

New Data on Nematodes of the Families Aporcelaimidae, Paraxonchidae, Qudsianematidae and Dorylaimidae Based on Examinations of a Raspberry Plantation in Bulgaria

Zhenya I. Ilieva¹, Iliyan L. Iliev² & Veselina G. Georgieva¹

¹Institute of Soil Science, Agrotechnology and Plant Protection, 35 P. Volov Street, 2230 Kostinbrod, Bulgaria;
E-mail: zhenya107a@gmail.com; veselina.g.georgieva@abv.bg

²Biological Faculty, Sofia University "St. Kl. Ohridski", 8 D. Tzankov Blvd., 1421 Sofia, Bulgaria;
E-mail: iliyana.lazarov.i@gmail.com

Abstract: The nematode fauna of an old raspberry plantation was studied by 28 bulk samples. Eleven species of four families of Dorylaimida were found. The occurrence and relative abundance of each species were calculated and the distribution of the recorded species in Bulgaria was summarised. The most abundant species of the studied families were *Aporcella simplex* and *Eudorylaimus subdigitalis*. *Discolaimoides bulbiferus* and *Crassolabium* cf. *cylindricum* are new geographical records for Bulgaria and *Aporcelaimus* cf. *americanus*, *Discolaimus agricolus* and *Eudorylaimus subdigitalis* for the Balkan Peninsula. Morphometrics and microphotography based on specimens of the studied populations are presented.

Key words: *Aporcelaimus*, *Aporcelaimellus*, *Aporcella*, *Discolaimus*, *Discolaimoides*, *Ecumenicus*, *Eudorylaimus*, *Crassolabium*, *Paraxonchium*, abundance, morphology

Introduction

Species of the families Aporcelaimidae, Paraxonchidae, Qudsianematidae and Dorylaimidae have been reported from different natural and agricultural habitats in Bulgaria (Table 1) but few studies focus on the morphology of the studied specimens (ILIEVA 1991, ILIEVA & ELIAVA 1993, NEDELICHEV et al. 2014). During a study on plant parasitic nematodes in a raspberry plantation in Plovdiv several species of the families were identified.

The objectives of the present study were to contribute new data on morphology of the recorded populations of Aporcelaimidae, Paraxonchidae, Qudsianematidae and Dorylaimidae and to analyse species distribution, abundance and occurrence.

Material and Methods

The study site was an experimental area of the Fruit Growing Institute, Plovdiv (42°06'49.4N, 24°43'32.5E, 132 m a.s.l.) in an eleven-year-old rasp-

berry plantation ('Lyulin' primocane-fruiting cultivar) on a 400 m² plot. It was sampled on the 4th of November, 2009. The soil type was Fluvisol. The soil had a layered structure with a more compact upper layer, one permeable layer at 60-70 cm depth and an underlying layer of low permeability at 90-105 cm. Soil bulk density varied from 1.45 to 1.66 mg/m³. The soil pH was about 7.3 in the 0-25 cm horizon (KOUMANOV et al. 2009). The area was watered using a drip irrigation system. Several herbicides were applied annually after tillage in March as follows: pendimethalin, metolachlor and oxadiargyl in 2002-2004, respectively; napropamid, dichlobenil, oxyfluorfen in 2005-2007 and flumioxasin and combined oxyfluorfen + metolachlor in 2009-2010 (RANKOVA & KUMANOV 2004, KOUMANOV et al. 2009; RANKOVA et al. 2014).

Twenty-eight bulk samples were collected at depths from 0 to 30 cm with an auger 30 mm wide. Each bulk sample was composed of ten cores taken in a zigzag pattern along the plant rows. After careful

homogenization a subsample of 100 g was processed from each sample. Extraction was performed with an Oostenbrink elutriator. The isolated nematodes were counted under inverted microscope IX Olympus, gently heated at 55°C for 3 minutes, fixed with 4% formaldehyde and transferred in anhydrous glycerin using the method of SEINHORST (1959). The mounted specimens were measured, photos were taken under DIC microscope Olympus BX60 with digital camera DP70 and specialised software Imaging System cell[^]B (Olympus).

Results and Discussion

Eleven species of the four studied families were identified in the present study. All previous records in Bulgaria are presented in Table 1.

Family Aporcelaimidae Heyns, 1965

This family was represented by three species in the studied area.

Aporcella simplex (Thorne et Swanger, 1936) Alvarez-Ortega, Subbotin et Peña-Santiago, 2013

Tables 1, 2 and 5, Fig. 1

Description: Female: Moderately slender body slightly curved ventrally upon fixation. Cuticle very finely striated and three-layered, 3.5 – 4 μm tick in anterior region, 3.0 - 5.0 μm tick in mid-body and 14 – 17 μm tick on caudal tip. Cervical lacunae absent. Eight to 13 dorsal and ventral cuticle pores visible in pharyngeal region (3 – 6 to the level of excretory pore, 5 – 7 pores after level of excretory pore on both sites). Lip region offset by expansion, 7 μm high in all measured specimens, 3.0-3.3 times as broad as high and 24-37% of body diameter at neck base. Lips somewhat flat frontally. Amphid fovea funnel-shaped, with aperture about a half (43 – 54%) of lip region diameter. Odontostyle short and strongly cuticularised, 3.3-4.4 times as long as wide, 0.9 - 1.2 times as long as lip region diameter and 1.0 – 1.2% of body length. Aperture 60 – 73% of odontostyle length. Guiding ring plicate at 8.3 – 10 μm from anterior end. Odontophore rod-like and 1.5 – 2.1 of odontostyle length. Excretory pore about the level of nerve ring or at 194 – 217 μm from anterior end. Anterior region of pharynx enlarging gradually and basal expansion 47 – 55% of neck length. Cardia broad conoid embedded in intestinal tissue. More or less prominent discoid structure observed in most of specimens. Female genital system amphidelphic with equally developed branches, anterior 10-12% of body length and posterior 10-11% of body length. Its structure as described by ÁLVAREZ-ORTEGA et al. (2013) but rather

weak constrictions than clear sphincters visible between different parts. Two specimens with four synchronous eggs and another three with one egg. Eggs oval 67 – 82 x 45 – 57 μm . Vagina extended 20 – 23 μm or 26 – 34% of body diameter. *Pars proximalis* 14 – 22 μm long and 15 – 20 μm wide, with parallel to slightly oval walls. *Pars distalis* 4.0 – 5.5 μm long. *Pars refringens* absent. Vulva post-equatorial. Prerectum 1.9 – 2.9 anal body diameters long and rectum 0.8 – 1.4. Tail straight ventrally and convex dorsally with finely rounded terminus and hyaline portion on the tip. Two pairs of pores on the tail.

Males not found and sperm not observed in females.

Remarks: Specimens identified in the present study were generally similar to the description of populations from natural areas in the south-eastern Iberian Peninsula (ÁLVAREZ-ORTEGA et al. 2013). They differed from that population by a smaller odontostyle aperture (60-73% vs 74-80%) and the form of *pars proximalis*: the parallel contour of outer walls vs sigmoid in Iberian populations. Nevertheless, we considered this population as *A. simplex*.

Distribution: In Europe, the species has been reported from agricultural and natural habitats in Austria, France, Italy, Poland and Spain (ÁLVAREZ-ORTEGA et al. 2013). Although *A. simplex* is widely distributed species in the Holarctic area (ÁLVAREZ-ORTEGA & PEÑA-SANTIAGO 2010), the present record was the second one for Bulgaria (Table 1) and the first for the Thrace Valley.

Aporcelaimellus obtusicaudatus (Bastian, 1865) Altherr, 1968

Tables 1, 2 and 5

Remarks: The isolated specimens resembled the population of Cañada de las Ánimas, Sierra de las Nieves, Ronda from the Province of Malaga, Spain (ÁLVAREZ-ORTEGA & PEÑA-SANTIAGO 2012).

Distribution: Frequently reported throughout Bulgaria in a variety of habitats, both managed and natural (Table 1). Although few old works gave some morphological data (ANDRASSY 1958; KATALAN-GATEVA 1966), no permanent slides were available for the most of articles. Records in those regions should be confirmed by contemporary research.

Aporcelaimus cf americanus Thorne et Swanger, 1936

Tables 1, 2 and 5, Fig. 2

Description: Females: Large-sized nematodes with moderately slender body curved ventrally upon fixation. Cuticle three-layered, 6 – 7 μm tick in mid-body and 15.5 – 17 μm on caudal tip. Cervical lacu-

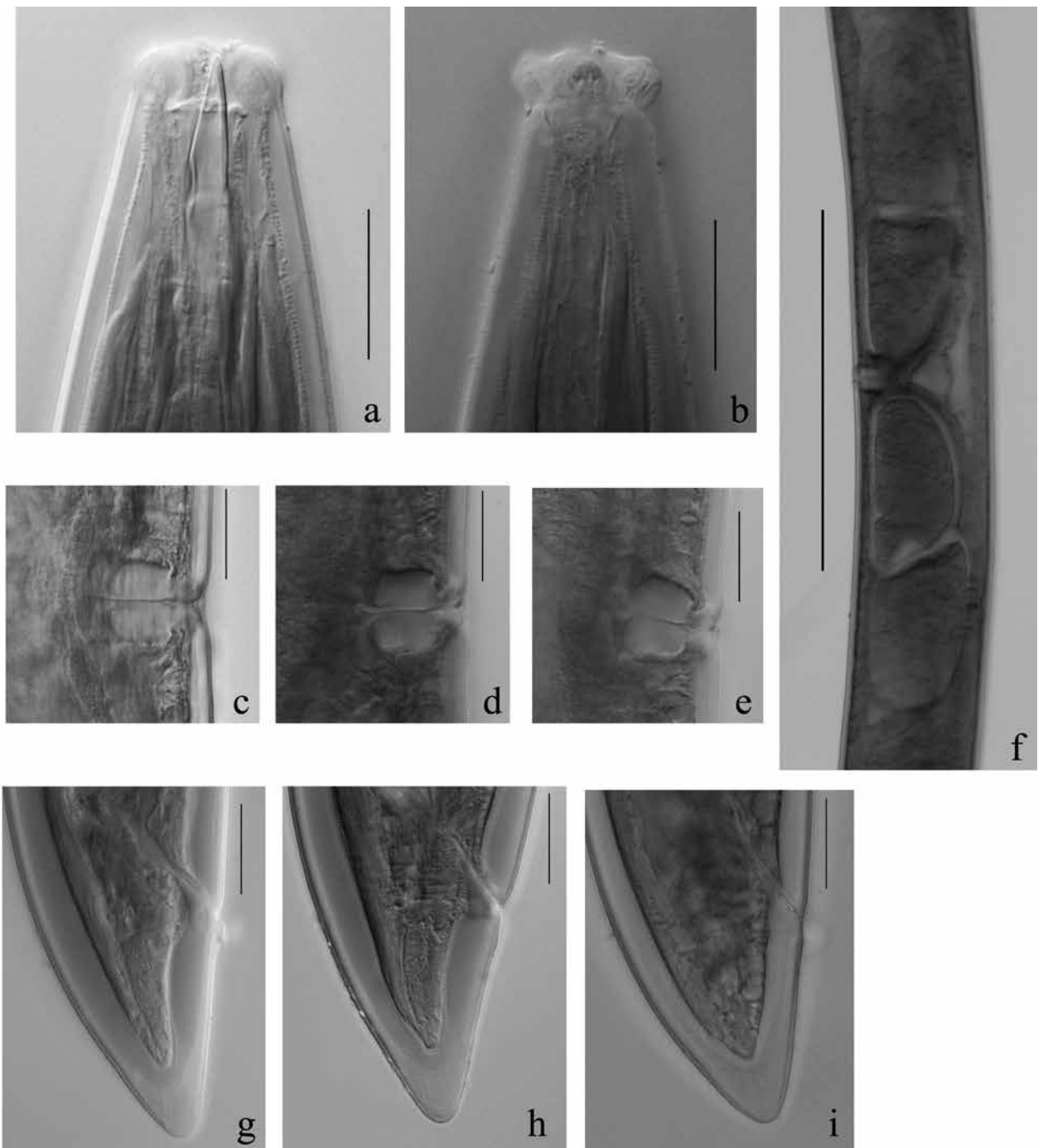


Fig. 1. *Aporcella simplex* – a. Lip region; b. Amphidial fovea; c., d. and e. Variation of vagina shape; f. Four synchronal eggs in genital tract; g., h. and i. Variation of tail shape (scale 20 μm – a, b, c, d, e, g, h and i; scale 200 μm – f)

nae present at odontophore level and 14–17 μm tick. Nineteen ventral and dorsal cuticle pores visible in pharyngeal region (two to the level of odontophore, five pores to the level of nerve ring and 12 after nerve ring on both sites but not symmetrically situated). Lip region offset by constriction, 7.5 μm high, 3.9–4 times as broad as high and 19% of body diameter at neck base. Lips look somewhat amalgamated. Amphid fovea wide goblet shaped with hardly visible median rib. Aperture 45% of lip region diameter.

Odontostyle short and strongly cuticularised, 4.0–4.5 times as long as wide, as long as lip region diameter and 0.4–0.5% of body length. Aperture occupies 64–70% of odontostyle length. Guiding ring plicate at 11.5–12.5 μm from anterior end. Odontophore rod-like and 1.8–2.0 of odontostyle length. Excretory pore well before the level of nerve ring or at 219–228 μm from anterior end. Nerve ring at 245–263 μm from anterior end. Pharynx enlarges gradually and basal expansion 66–71% of neck length. Cardia

broadly conoid 28 x 68 μm , embedded in intestinal tissue. Thin disk about 12 μm thick visible between pharynx and cardia. Female genital system didelphic-amphidelphic but gut in both specimens was full with compact matter and no uterus neither posterior branch was well visible. Anterior gonad 250 μm or 3.3% of body length. Ovary 69 μm long, starting with germinal end of ovary – 11 μm , followed by part of narrow unicellular rows – 22 μm , wider part of eight longitudinal cells with big nuclei – 20 μm long and part where eggs ripen – 16 μm . Oviduct narrow 46 μm long with junction between two last parts of ovary. *Pars dilatata* with shape of truncated cone, about 70 μm long. Uterus 127 μm long but no clear structure visible. Vagina extended 80 μm or 46% of body diameter. *Pars proximalis* 56 μm long and 50 μm wide, with almost parallel tick walls surrounded by strong musculature. *Pars refringens* trapezoid distally convex rounded and proximally more angular 22 x 40 μm . They look like formed by four pieces with a small proximal cleft in each semi part. *Pars distalis* 4.0 μm long. Two big excretory cells visible on both sites of vagina. One to three subventral cuticular pores before and two or three after vulva slit. Vulva equatorial with longitudinal slit well visible in one of the specimens. Prerectum 1.9 – 2.1 anal body diameters long and rectum 0.5. Tail broadly convex conoid with minute button-like protrusion on the tip. Two pairs of pores on the tail.

Males not found.

Remarks: The recovered specimens were characterised by the form of *pars refringens*, longitudinal vulva slit and shorter tail with specific shape. The most important differences with specimens described from Hungary (ANDRÁSSY 2000) were connected with structure of vulva and vagina. ANDRÁSSY (2000) described transverse vulva with heart-shaped *pars refringens* based on three specimens. Similar shape of *pars refringens* we found in the photos of Peter Mullin of the specimen RMNP SS-01 from the Rocky Mountain National Park, Colorado. Since there have been no male specimens isolated and no morphological data is available from other records of the species in Europe, we considered the species to be *A. cf americanus*.

Distribution: Rare in Europe, recorded in France, Hungary, the Netherlands and Poland (ANDRÁSSY 2000). This is the first record of the species on the Balkan Peninsula.

Family Paraxonchiidae Dhanachand et Jairajpuri, 1981

This family was presented by one species in the studied area.

Paraxonchium laetificans (Andrássy, 1956) Altherr et Loof, 1969

Tables 1, 2 and 5, Fig. 3

Description: Female: Body straight upon fixation often turned laterally; stout but tapering significantly in the neck region. Cuticle 1-2 μm thick at the level of odontophore, respectively 3 – 5 μm in mid-body and 15 – 25 μm on caudal tip with clearly visible three layers. Dorsal pores 12-16, mostly in pharyngeal region. Ventral pores 69 – 84 distributed as follows (e.g. 19 – 29 at pharyngeal region; 17 – 27 at cardia – vulva region and 23 – 29 at vulva – anus region). Lip region offset by deep constriction, 4 – 5.5 μm high, 1.8 – 2.5 times as broad as high and 16 – 19% of body diameter at neck base. Labial papillae elevated. Amphid fovea shaped as shallow cup with aperture 38 – 40% of lip region diameter. Odontostyle short and cuticularised, 4.0 – 5.0 times as long as wide, 0.6-0.9 times as long as lip region diameter and 0.8 – 1.1% of body length. Aperture occupies 53 – 67% of odontostyle length. Guiding ring not well visible. Odontophore long but posterior end unclear. Excretory pore at or after the level of nerve ring or 100 – 160 μm from anterior end. Nerve ring at 100 – 138 μm from anterior end. Pharynx enlarges gradually and basal expansion 48 – 55% of neck length. Three cardinal glands visible in pharyngeal-intestinal junction. Cardia elongate conoid embedded in intestinal tissue. Female genital system didelphic-amphidelphic. Anterior and posterior gonads on different sides of intestine but in two specimens at the same side. Structure as described by Heyns (1988). We add some data on vaginal structure of our population: Vagina extended 21 – 28 μm or 36 – 46% of body diameter. *Pars proximalis* 16 – 23 μm long and 14 – 19 μm wide, with oval to sigmoid walls surrounded by musculature. *Pars refringens* rounded trapezoid shaped, 4 – 5 x 8 – 13 μm . *Pars distalis* 3.0 – 4.0 μm long. Vulva equatorial with cross-like slit. Prerectum 1.6 – 3.1 anal body diameters long and rectum 0.8 – 1.2. Tail varies in shape from convex conoid to slightly subdigitate. Two pairs of subdorsal pores and a dorsal pore on the tail.

Males not found but sperms observed in females.

Remarks: Our population did not differ significantly from those of HEYNS (1988) but slightly longer odontostyle in some specimens were observed (11 – 15 μm vs 10 – 13 μm in Heyns).

Distribution: Distributed in Europe (the Czech Republic, Estonia, France, Germany, Hungary, Italy, Moldova, the Netherlands, Poland, Romania, Russia, Slovakia, Slovenia, Switzerland, Ukraine), North America (USA) and Asia (Iran, Iraq; HEYNS 1988, BUSHMAKIU et al. 2000, ČEREVKOVÁ 2006, BANIAMUDDIN et al. 2010, TABOLIN 2014). Species



Fig. 2. *Aporcelaimus cf. americanus* – a. Lip region; b. Amphidial fovea; c. Guiding ring; d. Pharyngeal cardia; e. Vagina; f. *Pars refringens*; g. Subventral position of vulva; h. Sphincter between *pars dilatata* and uterus; i. Anterior ovarium; j. Tail region; k. Tail; l. Chord; m. – Caudal pores (scale 20 μm – a, b, f, g, h and m; scale 200 μm – d and j; scale 100 μm – e and i)

is not very common in Bulgaria (Table 1) and it has been found only in natural habitats in mountain area till now. The present record was the first for the Thrace Valley region.

Family Qudsianematidae Jairajpuri, 1965

This family was represented by five species in the studied area.



Fig. 3. *Paraxonchium laetificans* – a. Neck; b. Lip region; c. Amphidial fovea; d. Lip region - lateral view; e. Pharyngeal cardia; f. Vagina; g. Vulva - lateral view; h. Anterior gonad; i. g. and k. Variations of tail shape; l. Lateral view of tail; m. Tail region and prerectum (scale 20 μm – b, c, d, e, f, g, i, j, k, and m; scale 100 μm – a, h and m)

****Discolaimus agricolus* Sauer et Annells, 1985**

Tables 1, 3 and 5, Fig. 4

Description: Female: Medium-sized nematodes with moderately stout body slightly to C-curved ventrally upon fixation. Cuticle finely an-

nulated, 1 – 2 μm tick at odontophore region, 2 – 3 μm tick at mid-body and 5 – 7 μm tick on caudal tip. Glandular lateral bodies with lateral pores visible in most specimens and arranged as follows: at pharyngeal area – 14 – 20; between cardia and vulva

– 12 – 16 and between vulva and anus – 37 – 44. Lip region sucker-like, 5 – 7 μm high, 4.5 – 5.2 times as broad as high and 53–65% of body diameter at neck base. Amphid fovea goblet shaped with aperture about a half of corresponding diameter. Odontostyle medium sized, 5.0 – 6.6 times as long as wide, 0.7 – 1.0 times as long as lip region diameter and 1.3 – 2.0% of body length. Aperture occupies 46 – 56% of odontostyle length. Guiding ring single and 8.2 – 11.0 μm from anterior end. Odontophore rod-like and 1.5 – 2.0 of odontostyle length. Excretory pore at 95 – 149 μm from anterior end or before to the level of nerve ring. Pharynx enlarges more abruptly and basal expansion was 45 – 50% of neck length with visible fine sheath. Thin disk about 4–7 μm , visible between pharynx and cardia. Cardia wider or elongated tongue-like 20–22 x 15–20 μm . Female genital system didelphic-amphidelphic with structure as described by Peña-Santiago et al. (2002). Prerectum 0.9 – 1.6 anal body diameters long and rectum 0.6 – 1. Tail convex conoid with wide blunt tip. Two pairs of pores on the tail.

Males not found and sperms not observed in females.

Remarks: The morphometrics of studied specimens were generally more similar to the original description of SAUER & ANNELLS (1985) than to the Spanish material of PEÑA-SANTIAGO et al. (2002). Our population was characterised by a slightly longer odontostyle (21 – 25 μm vs 19–23 μm in Spanish populations and 21 – 23 μm in Australian population) and relatively wider lips (25–29 μm vs 21–26 μm in Spanish population). PEÑA-SANTIAGO et al. (2002) consider the odontostyle length and lip width as the most conservative features of *Discolaimus* but specimens found in the present study assume an intermediate position between *D. major* and *D. agricolus* with respect to these two characters. We considered our population as *D. agricolus* because of other described features (stouter and shorter body, structure of cuticle, structure of pharynx, form of vagina) and because lip width and odontostyle length were closer to the range of *D. agricolus*.

Distribution: Reported in Australia (SAUER & ANNELLS 1985), Spain (PEÑA-SANTIAGO et al. 2002) and Iran (HADI-ALIJANVAND FADAEI-TEHRANI 2013). New for the Balkan Peninsula.

***Discolaimoides bulbiferus (Cobb, 1906) Heyns, 1963**

Tables 1, 3 and 5, Fig. 5

Description: Female: Medium-sized nematodes with slender body, ventrally C-curved to spiral upon fixation. Cuticle finely annulated, 1 μm tick at odontophore region, 1.5 – 2 μm tick at mid-body

and 6 μm tick on caudal tip. Glandular lateral bodies hardly visible. Lip region set off and slightly expanded, 2.5 μm high, 3 times as broad as high and 36 – 38% of body diameter at neck base. Amphid fovea goblet shaped with aperture about 1.5 times of lip diameter. Odontostyle small, 6.7 – 7.3 times as long as wide, 0.8 – 0.9 times as long as lip region diameter and 0.6 – 0.7% of body length. Aperture 32 – 35% of odontostyle length. Guiding ring single and at 5 μm from anterior end. Odontophore rod-like and 0.9 – 1.0 of odontostyle length. Nerve ring at 32% of neck length. Excretory pore at 93 – 127 μm from anterior end before or at the level of nerve ring. Pharynx enlarges abruptly and basal expansion 50 – 52% of neck. Disk-like structure 3 – 5 μm visible between pharynx and cardia. Cardia conoid and 14 μm x 17 μm . Female genital system didelphic-amphidelphic, each gonade about 11 – 12% of body length. Uterus about 40 – 50 μm , followed by not very clearly defined *pars dilatata* about 40 – 55 μm , oviduct 30 – 40 μm and ovarium 40 – 50 μm . *Pars proximalis* 13 μm long and 11 μm wide, with ovoid walls surrounded by weak musculature. *Pars refringens* absent. *Pars distalis* 1.0 μm long. Prerectum 2.9 – 3.2 anal body diameters long and rectum 1.4 – 1.5. Tail convex conoid with finely rounded tip and one pair of pores on the tail.

Males were not found.

Remarks: Our specimens did not differ significantly from the description of DAS et al. (1969).

Distribution: In Africa (Egypt, Ivory Coast, Nigeria, South Africa, Mauritius Island), Asia (India, Uzbekistan), North America: (USA, Hawaii, Utah), South America (Venezuela), Europe (Italy, Moldova, Poland, Slovenia, Spain; HEYNS 1963, DAS et al. 1969, ANDRASSY 1990, PEÑA-SANTIAGO et al. 2005). The spread of the species in Romania is doubtful (FAUNA EUROPAEA). New for Bulgaria.

Ecumenicus monohystera (de Man, 1880) Thorne, 1974

Tables 1, 3 and 5

Description: Female: Medium-sized nematodes with moderately slender body straight to slightly ventrally curved upon fixation. Cuticle very finely annulated, 2 μm tick at odontophore region, 1.5 – 2 μm at mid-body and 7 – 9.5 μm on caudal tip. Amphid aperture on the posterior part of lips about 35 – 40% of lip diameter. Lips almost continuous or slightly expanded as wide as 31 – 34% of pharyngeal body diameter. Odontostyle medium sized, 6.7 – 6.9 times as long as wide, 0.9 – 1.0 times as long as lip region diameter and 0.8 – 1.1% of body length. Aperture 35 – 40% of odontostyle length. Guiding ring single at 5.0 μm from anterior end. Odontophore rod-like and



Fig. 4. *Discolaimus agricolus* – a. Neck; b. Amphidia; c. and d. Lip region; e. Pharyngeal cardia; f. and g. Vagina; h., i. and k. Variations of tail shape (scale 20 µm – b, c, d, e, f, g, h, i and k; scale 100 µm – a)

1.8 – 2.3 of odontostyle length. Excretory pore at 144 – 198 µm from anterior end or after the level of nerve ring. Pharynx enlarges more gradually and basal expansion 41 – 49% of neck length. Cardia small surrounded by intestinal tissue. Thin disk between pharynx and cardia about 2 – 3 µm thick. Female genital system monodelphic-opistodelphic with wide simple uterus and not clear *pars dilatata*. Vagina oblique, 43 – 54% of corresponding diameter. *Pars proximalis*

10 – 12 µm long and 16 – 20 µm wide with parallel walls surrounded by weak musculature. *Pars refringens* large, convex triangle-shaped, 3.5 – 4 long and 7 – 10 µm wide. *Pars distalis* 3.0 µm long. Prerectum 1.2 – 2.2 anal body diameters long and rectum 0.8 – 1.4. Tail convex conoid with straight ventral site and digitated rounded tip. Two pairs of pores on tail.

Males not found.

Remarks: Our population resembled more

those described by COOMANS & GEREART (1962) than the Seville population described by PEÑA-SANTIAGO & ABOLAFIA (2007). It differed from the Belgium population by the narrower lips (9.5 – 10 μm vs. 10.5 – 12 μm) and from the Spanish by narrower lips (9.5 – 10 μm vs 10 – 11 μm), more anterior vulva position (29 – 34% vs 32 – 39%) and longer tail (32 – 38 μm vs 27 – 35 μm).

Distribution: World-wide distribution (ANDRASSY 1991). Common in different soils of natural and agricultural habitats in our country at elevation below 1800 m a.s.l. (Table 1).

***Eudorylaimus centrocerus* (DE MAN, 1880) ANDRASSY, 1959**

Tables 1 and 5

Remarks: There were several juveniles and only one female not in a good condition and that was the reason not to include its morphometrics in the study.

Distribution: Widespread in Europe (ANDRASSY 1991) and in different habitats in Bulgaria (Table 1) and could be regarded as one of the most common species of Qudsianematidae in Bulgaria.

****Eudorylaimus subdigitalis* Tjepakema, Ferris et Ferris, 1971**

Tables 3 and 5, Fig. 6

Description: Female: Small- to medium-sized nematodes with stout body, slightly ventrally curved to straight upon fixation. Cuticle very finely annulated, 2.7 – 3.5 μm tick at odontophore region, 2.5 – 3.5 μm at mid-body and 10 – 20 μm on caudal tip. Lips angular set off and slightly expanded. Lip region 5.5 – 6 μm high, 2.5 – 2.8 times as broad as high and 30 – 41% of body diameter at neck base. Amphid fovea cup shaped with aperture about 1.5 times of lip diameter. Odontostyle strongly sclerotised, 5.5 – 6.5 times as long as wide, 0.8 – 1.2 times as long as lip region diameter and 1.2 – 2.0% of body length. Aperture 40 – 50% of odontostyle length. Guiding ring single at 8.5 (7 – 9) μm from anterior end. Odontophore rod-like and 1.3 – 1.8 of odontostyle length. Excretory pore before or after the level of nerve ring or at 94 – 150 μm from anterior end. Nerve ring 35 – 38% of neck length. Pharynx enlarges gradually and basal expansion extended to 42 – 55% of neck. Cardia conoid and 20 – 25 μm x 17 – 20 μm . Disk-like structure between pharynx and cardia, 3 – 4 μm tick. Female genital system didelphic-amphidelphic, each gonad about 18 – 21% of body length. Uterus about 41 – 53 μm , followed by sphincter and oval to elongate *pars dilatata* about 20 – 36 μm , oviduct 38 – 55 μm and ovarium 80 – 103 μm . *Pars proximalis* 13 – 16 μm long and 24 – 26 μm wide, with sigmoid walls surrounded by musculature. *Pars refringens* flattened semicircular

shaped, 4 – 4.5 μm long and 9 – 10 μm wide. *Pars distalis* 3 – 3.5 μm long. Vulva after mid body length. Prerectum 1.3 – 3.2 anal body diameters long and rectum 0.9 – 1.3. Tail conoid with more convex dorsal part and elongated finely rounded tip more or less digitated. Cuticle on tail tip very tick and with layers that not closed on the tip and looks like a „duct“. Two pairs of pores on the dorsal part of the tail.

Males not found.

Remarks: In the intestinal area of one of the specimens bacteria-like formations were observed (Fig. 6). No external structures were seen. Specimens found in the present study did not differ significantly from the original description by TJEPKEMA et al. (1971) but the range of several of observed characters is expanded and some new data are added.

Distribution: Not widely distributed, reported from shrub and grasses in Indiana dune sands (TJEPKEMA et al. 1971), cultivated field and sod in South Dakota (THORNE, 1974), dune sands in St. Rossore, Pisa, Italy (MARINARI et al. 1982), from the Sierra Mágina Natural Park, Andalucía, Spain (LIÉBANAS et al. 2002) and different soils in perennial crops in Iran (HADI-ALIJANVAND & FADAEI-TEHRANI 2013). First record for the Balkan Peninsula.

Family Dorylaimidae de Man, 1876

This family was presented by two species in the studied area.

***Crassolabium* cf. *cylindricum* (Thorne, 1974) Peña-Santiago et Ciobanu, 2008**

Tables 4 and 5, Fig. 7

Description: Female: Medium-sized nematodes with moderately stout body, more open or curved C-shape upon fixation. Cuticle finely annulated and 3.5 μm tick at odontophore region, 3.0 μm at mid-body, with 3 layers at caudal tip and 7 – 10 μm tick. No specific cell formations on lateral chords. Lips hardly set off and not angular. Lip region 4.5 – 5 μm high, 2.6 – 2.7 times as broad as high and 30 – 32% of body diameter at neck base. Amphid fovea goblet shaped with aperture about 2.2 – 2.6 times of lip diameter. Odontostyle relatively short, 2.2 – 2.4 times as long as wide, 1.1 – 1.2 times as long as lip region diameter and 0.7 – 0.8% of body length. Aperture 35 – 42% of odontostyle length. Guiding ring single at 7 – 9 μm from anterior end. Odontophore rod-like and 1.9 – 2.0 of odontostyle length. Excretory pore at 128 – 150 μm after the level of nerve ring. Nerve ring 32 – 33% of neck length. Pharynx enlarges gradually and basal expansion is 44 – 45% of neck. Cardia conoid and 14 – 15 x 19 – 21 μm long. Disk-like structure be-

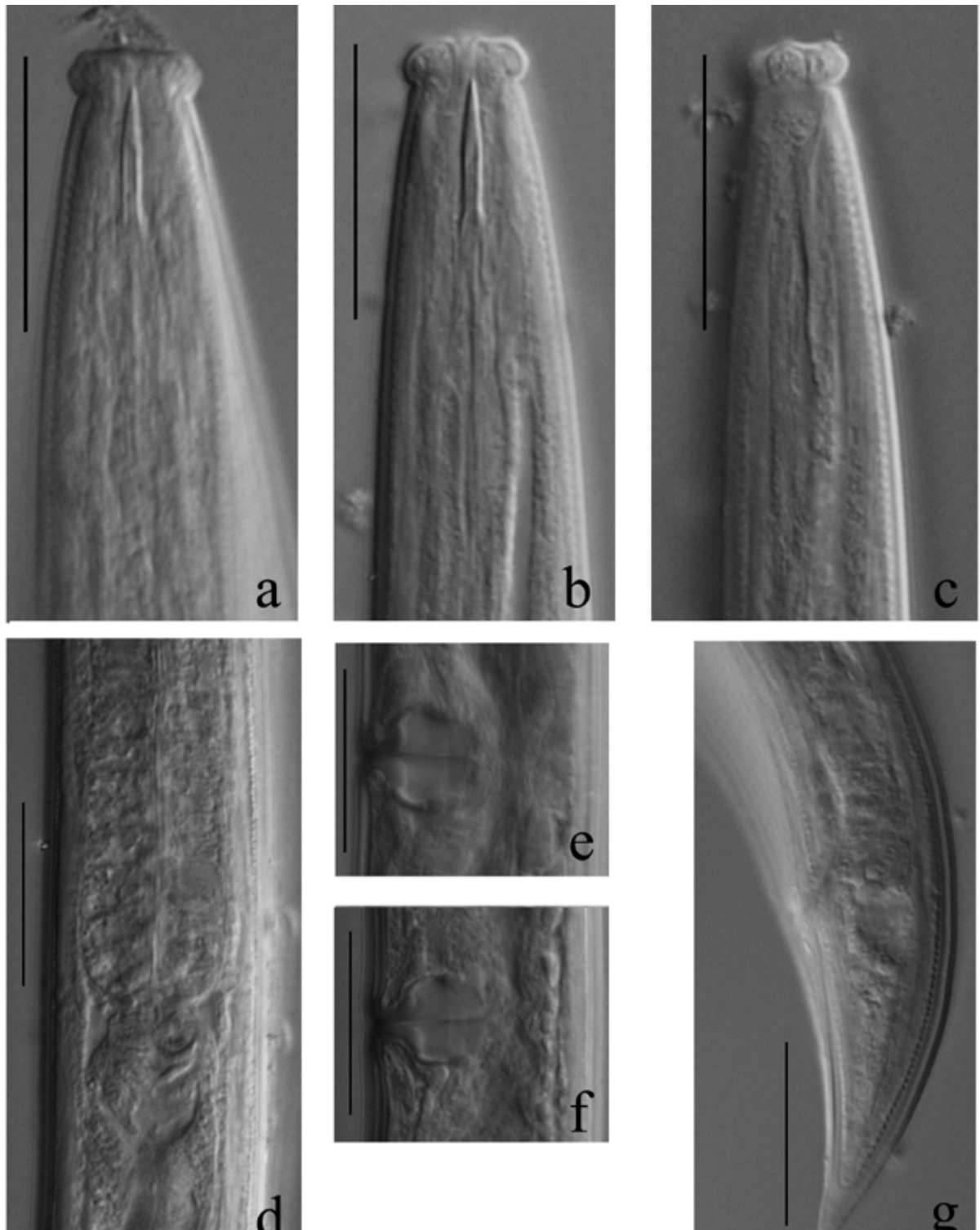


Fig. 5. *Discolaimoides bulbiferus* – a. and b. Lip region; c. Amphidia; d. Pharyngeal cardia; e. and f. Vagina; g. Tail region (scale 20 μm)

tween pharynx and cardia, 2 – 3 μm tick. Female genital system didelphic-amphidelphic, each gonad about 16 – 20% of body length. Uterus about 45 – 55 μm long, followed by oval *pars dilatata* about 18 – 20 μm long, strong sphincter, oviduct 38 – 55 μm and ovarium 80 – 103 μm . Structure of vagina

as follows: *Pars proximalis* 15 – 17 μm long and 16 – 20 μm , with oval to parallel walls surrounded by musculature. *Pars refringens* parallelogram shaped, 5 μm long and 16 – 18 μm wide. *Pars distalis* 2 – 3 μm long. Two gland cells visible close to *pars refringens*. Prerectum 1.2 – 2.0 anal body diameters long



Fig. 6. *Eudorylaimus subdigitalis*: a. – Neck; b. and c. – Lip region; d. – Amphidial fovea; e. and f. – Pharyngeal cardia; g., h. and i. – Vagina; j. – Anterior gonad; k., l. and m. – Variation of tail shape (Scale 20 µm – b, c, d, e, f, g, h, i, k, l and m; Scale 100 µm – a and j)

and rectum 0.7 – 0.9. Tail broadly conoid with more or less protruding part of body and two caudal pores at the posterior half of tail.

Males not found.

Remarks: Our population resembled *C. cylin-*

dricum (Thorne 1974) Peña-Santiago et Ciobanu, 2008 and *C. elegans* (Thorne, 1974) Peña-Santiago et Ciobanu, 2008. From the first it differed by thicker cuticle on tail tip (7-10 µm vs 4.5 µm), shorter odontostyle orifice (42–45% vs 48%), more poste-

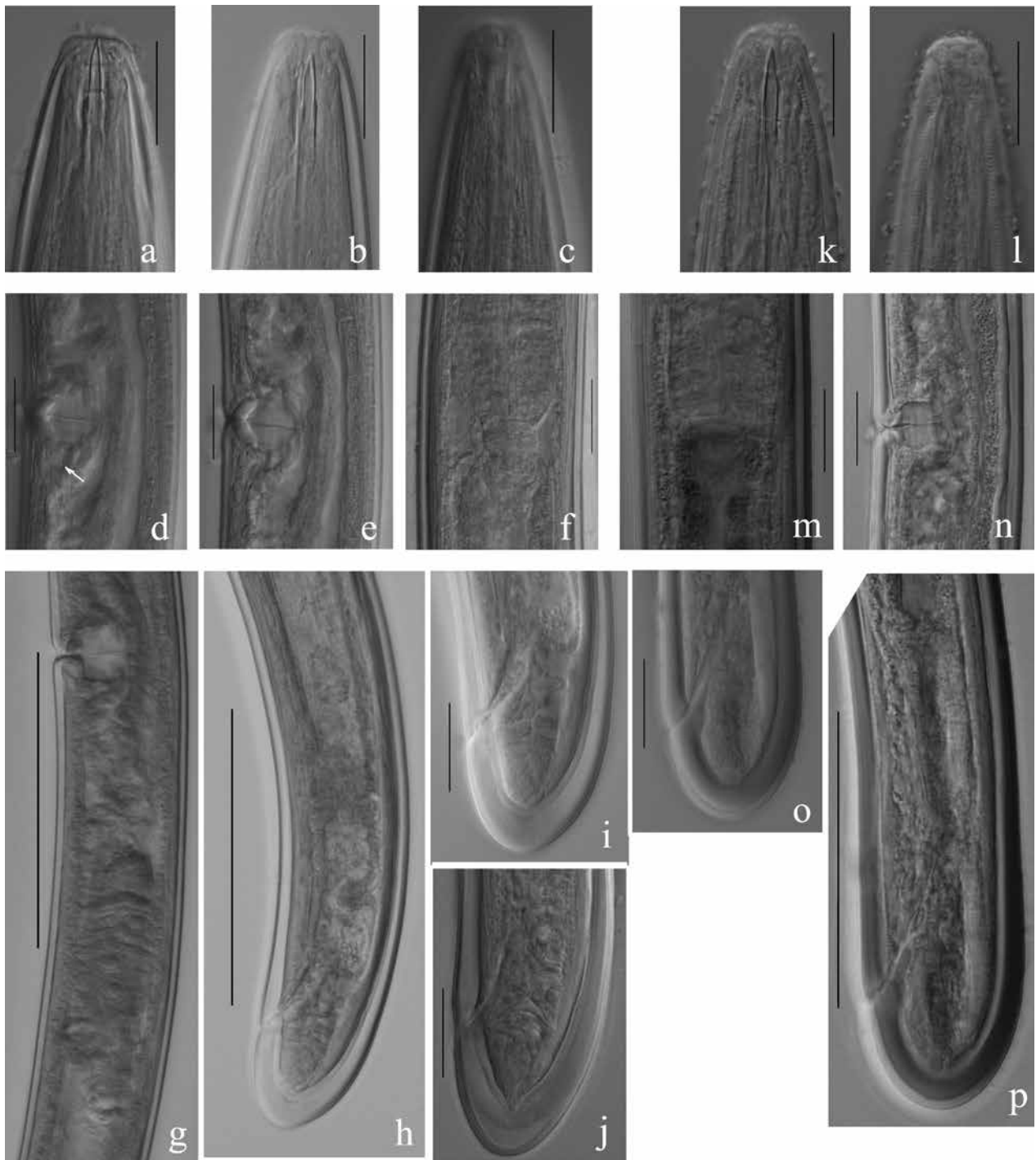


Fig. 7. *Crassolabium cylindricus*: a. and b. – Lip region; c. – Amphid fovea; d. and e. – Vagina; f. – Pharyngeal cardia; g. – Posterior gonad; h. – Posterior region; i. and j. – Tail; *C. rhopalocercus*: k. – Lip region; l. – Amphideal fovea; m. – Pharyngeal cardia; n. – Vagina; o. – Tail; p. – Posterior region (Scale 20 μm – a, b, c, d, e, f, i, j, k, l, m, n and o; Scale 100 μm – g, h and p)

rior position of S_1N_1 (79 – 81% vs 73%) and S_1N_2 (81 – 82% vs 76%), vaginal structure as described in PEÑA-SANTIAGO & CIOBANU (2011) and relatively longer tail with different shape ($c=53-59$ vs $c=61-67$) and position of caudal pores in all reported populations (THORNE 1974, AHMAD et al. 1985, CIOBANU et al 2007). Similar position of pharyngeal glands as

in our population was reported by HADI-ALIJEVAND & FADAEI-TEHRANI (2013). Our specimens differed from *C. elegans* by stouter body ($a = 32-35$ vs $a=40$), slender odontostyle according to figures and description of THORNE (1974), longer tail ($c=53-59$ vs $c=60$), shorter prerectum (1.2 – 1.8 times anal body diameter vs more than 3 anal body diameters).

We agree with PEÑA-SANTIAGO & CIOBANU's (2011) consideration that „*C. cylindricum* and *C. elegans* are very close (if not identical) species“. Wider range of variations of characters is observed in populations of frequently found species like *C. circuliferum* (Loof 1961) PEÑA-SANTIAGO ET CIOBANU, 2008 or *C. ettersergense* (de Man 1885) PEÑA-SANTIAGO ET CIOBANU, 2008. These are the reasons to consider our specimens as more close to *C. cylindricum*.

Distribution: Since its description from dying lawn grasses and prairie sod in South Dakota, USA (THORNE 1974), *C. cylindricum* has been reported from soil around roots of grasses and weeds in India (AHMAD ET AL. 1985), meadow soils in Romania (CIOBANU et al. 2007) and different soils under perennial crops in Iran (HADI-ALIJANVAND & FADAEI-TEHRANI 2013). New for Bulgaria.

***Crassolabium rhopalocercus* (De Man, 1876)
Peña-Santiago et Ciobanu, 2008**

Tables 1, 4 and 5, Fig. 7

Description: Female: Cuticle finely annulated and 3 μm tick at odontophore region, 4 μm tick at mid-body, 7 μm tick and with 3 distinct layers at caudal tip. Lip region 5 μm high, 2.8 times as broad as high and 33% of body diameter at neck base. Amphid fovea stirrups shaped with aperture about 1.8 times of lip diameter. Odontostyle robust, 1.6 times as long as wide, 0.8 times as long as lip region diameter and 1% of body length. Aperture 44% of odontostyle length. Guiding ring single at 9 μm from anterior end. Odontophore rod-like and 1.6 of odontostyle length. Excretory pore after the level of nerve ring or at 152 μm from anterior end. Nerve ring at 31% of neck length. Pharynx enlarges gradually and basal expansion 49% of neck length. Cardia conoid and 11 x 14 μm . Disk-like structure between pharynx and cardia 2 – 3 μm thick. Female genital system didelphic-amphidelphic G_1 – 12% and G_2 – 13% of body length. Uterus about 45 – 47 μm long. *Pars dilatata* not distinct, ovarium 82 – 83 μm . Structure of vagina as follows: *Pars proximalis* 18 μm long and 12 μm wide, with parallel walls surrounded by musculature. *Pars refringens* drop shaped, 3 μm long and 7 μm wide. *Pars distalis* 4 μm long. Prerectum 1.7 anal body diameters long

and rectum 1.2. Tail broadly rounded with two caudal pores.

Males not found.

Remarks: Our specimen is similar to description of LOOF (1999).

Distribution: Widely distributed in Europe (PEÑA-SANTIAGO & CIOBANU 2011) and Africa (Egypt), Asia (Azerbaijan, Georgia and Uzbekistan; ANDRÁSSY 1991). Species was found in two regions of South Bulgaria (Table 1) but none of the previous reports were supported by morphological descriptions of recovered specimens. First record for the Thrace Valley region.

Abundance and occurrence of identified species of the families Qudsianematidae, Aporcelaimidae, Paraxonchidae, Dorylaimidae were presented in Table 5. *Aporcella simplex* *Eudorylaimus subdigitalis* and *Aporcelaimellus obtusicaudatus* were the most abundant species, while *E. subdigitalis* occurred in almost every sample from the field. Less abundant but frequently found in the field were *Discolaimus agricolus*, *Ecumenicus monohystera* and *Paraxonchium laetificans*. Other species were rare with low abundance.

Conclusions

Three species of Aporcelaimidae, one of Paraxonchidae, five of Qudsianematidae and two of Dorylaimidae were identified in soil samples collected from an old raspberry plantation. New data on morphology of studied population were added.

Aporcella simplex, *Paraxonchium laetificans* and *Crassolabium rhopalocercus* were found for the first time from the Thrace Valley. *Discolaimoides bulbiferus* and *Crassolabium* cf. *cylindricum* are new geographic records for Bulgaria; and *Aporcelaimus* cf. *americanus*, *Discolaimus agricolus* and *Eudorylaimus subdigitalis* are new for the Balkan Peninsula.

The most frequently recovered species were *Aporcella simplex* and *Eudorylaimus subdigitalis*. Both were also subdominant in the whole nematode fauna.

Acknowledgements: The present study was partly supported by the Bulgarian Agricultural Academy, Contract No: POZM 93.

Table 1. Data on distribution and habitats of the studied species in Bulgaria from previous studies

№	Region	Habitat(s)	Source
APORCELAIMIDAE			
<i>Aporcella simplex</i> (THORNE ET SWANGER, 1936) ÁLVAREZ-ORTEGA ET AL., 2013			
1	Strandzha Mountain*	Forest habitats of <i>Fagus orientalis</i> LIPSKI, <i>Quercus frainetto</i> TEN and <i>Q. polycarpa</i> SHUR. Altitude: 250 – 385 m a.s.l. Soil type: Leptosols, Stagnic Alisols, Albic Luvisols	ILIEV (2014); ILIEV & ILIEVA (2014)
<i>Aporcelaimellus obtusicaudatus</i> (BASTIAN, 1865) ALTHERR, 1968			
2	Balkan Mountains	Humus and moss	ANDRASSY (1958)
	Pirin Mountains	Rhizosphere of <i>Isoetes lacustris</i> L.**; <i>Festuca rubra</i> L., <i>Silene bupleuroides</i> CHATER ET WALTERS, <i>Papaver alpinum</i> L., <i>Barisia alpina</i> L.	KATALAN-GATEVA (1968)
	Rila Mountains	Humus and moss Forest habitats (<i>Picea abies</i> L. – <i>Vaccinium myrtillus</i> L. + <i>Luzula silvatica</i> HUDS.), (<i>Pinus peuce</i> Griseb. + <i>P. abies</i> – <i>V. myrtillus</i>), (<i>Alnus viridis</i> (CHAUX.) – <i>mixtoherbosa</i>), and (<i>Fagus sylvestris</i> L. + <i>P. abies</i> – <i>Oxalis acetosella</i> L.) Subalpine meadows (<i>Festuca valida</i> (R. UECHTR.) – <i>Juniperus sibirica</i> L.) and (<i>Sesleria comosa</i> VELEN) Altitude: 1537 to 2031 m a.s.l.; Soil type: Humic Cambisols, Haplic Mollic Cambisols, Orthic Umbrosols	ANDRASSY (1958) ILIEVA (1998, 2007)
	Rhodope MountainS Dzhebel t., Devin t., Zlatograd t.	Soil and moss Rhizosphere of tobacco	ANDRASSY (1958) BAICHEVA (1982)
	Strandzha Mountain	Longose forest (<i>Fraxinus oxycarpa</i> WILLD., <i>Alnus glutinosa</i> Garth.) Oak forests (<i>Q. frainetto</i> , <i>Q. cerris</i> L.), and (<i>Q. hartwissiana</i> STEV., <i>Q. cerris</i> , <i>Carpinus orientalis</i> MILL.,) Beach and mixed forests (<i>F. orientalis</i> , <i>Q. polycarpa</i>) Shrubs on karst (<i>C. orientalis</i> , <i>Q. cerris</i> , <i>Syringa vulgaris</i> L.) and <i>Calluna vulgaris</i> HULL. on karst Meadows Altitude: 15 – 385 m a.s.l. Soil type: Eutric and District Fluvisols, Mollic Gleysols, Umbric Leptosols, Stagnic Alisols, Albic Luvisols, Chromic Luvisols, Chromic Cambisols, Planosols	ILIEV (2014); ILIEV & ILIEVA (2014)
	Vitosha Mountain	Humus and moss	ANDRASSY (1958)
	Varna	Humus	ANDRASSY (1958) BAICHEVA (1974)
	Blagoevgrad (Blagoevgrad t., Gotse Delchev t., Hadzhidimovo v., Kresna t.)	Rhizosphere of tobacco, strawberry, peach Soil type: Chromic Luvisols, Eutric and District Fluvisols	KATALAN-GATEVA & BUDUROVA (1978) KATALAN-GATEVA & BAICHEVA (1976, 1978)
	Burgas (Prisad v. Novo Panicharevo v.)	Oak forest (<i>Q. frainetto</i> + <i>Carex glauca</i>) Pasture Soil type: Chromic Luvisols	KATALAN-GATEVA (1980) ALEKSIEV ET AL (1998) ILIEV (1998)
	Haskovo (Momkovo v.)	Rhizosphere of Wheat, Oats, Barley, Rye, Rice, Alfalfa, Clover, Vetch, Tomato, Pepper, Tobacco, Eggplant	KATALAN-GATEVA (1965, 1966)

Table 1. Continued

№	Region	Habitat(s)	Source
	Pazardzhik (Septemvri) (Malo Konare)	Rhizosphere of Wheat (<i>Triticum aestivum</i>) Tomato, Pepper, Eggplant Meadow	KATALAN-GATEVA (1963, 1966)
	Plovdiv (Boyantsi v., Markovo v.)	Rhizosphere of Tomato, Pepper, Potato, Tobacco, Eggplant Soil type: Rendzic Leptosols	KATALAN-GATEVA (1966) KATALAN-GATEVA & STEFANOV (1978)
	Stara Zagora (Kazanka v., Chirpan t.)	Rhizosphere of Tomato, Pepper, Potato	KATALAN-GATEVA (1966)
PARAXONCHIDAE			
3	<i>Paraxonchium laetificans</i> (ANDRÁSSY, 1956) ALTHERR ET LOOF, 1969		
	Rhodope Mountains	Humus in beech forest Beech forest in Kupena Reserve Altitude: 1107 m a.s.l.	ANDRÁSSY (1958) ILIEV (unpublished data)
	Lozenska Mountain	Oak forest (<i>Q. frainetto</i> and <i>Q. cerris</i>) Altitude: 950 m a.s.l. Soil type: Chromic Cambisols	ILIEV (unpublished data)
	Strandzha Mountain	Oak forests (<i>Q. frainetto</i> , <i>Q. cerris</i> L.), (<i>Q. polycarpa</i> , <i>Q. frainetto</i>), and (<i>Q. hartwissiana</i> , <i>Q. cerris</i> , <i>C. orientalis</i>) Beach and mixed forests (<i>F. orientalis</i> , <i>Q. polycarpa</i>), Shrubs on karst (<i>C. orientalis</i> , <i>Quercus cerris</i> , <i>Syringa vulgaris</i>) and Karst with <i>Calluna vulgaris</i> Meadows Altitude: 250 – 385 m a.s.l. Soil type: Eutric Fluvisols, Stagnic Alisols, Chromic and Umbric Luvisols, Chromic Cambisols, Planosols	ILIEV (2014); ILIEVA & ILIEV (2014)
DORYLAIMIDAE			
4	<i>Crassolabium rhopalocercus</i> (DE MAN, 1876) PEÑA-SANTIAGO ET CIOBANU, 2008		
	Strandzha Mountain	Forest (<i>F. orientalis</i> , <i>Caprinus betulus</i>) Soil type: Stagnic Alisols	ILIEV (2014); ILIEVA & ILIEV (2014)
	Blagoevgrad (Petrich)	Rhizosphere of tobacco	BAICHEVA (1974)
QUDSIANEMATIDAE			
5	<i>Ecumenicus monohystera</i> (DE MAN, 1880) THORNE, 1974		
	Pirin Mountains	Rhizosphere of <i>Papaver alpinum</i>	KATALAN-GATEVA (1968)
	Burgas (Novo Panicharevo v. Prasad v.)	Pasture Soil type: Chromic Luvisols	ILIEV (1998)

Table 1. Continued

№	Region	Habitat(s)	Source
	Strandzha Mountain	Oak forest (<i>Q. frainetto</i> , <i>Q. cerris</i>) Mixed forest (<i>Q. polycarpa</i> , <i>F. orientalis</i>) and (<i>F. orientalis</i> , <i>Caprinus betulus</i> L.) Meadows Soil type: Fluvisols, Albic Fluvisols, Stagnic Alisols, <i>Agricultural area</i>	ILIEV (2014); ILIEV & ILIEVA (2014)
	Blagoevgrad (Blagoevgrad t, Bansko t Gotse Delchev t., Kulata v., Lozenitsa v., Petrich t., Razlog t.)	Rhizosphere of tobacco, grapevine, peach, almond, apple Soil type: Chromic Luvisols, Eutric and District Fluvisols	BAICHEVA (1974), KATALAN-GATEVA & BAICHEVA (1976, 1978) KATALAN-GATEVA & BUDUROVA (1978) KATALAN-GATEVA (1980, 1982) KATALAN-GATEVA ET AL. (1982)
	Haskovo	Rhizosphere of tobacco	KATALAN-GATEVA (1965, 1966)
	Plovdiv (Boyantsi v., Markovo v.)	Rhizosphere of barley, tobacco Soil type: Rendzic Leptosols	KATALAN-GATEVA (1966) KATALAN-GATEVA & STEFANOV (1978)
	Pazardzhik (Aleko Konstantinovo v., Dinkata v., Septemvri t.) Stara Zagora (Kazanka v.)	Rhizosphere of Alfalfa (<i>Medicago sativa</i>), tomato (<i>Lycopersicon esculentum</i> L.), lettuce (<i>Lactuca sativa</i> L.), pepper Rhizosphere of barley, pepper, tobacco <i>Eudorylaimus centroceruus</i> (DE MAN, 1880) ANDRASSY, 1959 Soil under moss	KATALAN-GATEVA (1966)
6	Balkan Mountain	Soil under moss	ANDRASSY (1958)
	Pirin Mountains	Rhizosphere of <i>Viola perinensis</i> W. BECKER and <i>Pinguicula vulgaris</i> L.	KATALAN-GATEVA (1968)
	Rila Mountains	High mountain meadow (<i>Sesleria comosa</i> VELEN) Altitude: 2031 m a.s.l. Soil type: Humic Cambisols	ILIEVA (2007)
	Strandzha Mountain	Mixed forest (<i>F. orientalis</i>) Soil type: Stagnic Alisols, Planosols	ILIEV (2014); ILIEVA & ILIEV (2014)
	Blagoevgrad (Blagoevgrad t., Kresna t., Petrich t.)	Rhizosphere of strawberry, tobacco, peach, <i>Amygdalus nana</i> L., Soil type: Chromic Luvisols, Fluvisols	BAICHEVA (1974) KATALAN-GATEVA & BUDUROVA (1978) KATALAN-GATEVA & BAICHEVA (1976) KATALAN-GATEVA (1980, 1982)
	Haskovo	Rhizosphere of wheat, barley	KATALAN-GATEVA (1965)
	Plovdiv (Markovo v.)	Rhizosphere of tobacco Soil type: Rendzic Leptosols	KATALAN-GATEVA & STEFANOV (1978)
	Sofia (Samokov t.)	Rhizosphere of hop	KATALAN-GATEVA & MILKOVA (1978)

*Mountains are situated on more than one administrative region and are given separately

**In KATALAN-GATEVA (1968) botanical material was identified by D. JORDANOV as *Isoetes echinospora* DURIEU. but STEFANOVA & IVANOVA (2000) proved that only *I. lacustris* was spread in the Pirin mountain.

Table 2. Morphometric data of species of the families Aporcelaimidae and Paraxonchidae (populations found in the present study). Measurements in μm (except L, in mm) presented as mean \pm standard deviation followed by the range (in parentheses)

Character	<i>Aporcelaimellus obtusiacaudatus</i> (n=11)	<i>Aporcella simplex</i> (n=15)	<i>Aporcelaimus cf americanus</i> (n = 2)	<i>Paraxonchium laetificans</i> (n=12)
L	2.52 \pm 0.23 (2.20–2.80)	2.11 \pm 0.19 (1.79–2.38)	7.5, 5.9	1.36 \pm 0.09 (1.17 – 1.55)
A	27 \pm 2 (24 – 31)	28 \pm 1 (26 – 31)	43, 34	23 \pm 2 (20 – 27)
B	4.3 \pm 0.2 (4.0 – 4.7)	4.2 \pm 0.3 (4.0 – 4.8)	8.5, 6.5	3.9 \pm 0.2 (3.6 – 4.2)
C	57 \pm 5 (50 – 65)	40 \pm 2 (37 – 45)	125, 107	33 \pm 4 (25 – 39)
c'	0.9 \pm 0.1 (0.8 – 1.1)	1.1 \pm 0.1 (1.0 – 1.3)	0.5, 0.5	1.0 \pm 0.1 (0.8 – 1.2)
V (%)	51 \pm 3 (45 – 56)	54 \pm 2 (52 – 56)	48, 52	59 \pm 1 (57 – 62)
Body diameter at lip region	20.2 \pm 1.2 (19 – 22)	21.6 \pm 0.7 (21 – 23)	29, 30	9.9 \pm 0.6 (9 – 11)
Body diameter at base of pharynx	84 \pm 9 (72 – 95)	71 \pm 8 (59 – 86)	150, 155	55 \pm 3 (50 – 63)
Body diameter at mid-body	94 \pm 12 (80 – 111)	75 \pm 6 (65 – 84)	175	60 \pm 3 (53 – 65)
Body diameter at anus	50 \pm 7 (45 – 60)	47 \pm 4 (41 – 51)	120, 115	41 \pm 5 (34 – 49)
Odontostyle length	21 \pm 2 (18.5 – 24)	21 \pm 1 (20 – 22.5)	30, 29	13 \pm 1.5 (11 – 15)
Odontostyle aperture	12.0 \pm 1.3 (10.5 – 14.5)	14.1 \pm 0.9 (12 – 15)	21, 18	8.1 \pm 0.2 (8 – 8.5)
Odontostyle width	5.0 \pm 0.6 (4.0 – 6.0)	5.9 \pm 0.5 (5.0 – 6.7)	7, 6.5	3
Odontophore	40 \pm 3 (36 – 44)	39 \pm 4 (31–43)	55, 57	
Amphidial aperture	8.8 \pm 1.5 (7 – 10)	10.4 \pm 0.7 (9.6 – 11.4)	13, 12	4.3 \pm 0.6 (4.0–5.0)
Neck length	579 \pm 37 (527 – 628)	500 \pm 47 (427 – 550)	885, 900	345 \pm 21 (300 – 370)
Distance from anterior end to vulva	1280 \pm 176 (1073 – 1558)	1118 \pm 125 (935 – 1305)	3565 3065	805 \pm 62 (700 – 920)
Prerectum length	115 \pm 31 (70 – 150)	110 \pm 19 (72 – 130)	230, 243	101 \pm 16 (80 – 120)
Rectum length	53 \pm 9 (39 – 66)	45 \pm 10 (32 – 60)	65, 53	41 \pm 4 (35 – 46)
Tail length	44 \pm 3 (39 – 48)	52 \pm 4 (45 – 59)	60, 53	42 \pm 4 (35 – 47)
Pharyngeal characters* (%)				
DN	58 \pm 1 (58 – 59) (n=4)	57 \pm 1 (55 – 58)	40, 33	62 \pm 3 (60 – 65)
SV ₁ N ₁	77 (n=2)	65 \pm 5 (59 – 74) (n=9)	?, 52	68 \pm 3 (64 – 72) (n=4)
SV ₁ N ₂	87 (86 – 87) (n=3)	78 \pm 2 (75 – 81) (n=11)	?, 63	70 \pm 1 (69 – 71) (n=3)
SV ₂ N ₁		89 \pm 2 (86 – 92) (n=9)	?, 89	82 \pm 3 (81 – 84) (n=5)
SV ₂ N ₂		90 \pm 3 (86 – 93) (n=9)	?, 90	84 \pm 1 (81 – 85) (n=4)

*after LOOF & COOMANS (1970)

Table 3. Morphometric data of the species belonging to family Qudsianematidae (populations found in the present study). Measurements in μm (except L, in mm) presented as mean \pm standard deviation followed by the range (in parentheses)

Character	<i>Discolaimus agricolus</i> (n=25)	<i>Discolaimoides bulbiferus</i> (n=2)	<i>Ecumenicus monohystera</i> (n=11)	<i>Eudorylaimus subdigitalis</i> (n=48)
L	1.59 \pm 0.16 (1.30–1.88)	1.60, 1.63	1.12 \pm 0.07 (0.99–1.18)	1.10 \pm 0.01 (0.93–1.47)
a	33 \pm 4 (28–40)	57, 58	37 \pm 2 (34–39)	23 \pm 2 (20–28)
b	4.4 \pm 0.4 (4.0–5.4)	4.4, 4.5	4.6 \pm 0.5 (3.9–5.1)	3.6 \pm 0.2 (3.0–4.2)
c	64 \pm 10 (47–75)	41, 42	32 \pm 2 (31–36)	26 \pm 3 (21–34)
c'	0.9 \pm 0.1 (0.7–1.2)	2.4, 2.3	1.6 \pm 0.1 (1.5–1.7)	1.3 \pm 0.1 (1.1–1.6)
V (%)	52 \pm 2 (48–57)	48, 49	32 \pm 2 (29–34)	61 \pm 2 (57–65)
Body diameter at lip region	27 \pm 1 (25–29)	9	9.9 \pm 0.2 (9.5–10)	15 \pm 1 (14–17)
Body diameter at base of pharynx	45 \pm 2 (40–49)	25, 24	30 \pm 2 (28–32)	44 \pm 3 (37–49)
Body diameter at mid-body	48 \pm 3 (41–55)	28	31 \pm 1 (29–32)	47 \pm 3 (40–55)
Body diameter at anus	30 \pm 2 (27–34)	16, 17	22 \pm 2 (20–24)	35 \pm 2 (30–43)
Odontostyle length	23 \pm 1 (21–25)	11	10 \pm 0.5 (10–11)	18 \pm 1 (16–23)
Odontostyle aperture	13 \pm 0.8 (11–13.5)	3.5	3.5 \pm 0.3 (3.0–3.7)	7.6 \pm 0.7 (7–9)
Odontostyle width	4.0 \pm 0.3 (3.5–4.7)	2	1.5 \pm 0.05 (1.5–1.6)	3.1 \pm 0.4 (2.5–3.5)
Odontophore (μm)	37 \pm 8 (31–50)	10	20 \pm 3 (18–23)	28 \pm 3 (23–33)
Amphidial aperture	9.3 \pm 1 (8–10)	6	5.5 \pm 0.2 (5–6)	7 \pm 2 (6–10)
Neck length	354 \pm 23 (312–400)	360, 361	245 \pm 17 (225–261)	304 \pm 27 (250–356)
Distance from anterior end to guiding ring	10.0 \pm 0.7 (8.2–11)	5	5 \pm 0	8.5 \pm 0.6 (7.0–9.5)
Vagina	14.6 \pm 1.6 (12.4–19)	14	14.7 \pm 2.0 (13–17)	20 \pm 1.4 (18–22)
Prerectum	41 \pm 16 (24–66)	51, 50	41 \pm 9 (24–47)	64 \pm 17 (30–105)
Rectum	24 \pm 3 (20–34)	27, 26	24 \pm 6 (18–33)	30 \pm 4 (25–40)
Tail	25 \pm 4.3 (19.4–35)	39	35 \pm 2.4 (32–38)	44 \pm 5 (35–54)
DN	55 \pm 5 (45–62) (n=11)	60 (n=1)	64 (n=1)	64 \pm 1 (61–65) (n=13)
DO	51 \pm 3 (46–56) (n=7)	57 (n=1)	61 (n=1)	60 \pm 3 (56–66) (n=11)
SV ₁ N ₁	69 \pm 4 (55–79) (n=6)	79 (n=1)	76 (n=1)	73 \pm 4 (68–81) (n=14)
SV ₁ N ₂	79 \pm 7 (60–77) (n=10)			76 \pm 4 (70–82) (n=12)
SV ₂ N ₁	87 \pm 4 (81–92) (n=7)	87 (n=1)		89 \pm 1 (86–91) (n=13)
SV ₂ N ₂	89 \pm 5 (82–94) (n=7)	87 (n=1)		89 \pm 4 (77–94) (n=11)

*after LOOF & COOMANS (1970)

Table 4. Morphometric data of the species belonging to family Dorylaimidae (populations found in the present study). Measurements in μm (except L, in mm).

Character	<i>Crassolabium cf cylindricum</i> (n=3)			<i>Crassolabium rhopalocercus</i> (n=1)
	L	1.4	1.5	1.7
a	32	34	35	39
b	4.0	4.1	4.8	4.1
c	53	59	55	75
c'	0.9	0.8	0.9	0.7
V (%)	47	46	48	48
Body diameter at lip region	13	13	13.5	14
Body diameter at base of pharynx	41	42	45	43
Body diameter at mid-body	44	45	49	42
Body diameter at anus	30	33	34	31
Odontostyle length	11	11	12	17
Length of odontostyle aperture	5	4	5	7.5
Odontostyle width	2.5	2.5	2.5	3.5
Odontophore (μm)	22	22	23	27
Amphidial aperture	5	6	6	8
Neck length	355	370	355	400
Vagina	22	23	22	20
Prerectum	60	40	62	52
Rectum	22	24	32	38
Tail	27	26	31	22
DN	62	63	64	53
DO	63	59	61	50
SV ₁ N ₁	81	79	79	75
SV ₁ N ₂	82	81	81	
SV ₂ N ₁	91	90	90	88
SV ₂ N ₂	92	91	90	88

*after LOOF & COOMANS (1970)

Table 5. Abundance and occurrence of the recorded species in the studied area

Species	Average (100 g soil)	Min	Max	Occurrence (% of all samples)
APORCELAIMIDAE				
1. <i>Aporcella simplex</i>	6.5	1	18	89%
2. <i>Aporcelaimellus obtusicaudatus</i>	4.7	1	24	75%
3. <i>Aporcelaimus cf americanus</i>	1.0	1	1	11%
PARAXONCHIDAE				
4. <i>Paraxonchium laetificans</i>	2.2	1	7	61%
QUDSIANEMATIDAE				
5. <i>Discolaimus agricolus</i>	2.4	1	6	71%
6. <i>Discolaimoides bulbiferus</i>	1.5	1	2	21%
7. <i>Ecumenicus monohystera</i>	1.5	1	3	61%
8. <i>Eudorylaimus centrocerus</i>	1.0	1	1	14%
9. <i>Eudorylaimus subdigitalis</i>	6.4	1	15	96%
DORYLAIMIDAE				
10. <i>Crassolabium cf cylindricum</i>	1.0	1	1	11%
11. <i>Crassolabium rhopalocercus</i>	1.0	1	1	7%

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