified as <i>P. neoamblycephalus</i> were morphologically and molecularly characterized by Singh <i>et al.</i> (2021). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. neonanus</i> | Mathur <i>et al.</i> (1967) | India, Uttar Pradesh, Meerut / <i>Ziziphus</i> sp. | ON873226 | - | ON873976 | Specimens collected from Málaga, Spain in maritimus pine, identified as <i>P. neonanus</i> were morphologically and molecularly characterized by Palomares-Rius <i>et al.</i> (2022b) Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. neoprojectus</i> | Wu & Hawn (1975) | Canada, Alberta / alfalfa | MW282762 | MW282775 | - | Specimens collected from Alberta, Canada in <i>Chenopodium</i> sp., identified as <i>P. neoprojectus</i> were morphologically and molecularly characterized by Munawar <i>et al.</i> (2021). Molecular characterization of COI gene of specimens collected from type host and locality is required. |
| <i>P. pandatus</i> | Raski (1976) | Nigeria, Katsina / grapefruit | MZ265116 | MZ265041 | MZ262247 | Specimens collected from Caravaca, Murcia, Spain in <i>Pinus halepensis</i> , identified as <i>P. pandatus</i> were morphologically and molecularly characterized by Clavero-Camacho <i>et al.</i> (2021). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. paraaonli</i> | Palomares-Rius <i>et al.</i> (2022b) | Spain, Málaga, Casares/ maritimus pine | ON873200 | ON873174 | ON873946 | Specimens collected from the type host and locality were morphologically and molecularly characterized by Palomares-Rius <i>et al.</i> (2022b) |
| <i>P. paralatescens</i> | Munawar <i>et al.</i> (2018) | China, Zhejiang Province, Anji County / bamboo trees | MH200616 | MH200615 | - | Specimens collected from the type host and locality were morphologically and molecularly characterized by Munawar <i>et al.</i> (2018). Molecular characterization of COI gene of specimens collected from type host and locality is required. |
| <i>P. parastraeleni</i> | Clavero-Camacho <i>et al.</i> (2021) | Spain, Jaén, Arroyo Frío / <i>Quercus faginea</i> | MZ265064 | MZ265004 | MZ262208 | Specimens collected from the type host and locality were morphologically and molecularly characterized by Clavero-Camacho <i>et al.</i> (2021). |
| <i>P. pedrami</i> | Clavero-Camacho <i>et al.</i> (2021) | Spain, Córdoba / almond | MW798283 | MW798329 | MW797009 | Specimens collected from the type host and locality were morphologically and molecularly characterized by Clavero-Camacho <i>et al.</i> (2021). |
| <i>P. peraticus</i> | Raski (1962) | Germany, Rehlinger Trausch / grapes | MK506805 | MK506792 | - | Specimens collected from Ardebil, Iran in <i>Prunus</i> sp., identified as <i>P. peraticus</i> were morphologically and molecularly characterized by Mokaram Hesar <i>et al.</i> (2019). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. pestis</i> | Thorne (1943) | USA, California, Santa Clara / <i>Juglans regia</i> | MK506802 | MK506790 | - | Specimens collected from East Azerbaijan, Iran in <i>Juglans regia</i> , identified as <i>P. pestis</i> were morphologically and molecularly characterized by Mokaram Hesar <i>et</i> |

| | | | | | | |
|---------------------------|--------------------------------------|--|----------|----------|----------|--|
| | | | | | | <i>al.</i> (2019). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. plesiostraeleni</i> | Palomares-Rius <i>et al.</i> (2022b) | Spain, Málaga, Tolox, | ON873204 | ON873179 | ON873954 | Specimens collected from the type host and locality were morphologically and molecularly characterized by Palomares-Rius <i>et al.</i> (2022b) |
| <i>P. projectus</i> | Jenkins (1956) | USA, Maryland, Upper Marlboro / grass | MT668712 | MT668705 | MW238473 | Specimens collected from California, North Dakota, USA and South Africa identified as <i>P. projectus</i> were morphologically and molecularly characterized by Van den Berg <i>et al.</i> (2014) and Subbotin <i>et al.</i> (2020). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. recisus</i> | Siddiqi (1996) | Carimagua, Colombia / <i>Stylosanthes guianensis</i> | MZ265119 | MZ265043 | MZ262252 | Specimens collected from Jaén, Spain in <i>Quercus faginea</i> , identified as <i>P. recisus</i> were morphologically and molecularly characterized by Clavero-Camacho <i>et al.</i> (2021). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. roboris</i> sp. n. | This study | USA, Florida / <i>Quercus virginiana</i> | OQ749956 | OQ749714 | OQ755148 | Specimens collected from the type host and locality were morphologically and molecularly characterized in this study. |
| <i>P. rostrocaudatus</i> | Huang & Raski (1987) | Brazil, Fazenda Sossego / rice | KR270601 | KR270604 | - | Specimens collected from China in bamboo, identified as <i>P. rostrocaudatus</i> were morphologically and molecularly characterized by Zhuo <i>et al.</i> (2018). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. salubris</i> | Raski (1975b) | Brazil, Porto Seguro / <i>Theobroma cacao</i> | ON873233 | - | ON873980 | Specimens collected from Málaga, Spain in maritimus pine, identified as <i>P. salubris</i> were morphologically and molecularly characterized by Palomares-Rius <i>et al.</i> (2022b). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. sheri</i> | Raski (1973) | France, Digne / grasses | MZ265121 | MZ265044 | MZ262253 | Specimens collected from Jaén, Spain in grasses, identified as <i>P. sheri</i> were morphologically and molecularly characterized by Clavero-Camacho <i>et al.</i> (2021). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. similis</i> | Khan <i>et al.</i> (1967) | India, Mysore, Dhadesugar / sorghum | MK506806 | MK506793 | - | Specimens collected from East Azerbaijan, Iran in <i>Prunus</i> sp., identified as <i>P. similis</i> were morphologically and molecularly characterized by Mokaram Hesar <i>et al.</i> (2019). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. sinensis</i> | Munawar <i>et al.</i> (2020) | China Zhejiang Province, Jiaxing City / white mulberry | MN129026 | MN129021 | - | Specimens collected from the type host and locality were morphologically and molecularly characterized by Munawar <i>et al.</i> (2020). Molecular characterization of COI gene of specimens collected from type host and locality is required. |
| <i>P. straeleni</i> | De Coninck (1931) | Belgium, Liège Province, High Fens / moss | MW413685 | MW413624 | MW421708 | Specimens collected from California, USA and Belgium in grasses identified as <i>P. straeleni</i> were morphologically and molecularly characterized by Van den Berg <i>et al.</i> (2014) and Singh <i>et al.</i> (2021). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. tateae</i> | Wu & Townshend (1973) | Canada, Ontario / corn | MW282754 | MW282766 | MZ262262 | Specimens collected from Southern Alberta, Canada in potato and Zaragoza, Spain in almond, identified as <i>P. tateae</i> were morphologically and molecularly characterized by Munawar <i>et al.</i> , (2021) and Clavero-Camacho <i>et al.</i> (2021). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. tenuicaudatus</i> | Wu (1961) | Canada, Ontario, North Gowe / red clover | MW798306 | MW798347 | MW797021 | Specimens collected from Murcia, Spain in almond, identified as <i>P. tenuicaudatus</i> were morphologically and molecularly characterized by Clavero-Camacho <i>et al.</i> (2021). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. teres</i> | Raski (1976) | Brazil, Espirito Santo / <i>Theobroma cacao</i> | MN088376 | - | - | Specimens collected from Khuzestan, Iran in <i>Pistacia atlantica</i> , identified as <i>P. teres</i> were morphologically and molecularly characterized by Mirbabaei <i>et al.</i> (2019). |

| | | | | | | |
|-----------------------|--------------------------------------|--|----------|----------|----------|---|
| | | | | | | Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. variabilis</i> | Raski (1975) | USA, California / <i>Rhus trilobata</i> | MZ265127 | MZ265051 | MZ262265 | Specimens collected from Cordoba, Spain in wild olive, identified as <i>P. variabilis</i> were morphologically and molecularly characterized by Clavero-Camacho <i>et al.</i> (2021). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. veruculatus</i> | Wu (1962) | Scotland, Kilmcolm / heather | MW798311 | MW798350 | MW797027 | Specimens collected from Almería, Spain in almond, identified as <i>P. veruculatus</i> were morphologically and molecularly characterized by Clavero-Camacho <i>et al.</i> (2021). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. verus</i> | Brzeski (1995) | Mexico, Texcoco / forest | MZ265130 | MZ265054 | MZ262268 | Specimens collected from Cordoba, Spain in wild olive, identified as <i>P. verus</i> were morphologically and molecularly characterized by Clavero-Camacho <i>et al.</i> (2021). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. vitecus</i> | Pramodini <i>et al.</i> (2006) | India, Manipur / <i>Vitex peduncularis</i> | MZ265136 | MZ265059 | MZ262272 | Specimens collected from Cordoba, Spain in wild olive, identified as <i>P. verus</i> were morphologically and molecularly characterized by Clavero-Camacho <i>et al.</i> (2021). Molecular characterization of specimens collected from type host and locality is required. |
| <i>P. zurgenerus</i> | Clavero-Camacho <i>et al.</i> (2021) | Spain, Almería, Zurgena / almond | MW798286 | MW798331 | MW797010 | Specimens collected from the type host and locality were morphologically and molecularly characterized by Clavero-Camacho <i>et al.</i> (2021). |
| <i>P. wuae</i> | Yu <i>et al.</i> (2016) | Canada, Ontario, Ottawa / cow parsnip | KM061782 | KM061783 | - | Specimens collected from the type host and locality were morphologically and molecularly characterized by Yu <i>et al.</i> (2016). Molecular characterization of COI gene of specimens collected from type host and locality is required. |