

***Enchodelus decraemerae* sp. n. and *Enchodorus dolichurus* Vinciguerra, 1976 (Dorylaimida: Nordiidae), two rare species from Iran**

Ebrahim Pourjam¹, Majid Pedram¹, Maria T. Vinciguerra² and Robert T. Robbins³

¹ College of Agriculture, Plant Pathology Department, University of Tarbiat Modares, Tehran, Iran
e-mail: pourjame@modares.ac.ir

² Dipartimento di Biologia Animale, Università di Catania, via Androne 81, I-95124 Catania, Italy;

³ Department of Plant Pathology, 2601 N. Young Avenue, University of Arkansas, Fayetteville, AR 72704, USA

Accepted for publication 2 September 2010

Summary. A new species of *Enchodelus* is described in this study. It belongs to the group of species with very long odontostyle (61-67 μm) and conical tail and is also characterised by having a 1.49-1.72 mm long body, 25-36 μm long tail and presence of abundant males in the population with 45-52 μm long spicules and 10-12 irregularly spaced ventromedian copulatory supplements. The new species is compared with *E. maximus* Baqri and Jairajpuri, 1974 and *E. nepalensis* Zullini, 1973, from which it differs from *E. maximus* by its shorter body (1.49-1.72 vs 2.48-2.60 mm), smaller *a* value (23.0-30.5 vs 41-45), longer odontostyle (61-67 vs 54-57 μm), posteriorly located guiding ring (45-51 vs 35-36 μm from anterior end), much shorter female tail (*c'* 0.9-1.3 vs about 2) and having functional males in population vs absence of males. It also can be differentiated from *E. nepalensis* by having shorter body (1.49-1.72 vs 2.1-2.3 mm), smaller *b* value (5.0-5.7 vs 6.4-6.5), shorter female tail (*c'* 0.9-1.3 vs 1.7) and by having 10-12 ventromedian copulatory supplements vs 5. *Enchodorus dolichurus* Vinciguerra, 1976, a rare species of a rare genus, found so far only in Italy, is also redescribed and illustrated for the first time from Iran.

Key words: *Enchodelus*, morphology, nematodes, new species, taxonomy.

Three species of *Enchodelus*, namely *Enchodelus babakicus* Pedram, Niknam, Guerrero, Ye & Robbins, 2009, *E. macrodorus* (de Man, 1880) Thorne, 1939 and *E. veletensis* Guerrero, Liébanas & Peña-Santiago, 2007, have been so far reported from Iran (Pedram *et al.*, 2009a, b). *Enchodelus babakicus* and *E. macrodorus* belong to the *E. macrodorus*-group, and are characterised by having long odontostyle (>35 μm), flanged odontophore, tripartite uterus and short, rounded tail (Guerrero *et al.*, 2008). *Enchodelus veletensis* belongs to the group of species characterised by conical tail and has a 29-35 μm long odontostyle. During an extensive survey on soil nematodes conducted in Iran from October 2009 to March 2010, some soil samples yielded a new species of *Enchodelus* with very long odontostyle and conical tail. The new species, found in mountains of Ahar village, Tehran, is here described as *E. decraemerae* n. sp. *Enchodorus dolichurus* Vinciguerra, 1976, found for the first time after its description, is also redescribed.

MATERIAL AND METHODS

The nematodes were extracted from soil samples by suspending some soil in water and using a series of 850 and 250 μm mesh sieves; the nematodes of interest were hand picked under a stereomicroscope model Nikon SMZ1000. The specimens were killed by adding hot 4% formalin and were transferred to anhydrous glycerin according to de Grijse (1969). Permanent slides were made and the nematodes were examined under light microscope model Nikon E600. For a better observation of the structure of odontostyle and odontophore, some specimens were mounted in pure water. The pharyngeal gland nuclei position was calculated following Andrassy's formula (Andrassy, 1998). Drawings were made by using a drawing tube attached to microscope and the scanned files of drawings were transferred to CorelDRAW[®] software version 12 and redrawn.

Table 1. Morphometrics of *Enchodelus decraemerae* sp. n. All measurements are in μm except L in mm, and in the form: mean \pm s.d. (range).

| | Holotype | Paratype females | Paratype males |
|-------------------------------|----------|----------------------------|-----------------------------|
| n | | 10 | 8 |
| L | 1.71 | 1.60 \pm 0.1 (1.49-1.72) | 1.36 \pm 0.12 (1.20-1.52) |
| a | 27.2 | 25.5 \pm 2.5 (23.0-30.5) | 25.5 \pm 2.5 (25-29) |
| b | 5.2 | 5.5 \pm 0.2 (5.0-5.7) | 4.7 \pm 0.3 (4.2-5.2) |
| c | 53.5 | 54 \pm 5 (41.5-60.5) | 44.5 \pm 4.0 (40.0-52.5) |
| c' | 1.1 | 1.1 \pm 0.1 (0.9-1.3) | 0.9 \pm 0.1 (0.9-1.0) |
| V | 48.5 | 49.5 \pm 2.0 (47.5-53.0) | – |
| Anterior end to vulva | 832.5 | 795 \pm 45.5 (705-855) | – |
| Lip region width | 15 | 14.2 \pm 0.5 (14-15) | 14.0 \pm 0.5 (13-14) |
| Odontostyle length | 64 | 64.0 \pm 2.5 (61-67) | 62.0 \pm 2.3 (60-66) |
| Odontophore length | 60 | 55.0 \pm 2.5 (52-60) | 50.0 \pm 1.5 (48-52) |
| Stylet total length | 124 | 119 \pm 4 (113-124) | 112.0 \pm 2.5 (110-117) |
| Anterior end to guiding ring | 48 | 47 \pm 2 (45-51) | 45.5 \pm 3.0 (42-49) |
| Neck length | 327 | 303.5 \pm 17.5 (283-328) | 290.5 \pm 11.5 (274-310) |
| Pharyngeal expansion length | 100 | 89.0 \pm 8.5 (77-100) | 80.5 \pm 4.0 (75-85) |
| Pharyngeal expansion width | 30 | 31.5 \pm 1.5 (30-34) | 29.0 \pm 1.5 (27-31) |
| Body width at neck base | 53 | 51 \pm 3 (48-57) | 49.0 \pm 2.5 (47-54) |
| - at mid-body | 63 | 62.5 \pm 5.5 (55-71) | 54.5 \pm 4.5 (48-59) |
| - at anus | 30 | 28.5 \pm 1.5 (26-30) | 33.5 \pm 1.5 (32-35) |
| Tail length | 32 | 30.0 \pm 3.5 (25-36) | 30.5 \pm 2.0 (29-35) |
| Cuticle thickness at tail end | 10 | 11.0 \pm 1.5 (9-14) | 8.7 \pm 2.0 (5-11) |
| Spicule length | – | – | 48 \pm 3 (45-52) |
| Spicule width | – | – | 14.0 \pm 0.8 (13-15) |
| Supplements | – | – | 11 \pm 1 (10-12) |
| Prerectum length | 110 | 74.0 \pm 20.5 (54-110) | – |
| Rectum length | 27 | 29.5 \pm 1.5 (27-32) | – |

DESCRIPTION

Enchodelus decraemerae sp. n. (Fig 1)

Measurements: See Table 1.

Females: Slender nematodes of medium size. Habitus after fixation curved ventrad. Body tapering towards both ends very gradually. Cuticle 2.0-3.0 μm thick in the anterior region and at mid-body and 3.0-4.0 μm anterior to anus. Lateral chords 22.5-24.5% of corresponding body width. Lateral pores obscure. Lip region 2.8-3.0 times as wide as high, separated from the rest of body by a shallow depression; labial and cephalic papillae very slightly protruding. Amphidial fovea cup-shaped, opening at level of cephalic depression and occupying 55-60% of corresponding body diameter. Odontostyle very long and slender, slightly curved, 4.3-4.7 times as long as lip width, with furcated base. Odontophore shorter than odontostyle with distinct basal flanges. Guiding ring double, with its fixed ring located at 45-51 μm from anterior end and a guiding sheath of 9-10 μm in resting position of odontostyle. Pharynx consisting of a slender but well muscled portion

expanding gradually into the basal expansion, which occupies 27-30% of neck length. Pharyngeal gland nuclei located as follows: D: 75.5-80.0%, AS1 and AS2: not seen; PS: 50.0-56.5%. Cardia as long as wide (11-15 \times 12-14 μm), cylindroid. Intestine simple, containing green material in almost all examined specimens. Genital system didelphic-amphidelphic, with both branches equally and well developed. Ovaries reflexed, 243-325 μm long, with maturing oocytes in almost all examined specimens. Oviduct 230-310 μm long, consisting of a slender distal part and of a well developed *pars dilatata*. Sphincter clearly visible between oviduct and uterus. Uterus 105-142 μm long, tripartite, consisting of a wide proximal part with distinct lumen containing mature eggs (Fig. 1, C) 93-105 μm long and/or elliptic sperms in dimension of 6-7 \times 2 μm , a narrower intermediate region and a well developed spheroid *pars dilatata distalis*. Vagina extending inwards for 22.5-24.5% of corresponding body width; *pars proximalis* about as long as wide, 16-25 \times 17-25 μm ; *pars refringens* in lateral view composed of two sclerotised pieces, each in dimension of 7-9 \times 11-13 μm , and *pars distalis* 3-4 μm thick. Vulva a transverse slit. Prerectum 2.0-3.7

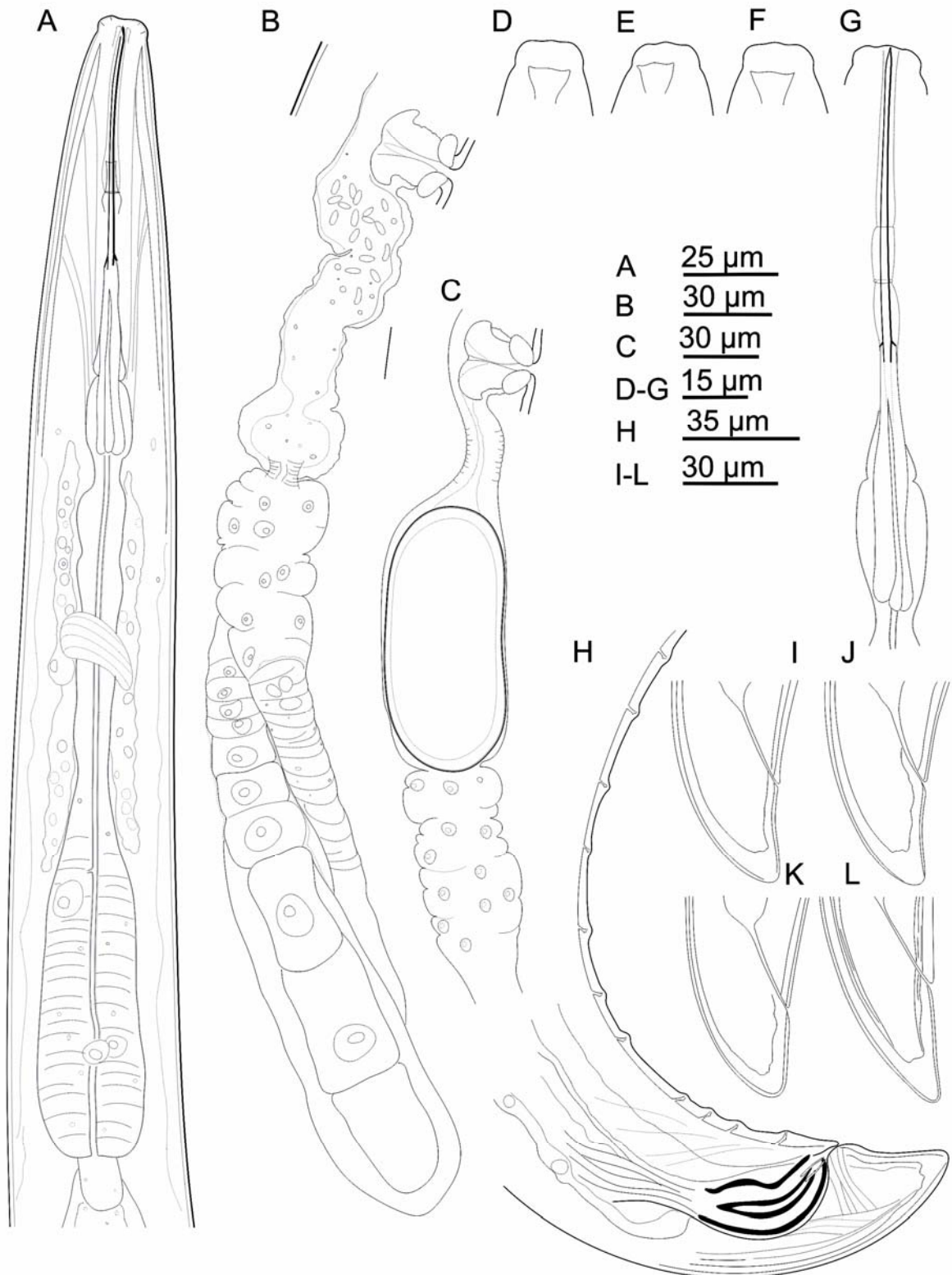


Fig. 1. *Enchodelus decraemerae* sp. n. A: Neck region, B: Posterior genital tract, C: A part of female genital tract and a mature egg, D-F: Lip region and the position of amphid, G: Odontostyle and odontophore in detail (fresh material), H: Posterior end of male, I-L: Female tail.

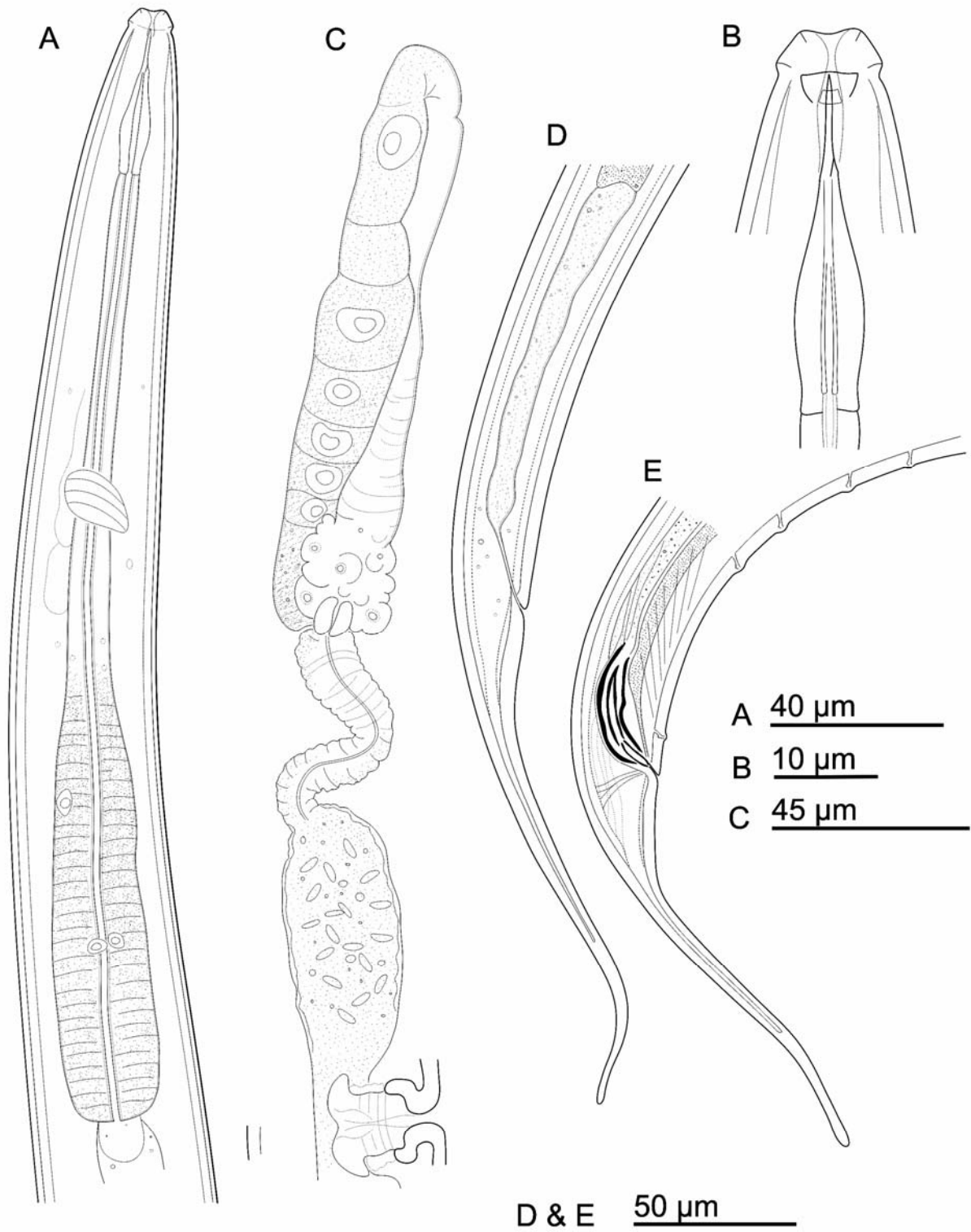


Fig. 2. *Enchodorus dolichurus* Vinciguerra, 1976. A: Neck region; B: Lip region; C: Anterior genital tract, D: Posterior end of female, E: Posterior end of male.

Table 2. Morphometrics of *Enchodorus dolichurus* from Iran. All measurements are in μm except L in mm and in the form: mean \pm s.d. (range).

| | Iranian population | | Original description | |
|------------------------------|-------------------------------|------------|----------------------|-----------|
| | Females | Males | Females | Males |
| n | 4 | 2 | 4 | 3 |
| L | 1.53 \pm 0.04 (1.50-1.58) | 1.46, 1.54 | 1.38-1.57 | 1.41-1.49 |
| a | 34.5 \pm 3.5 (30.0-38.5) | 35.7, 37.7 | 27-32 | 27-31 |
| b | 5.5 \pm 0.1 (5.5-5.8) | 5.7, 6.0 | 3.0-5.8 | 4.4-6.3 |
| c | 9.5 \pm 0.3 (9.2-9.8) | 10.5, 10.7 | 11-13 | 11-15 |
| c' | 7.0 \pm 0.5 (4.0-6.8) | 5.0, 5.5 | – | – |
| V | 44.0 \pm 1.5 (42.5-46.5) | – | 46-47 | – |
| Anterior end to vulva | 677 \pm 38 (635.0-712.5) | – | – | – |
| Lip region width | 11.2 \pm 0.5 (11-12) | 11, 11 | 11 (holotype) | – |
| Odontostyle length | 11.5 \pm 0.5 (11-12) | 11, 12 | 6.5-10.5 | – |
| Odontophore length | 27.0 \pm 1.5 (25-29) | 26, 27 | 18-19 | – |
| Stylet total length | 39.0 \pm 1.5 (37-41) | 38, 38 | – | – |
| Anterior end to guiding ring | 8.3 \pm 1.0 (7-9) | 7, 8 | 7-8 | – |
| Neck length | 274.0 \pm 7.5 (265-283) | 245, 271 | – | – |
| Pharyngeal expansion length | 97.5 \pm 3.0 (95-100) | 85, 90 | – | – |
| Pharyngeal expansion width | 22.5 \pm 1.5 (20-24) | 20, 22 | – | – |
| Body width at neck base | 42 \pm 3 (39-46) | 39, 40 | 37 (holotype) | – |
| - at mid-body | 44.5 \pm 4.5 (40-50) | 41, 41 | 43 (holotype) | – |
| - at anus | 23.5 \pm 0.5 (23-24) | 26, 28 | 22 (holotype) | – |
| Tail length | 162.5 \pm 9.5 (153-172) | 141, 144 | – | – |
| Spicule length | – | 40, 43 | 40-42 | – |
| Spicule width | – | 9, 9 | – | – |
| Supplements | – | 3, 4 | 3-5 | – |
| Prerectum length | 105.5 \pm 12.0 (90.0-117.5) | – | 50-60 | – |
| Rectum length | 30.5 \pm 1.5 (28-32) | – | – | – |

times and rectum about as long as anal body width. Tail conical with rounded tip and hyaline terminal portion of 9-14 μm .

Males: General morphology similar to that of females, with posterior region more ventrally curved. Genital system diorchic, with opposed testes. The precloacal pair of papillae located at 12-15 μm distance from cloacal opening and a series of 10-12 irregularly spaced ventromedian supplements ending at 27-45 μm distance from cloacal opening, at spicule level. Spicules dorylaimoid, massive, 3.0-3.8 times as long as wide. Lateral guiding pieces 9-11 μm long. Tail ventrally curved, with rounded tip and 5-11 μm thick hyaline portion.

Differential diagnosis and relationships:

Enchodelus decraemerae sp. n. is an amphimictic species with medium female body length (1.49-1.72 mm) and is characterised by having rather low and slightly set off lip region, a very long odontostyle (61-67 μm), an odontophore with developed flanges, didelphic female genital apparatus, transverse vulva, vagina with well developed *pars refringens*, conical tail with rounded tip, males with 10-12 irregularly spaced supplements.

The new species belongs to a group of species within genus *Enchodelus* with odontostyle longer

than 50 μm and conical tail, which Ahmad and Jairajpuri (1980) ascribed to the subgenus *Nepalus*. It can be compared with two known species of this group, namely *E. maximus* Baqri & Jairajpuri, 1974 and *E. nepalensis* Zullini, 1973. The new species can be differentiated from *E. maximus* by its shorter body (1.49-1.72 vs 2.48-2.60 mm), smaller *a* value (23.0-30.5 vs 41-45), longer odontostyle (61-67 vs 54-57 μm), posteriorly located guiding ring (45-51 vs 35-36 μm from anterior end), much shorter female tail ($c' = 0.9-1.3$ vs about 2) and having functional males in population vs absence of males. It can also be differentiated from *E. nepalensis* by having shorter body (1.49-1.72 vs 2.1-2.3 mm), smaller *b* value (5.0-5.7 vs 6.4-6.5), shorter female tail ($c' = 0.9-1.3$ vs 1.7) and by having 10-12 ventromedian copulatory supplements vs 5.

Type habitat and locality. Collected from rhizosphere of mosses on rocks, mountains of Ahar village, Tehran on March 2010.

Type material. Holotype female, 10 paratype females and 10 paratype males deposited in the Nematology Laboratory of the Faculty of Agriculture, University of Tarbiat Modares, Tehran, Iran; 2 paratype females and 2 paratype males in separate slides deposited at CABI UKCentre,

Surrey, UK, and USDA Nematode Collection, Beltsville, MD, USA.

Etymology. Named in honor of Prof. Wilfrida Decraemer.

***Enchodorus dolichurus* Vinciguerra, 1976
(Fig 2)**

Measurements: See Table 2.

Females: Nematodes of medium size, slightly curved ventrad after fixation. Body tapering towards both ends very gradually. Cuticle marked with slight transverse striae, 2.0-3.0 μm thick in the anterior region and at mid-body, and 4.0 μm anterior to anus. Lateral chords 24-25 % of corresponding body width. Lip region cap-like, 2.2 times as wide as high, well set off from the rest of body by a constriction; labial and cephalic papillae protruding, giving lips an angular aspect. Amphidial fovea cup-shaped, opening at lips base, occupying 50-60% of corresponding body diameter. Odontostyle needle-like, about as long as lip width, with very small aperture. Odontophore rod-like, more than twice as long as odontostyle. Guiding ring double, the posterior one located at 7-9 μm from anterior end. Pharynx consisting of a slender but well muscled portion expanding gradually into the basal expansion, which occupies 35% of neck length. Pharyngeal gland nuclei located as follows: D: 71.5-73.0%, AS1 and AS2: not seen; PS: 45.0-46.5%. Cardia cylindroid, about as long as wide (8-11 \times 10 μm). Intestine simple, containing green material in almost all examined specimens. Genital system didelphic-amphidelphic, genital branches 180-225 μm long. Ovaries reflexed, 50-70 μm long. Oviduct 95-120 μm long, consisting of a slender distal part and of a well developed *pars dilatata*. Sphincter well developed between oviduct and uterus. Uterus 80-110 μm long, consisting of a wide proximal part with distinct lumen containing a mature egg in one female, 40-95 μm in size, and/or very small elliptic sperms (2 \times 4 μm) and of a narrower distal part. Vagina extending inwards for 50-55% of corresponding body width; *pars proximalis* about as long as wide, 17-20 \times 17-22 μm ; *pars refringens* in lateral view composed of two sclerotised pieces 3-4 μm long, and *pars distalis* 5-6 μm long. Vulva a transverse slit. Prerectum 3.9-4.8 times and rectum about as long as anal body width. Tail elongate conoid, almost filiform in its distal part, 4-7 times as long as anal body width.

Males: General morphology similar to that of females, with posterior region more ventrally curved. Genital system diorchic, with opposed testes. An adanal pair of male copulatory

supplements located at 13-14 μm from cloacal opening and a series of 3-4 well spaced ventromedian supplements ending at 70-80 μm distance from cloacal opening. Spicules dorylaimoid, massive, 4.4-4.8 times as long as wide. Lateral guiding pieces 11 μm long. Tail convex-conoid proximally, then almost filiform, 5-5.5 times as long as anal body width.

The morphometric and morphological characters of this population accord fairly well with the original data except for index c (see table 2), slightly smaller from that in original description (9.2-9.8 vs 11-13). This is the first report of genus *Enchodorus* from Iran and of *E. dolichurus* after its first record in Italy.

A population of this species was found in superficial soil samples collected from Nahar Khoran forests, Gorgan, north of Iran, in association with mosses on March 2010.

ACKNOWLEDGEMENT

The authors thank Prof. Aldo Zullini, Prof. Virginia R. Ferris and Prof. Reyes Pena-Santiago for kind assistance, and Azam Houshmand for her help.

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E. Pourjam, M. Pedram, M. T. Vinciguerra, R. T. Robbins. *Enchodelus decraemerae* n. sp. и *Enchodorus dolichurus* Vinciguerra, 1976 (Dorylaimida: Nordiidae), два редких вида из Ирана.

Резюме. Дано описание нового вида рода *Enchodelus*, относящегося к группе видов с очень длинным одонтостилем (61-67 мкм) и коническим хвостовым концом. Новый вид также характеризуется длиной тела 1,49-1,72 мм, длиной хвостового конца 25-36 мкм и наличием большого количества самцов. Последние имеют длину спикул 45-52 мкм и 10-12 нерегулярно располагающихся супплементов. Новый вид близок к *E. maximus* Ваqri et Jairajpuri, 1974 и *E. nepalensis* Zullini, 1973, но отличается от *E. maximus* более коротким телом (1,49-1,72 vs 2,48-2,60 мм), меньшим значением индекса 'a' (23,0-30,5 vs 41-45), более длинным одонтостилем (61-67 vs 54-57 мкм), смещенным кзади направляющим кольцом (в 45-51 vs 35-36 мкм от головного конца), меньшей длиной хвостового конца самок ($c' = 0,9-1,3$ vs около 2) и наличием самцов в популяции vs отсутствие самцов. Он также отличается от *E. nepalensis* более коротким телом (1,49-1,72 vs 2,1-2,3 мм), меньшим значением индекса 'b' (5,0-5,7 vs 6,4-6,5), более коротким хвостовым концом самок ($c' = 0,9-1,3$ vs 1,7) и наличием 10-12 вентромедианных супплементов, а не пяти. Приводится переписание *Enchodorus dolichurus* Vinciguerra, 1976 – редкого вида редкого рода, описанного ранее из Италии и впервые найденного в Иране. Приводятся данные по морфологии и рисунки найденных в Иране представителей этого вида.
