Description of *Prionchulus girchi* sp. nov. (Nematoda: Mononchina) with additional data on two known species of the genus *Prionchulus* from Lorestan province, Iran

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Summary

Three species of mononchids belonging to the *Prionchulus* Cobb, 1916 genus, one new and two previously known species collected from natural ecosystem of Khorramabad county, Lorestan province, south west of Iran, are described. *Prionchulus girchi* sp. nov. is morphologically characterized by its 2.1 – 2.2 mm body length, numerous cuticular pores, slightly offset lip region, prominent labial and cephalic papillae, cephalic papillae larger than labial ones, barrel-shaped and spacious (40 – 43 × 22.5 – 24 µm) buccal cavity, weakly rounded tail tip and weakly expressed tail tip's hyaline. In this study, *P. fagi* and *P. muscorum* were also collected and some additional data of these two species are also given.

Keywords: *Crataegus aronia*; Mononchida; new species; *Prionchulus girchi* sp. nov.; *Prionchulus fagi*; *Quercus libani*

Introduction

Mononchid nematodes as a group sensitive to habitats disturbances are considered as indicators of ecological changes (Johnson, *et al.* 1974; Bongers, 1990). The order Mononchida has been proposed by Jairajpuri (1969), which include two superfamily and forty-nine genera (Ahmad & Jairajpuri, 2010). The genus *Prionchulus* comprises of more than thirty three species, which have been described from various parts of the world (Jana *et al.*, 2010; Vu *et al.*, 2018; Winiszewska & Susulovsky, 2003; Zell, 1985), but only three species of this genus have been described and reported from Iran (Ghaderi *et al.*, 2012; Naghavi *et al.*, 2017). *Prionchulus* species are characterized by large and barrel-shaped buccal cavity, dorsal tooth stout, situated in anterior half of buccal cavity, opposed subventral denticulate ridges, pharyngo-intestinal junction non-tuberculate, female genital system amphidelphic (Ahmad & Jairajpuri, 2010). In this study *P. girchi* sp. nov. and two other known species viz. *P. fagi* and *P. muscorum* have been collected

and studied using a discriminant analysis based on their most important morphological characters within this genus of Mononchids in Khorramabad County, Lorestan province, Iran.

Material and Methods

Nematode surveys were conducted from 2017 to 2018 in natural ecosystem of Khorramabad County, Lorestan province, south west of Iran. Soil samples were collected from the 5 – 30 cm depth of forest soils and processed in the Laboratory of nematology in Lorestan University, Khorramabad, Iran. Nematodes were extracted from 250 cm³ of soil samples, adapting Brown & Boag (1987) modified method. Specimens to be used for light microscopy studies were killed and transferred to dehydrated glycerin, and then permanent microscopic slides of the nematodes were prepared. Morphological and morphometric characters of nematodes were examined and photographed using an Olympus Bx31 light microscope equipped with a Dino-eye microscope eye-piece camera in

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Table 1. Morphometrics of *Prionchulus girchi* sp. nov. from Lorestan, Iran. All measurements are in μm (except for L in mm) and are in the form: mean $\pm$ s.d. (range).

Location	Chenar Shureh (Type)		Imanabad
Character*			
n	Holotype	Paratype (n=3)	Female (n=2)
L	2.2	2.2 $\pm$ 0.8 (2.1 – 2.3)	2.1 , 2.1
a	30.7	28.7 $\pm$ 1.3 (26.6 – 30.7)	20.7 , 23.7
b	4.14	4.1 $\pm$ 0.1 (4.0 – 4.3)	4.0 , 4.3
c	18.9	17.7 $\pm$ 0.4 (17.0 – 19.0)	15.5 , 16.3
c'	3.6	3.3 $\pm$ 0.1 (3.0 – 3.6)	2.7 , 3.1
v	67.0	66.0 $\pm$ 0.8 (65.0 – 67.0)	65.0 , 66.0
G ₁	17.0	18.6 $\pm$ 1.1 (17.0 – 21.0)	22.0 , 22.0
G ₂	14.0	16.3 $\pm$ 2.1 (14.0 – 20.0)	19.0 , 20.0
Buccal cavity length	42.5	42.0 $\pm$ 0.4 (41.0 – 42.5)	40.0 , 43.0
Buccal cavity diameter	24.0	22.9 $\pm$ 0.3 (22.5 – 24.0)	23.0 , 24.0
Lip region width	43.0	43.3 $\pm$ 2.4 (43.0 – 44.0)	44.0 , 44.5
Neck length	527.3	526.6 $\pm$ 3.5 (522.0 – 530.0)	496.0 , 517.0
Nerve ring from anterior end	160.0	160.8 $\pm$ 0.8 (160.0 – 162.0)	146.0 , 155.0
Excretory pore from anterior end	177.0	177.3 $\pm$ 5.3 (170.0 – 185.0)	170.0 , 172.0
Amphidial aperture diameter	4.0	4.6 $\pm$ 0.3 (4.0 – 5.0)	4.5 , 5.0
Amphidial position from anterior end	17.0	18.6 $\pm$ 0.3 (17.5 – 19.0)	17.0 , 18.5
Tooth length	4.2	4.8 $\pm$ 0.1 (4.3 – 5.3)	4.5 , 5.3
Dorsal tooth from buccal base	32.5	32.6 $\pm$ 0.2 (32.0 – 33.0)	32.0 , 33.0
Body diameter at neck base	63.0	63.6 $\pm$ 4.4 (57.0 – 69.0)	70.8 , 92.3
Body diameter at mid body	71.0	76.3 $\pm$ 2.3 (71.0 – 79.0)	90.0 , 103.0
Body diameter at anal region	31.0	37.5 $\pm$ 3.3 (31.0 – 41.0)	44.0 , 48.0
Tail	115.0	124.6 $\pm$ 6.6 (115.0 – 135.0)	131.0 , 138.0

*total body length (L), body length/greatest body width (a), body length/neck length (b), body length/tail length (c), tail length/tail diameter at anus region (c'), % distance of vulva from anterior end/body length (V), % length of anterior female genital branch in relation to body length (G1), % length of posterior female genital branch in relation to body length (G2).

conjunction with Dino Capture version 2.0 software. Raw photographs were edited using Adobe® Photoshop® CS. Drawing and photoplate were prepared by Corel DRAW®, software version 12. Nematodes were identified at specific level using available identification keys (Ahmad & Jairajpuri, 2010 and Jana *et al.*, 2010).

Ethical Approval and/or Informed Consent

The conducted research is neither related to human nor animals use.

Results and Discussion

Prionchulus girchi sp. nov.

(Figs. 1, 2)

Measurements

See table 1.

Description

Female

Body medium sized, open 'C'-shaped upon fixation, more curved in tail region. Body tapering towards both ends. Cuticle smooth, relatively thin, 4.2 – 5.3 μm thick in mid-body with numerous pronounced body pores along body length. Lip region offset by slightly depression, ca 4.2 – 4.4 times as wide as high, with large conical and prominent labial and cephalic papillae, cephalic papillae larger than labial ones, amphidial apertures oval at level of dorsal tooth apex, buccal cavity barrel-shaped, 1.7 – 1.9 times as long as it is wide with funnel-shaped base, dorsal wall at the level of dorsal tooth apex 4.4 – 4.8 μm thick, dorsal tooth medium-sized, its apex located at 9 – 10 μm from anterior end of the sclerotized buccal cavity and 17.5 – 19 μm from anterior end, subventral walls with two longitudinal, denticulate ridges, subventral denticles 8 – 10 in number, distance between first and last denticle 15 – 17 μm . Pharynx cylindrical and muscular ca 22 – 25 % of the body length,

Fig. 1. *Prionchulus girchi* sp. n. A: Entire female body; B: Neck region; C: Anterior end; D: Female reproductive system; E: vaginal region; F: Caudal region.

Table 2. Morphometrics of *Prionchulus fagi* Zell, 1985 and *P. muscorum* (Dujard, 1845) Wu & Hoppli, 1929. All measurements are in μm (except for L in mm) and are in the form: mean $\pm$ s.d. (range).

Species	<i>P. fagi</i>		<i>P. muscorum</i>	
Location	Hamvar-Kulivand	Robatnamaki	Imanabad	
n	Female (n=4)	Female (n=4)	Female (n=3)	
L	2.8 $\pm$ 0.9 (2.7 – 3.0)	2.1 $\pm$ 0.8 (1.9 – 2.2)	2.7 $\pm$ 0.2 (2.7 – 2.8)	
a	27.0 $\pm$ 1.2 (26.5 – 29.5)	21.8 $\pm$ 0.9 (20.0 – 23.5)	24.6 $\pm$ 0.4 (24.0 – 25.0)	
b	4.2 $\pm$ 0.1 (4.0 – 4.4)	4.2 $\pm$ 0.1 (4.0 – 4.4)	4.6 $\pm$ 0.1 (4.4 – 4.8)	
c	15.5 $\pm$ 0.8 (14.5 – 16.5)	16.9 $\pm$ 0.3 (16.2 – 18.5)	17.3 $\pm$ 0.4 (16.5 – 17.8)	
c'	3.2 $\pm$ 0.1 (3.0 – 3.3)	2.9 $\pm$ 0.3 (2.4 – 3.7)	2.9 $\pm$ 0.1 (2.8 – 3.2)	
v	65.8 $\pm$ 0.7 (64.0 – 66.5)	65.0 $\pm$ 0.7 (64.0 – 67.0)	64.6 $\pm$ 0.3 (64.0 – 65.0)	
G ₁	19.3 $\pm$ 0.4 (18.5 – 21.0)	20.5 $\pm$ 1.2 (18.0 – 23.0)	22.0 $\pm$ 0.8 (21.0 – 23.0)	
G ₂	18.8 $\pm$ 0.1 (18.5 – 19.0)	18.8 $\pm$ 0.7 (18.0 – 20.0)	17.6 $\pm$ 0.3 (17.0 – 18.0)	
Buccal cavity length	48.0 $\pm$ 0.2 (47.5 – 49.0)	45.0 $\pm$ 1.8 (43.0 – 47.0)	47.5 $\pm$ 0.3 (47.0 – 48.0)	
Buccal cavity diameter	27.3 $\pm$ 0.2 (27.0 – 28.0)	26.0 $\pm$ 0.9 (24.0 – 27.0)	24.3 $\pm$ 0.1 (24.0 – 25.0)	
Lip region width	48.0 $\pm$ 1.2 (46.0 – 49.5)	45.5 $\pm$ 1.2 (43.0 – 47.0)	48.2 $\pm$ 0.8 (46.5 – 49.5)	
Neck length	650.0 $\pm$ 15.2 (630.0 – 670.0)	504.5 $\pm$ 13.8 (490.5 – 519.0)	587.5 $\pm$ 6.5 (580.0 – 600.0)	
Nerve ring from anterior end	173.0 $\pm$ 2.4 (170.0 – 182.0)	175.0 $\pm$ 11.2 (160.0 – 190.0)	182.6 $\pm$ 7.5 (173.0 – 195.0)	
Excretory pore from anterior end	211.0 $\pm$ 1.8 (209.0 – 213.0)	206.0 $\pm$ 3.4 (200.0 – 210.0)	211.0 $\pm$ 4.5 (204.0 – 216.0)	
Amphidial aperture diameter	5.2 $\pm$ 0.1 (5.0 – 5.40)	4.8 $\pm$ 0.2 (4.5 – 5.5)	5.8 $\pm$ 0.3 (5.5 – 6.3)	
Amphidial position from anterior end	18.2 $\pm$ 0.2 (17.0 – 18.5)	16.0 $\pm$ 0.4 (15.0 – 17.0)	16.0 $\pm$ 0.2 (15.0 – 16.5)	
Tooth length	10.0 $\pm$ 0.8 (9.5 – 11.0)	10.0 $\pm$ 0.1 (9.8 – 10.2)	9.7 $\pm$ 0.1 (9.5 – 10.0)	
Dorsal tooth from buccal base	34.4 $\pm$ 0.2 (34.0 – 35.0)	32.2 $\pm$ 1.8 (29.2 – 34.0)	37.1 $\pm$ 0.5 (36.5 – 38.0)	
Body diameter at neck base	96.0 $\pm$ 4.2 (90.0 – 101.5)	85.2 $\pm$ 4.1 (80.0 – 90.0)	91.0 $\pm$ 1.3 (88.5 – 92.5)	
Body diameter at mid body	105.0 $\pm$ 1.8 (103.0 – 107.5)	99.2 $\pm$ 6.1 (92.0 – 110.0)	111.3 $\pm$ 0.5 (110.0 – 112.0)	
Body diameter at anal region	58.2 $\pm$ 1.1 (57.0 – 59.5)	43.6 $\pm$ 5.2 (31.0 – 50.0)	54.5 $\pm$ 2.2 (52.0 – 57.0)	
Tail	194.2 $\pm$ 3.1 (190.0 – 200.0)	126.0 $\pm$ 5.3 (117.0 – 136.0)	161.1 $\pm$ 4.3 (155.5 – 168.0)	

nerve ring at 28 – 31 % of neck length, excretory pore weakly marked, in some specimens at 32 – 34 % of neck length. Orifices of the pharyngeal glands: DO at ca 55 – 59 %, SV1O1 and SV1O2 at ca 77 – 79 %, and SV2O1 and SV2O2 at ca 94 – 96 % of pharyngeal length, pharyngo-intestinal junction non-tuberculate. Genital branches nearly symmetrical, anterior branch 363 – 468 μm , posterior 300 – 451 μm long. Ovaries straight, reflexed and with one row of oocytes, anterior ovary 127 – 197 μm , posterior 107 – 202 μm long, not reaching to the uterus oviduct junction, oviduct short with well-marked *pars dilatata*, 95 – 110 μm , 0.84 – 1.1 times the corresponding body diameter, uterus 48 – 56 μm long, 0.57 – 0.69 the corresponding body diameter. Vulva a transverse slit with, protruding lips, located posterior to middle of the body, vagina perpendicular to the body axis, extending inwards for 40 – 45 % of the body diam., *pars proximalis* 23 – 26 μm long with sigmoid contours and surrounded by strong circular musculature, *pars refringens* 3 – 4.5 μm long with two drop shaped sclerotizations, *pars distalis vaginae* short, thick walled. Rectum almost straight, 38 – 40 μm and 0.89 – 0.98 times the anal body diameter. Tail conical, slightly ventrally bent, regularly tapering with three to

four caudal pores on each side, tail terminus with weakly rounded tip, hyaline area of tail 7.5 – 7.8 μm long and weakly expressed, without caudal glands and spinneret.

Male: Not found.

Type locality and Habitat

The new species collected from Chenar shureh village, Khorramabad County, Lorestan province, Southwest Iran, (GPS coordinates: N 33° 14' 47" E 48° 46' 59", altitude 1790 m a.s.l.), in the rhizosphere of Hawthorn (*Crataegus aronia* L.) and from Imanabad village, Azna area, Khorramabad County, Lorestan province, Southwest Iran, (GPS coordinates: N 33° 23' 11" E 48° 36' 16", altitude 1661 m a.s.l.), in the rhizosphere of Oak (*Quercus libani* L.).

Type material

Holotype and paratype females deposited in the Collection of the Nematology Laboratory, Lorestan University.

Diagnosis and Relationships

The new species is characterized by a medium body size, numerous distinct cuticular pores, slightly offset lip region, prominent labial and cephalic papillae, cephalic papillae larger than labial ones, barrel-shaped and spacious (40 – 43 $\times$ 22.5 – 24 μm) buccal cav-

Fig. 2. A, B, G, J, M: *Prionchulus fagi* Zell, 1985. A: Anterior region; B: Sub ventral denticles; G: Amphidial aperture, J: Anterior genital branch, M: Caudal region, C, D, H, K, N: *P. muscorum* (Dujardin, 1845) Wu & Hopperli, 1929. C: Anterior region; D: Sub ventral denticles; H: Amphidial aperture, K: Anterior genital branch, N: Caudal region, E, F, I, L, O: *P. girchi* sp. nov. E: Anterior region; F: Sub ventral denticles; I: Amphidial aperture, L: Anterior genital branch, O: Caudal region. (Scale bar: A-I=10 μ m; J-O=20 μ m.)

ity, lower position of dorsal tooth (22 – 25 % of the buccal cavity length), weakly rounded tail tip and weakly expressed hyaline, *pars proximalis vaginae* with arcuate walls, *pars refringens* vaginae with two drop-shaped sclerotizations; *pars distalis* vaginae short, thick walled. *P. girchi* sp. nov. is closely related to *P. pinophilus* Winiszewska & Susulovsky, 2004, *P. fistulosus* Susulovsky & Winiszewska, 2002, *P. auritus* Andrassy, 1985 and *P. muscorum* (Dujardin, 1845) Wu & Hoeppli, 1929. The new species is very similar to *P. pinophilus* (data from Winiszewska & Susulovsky, 2004) are taken for comparative purposes), but *P. girchi* sp. nov. can be differentiated from *P. pinophilus* by the position of dorsal tooth apex from base of buccal cavity (75 – 78 % vs 84 %), dorsal tooth length (3 – 3.3 vs 5 μ m), number of subventral denticles (8 vs 12), distance between first and last denticle (14.5 – 15.5 vs 18.5 μ m), distance of amphidial aperture from anterior end (11 – 12.5 vs 8.6 μ m), longer anterior (363 – 476 vs 250 μ m) and posterior genital branches (300 – 451 vs 250 μ m), posteriorly located vulva ($V = 65 - 67$ vs 61 %) and caudal gland (absent vs spherical glandular bodies in proximal part). Moreover, the new species can be differentiated from *P. fistulosus* (original description by Susulovsky & Winiszewska, 2002) by having narrower lip region (43 – 44.5 vs 46.7 – 51.4 μ m), shorter buccal cavity (40 – 43 vs 47.2 – 51 μ m) and shorter tail (115 – 138 vs 124 – 177 μ m). It can also be separated from *P. auritus* (see detailed description by Orselli & Vinciguerra, 2007) by having narrower lip region (43 – 44.5 vs 47 – 57.5 μ m), shorter buccal cavity (40 – 43 vs 43 – 49.5 μ m), amphidial position (amphid at the level of apex of dorsal tooth vs anterior of dorsal tooth) and shorter tail (115 – 138 vs 145 – 195 μ m). Finally, *P. girchi* sp. nov. differs from *P. muscorum* (data from Winiszewska & Susulovsky, 2003) by the size of cephalic and labial papillae (lip region with large conical and prominent labial and cephalic papillae vs lip region rounded with small labial and cephalic papillae), subventral denticle numbers (8 – 10 vs 10 – 14), the size of cuticular pores (cuticle smooth with numerous distinguished body pore vs indistinct pores along the body), shorter buccal cavity (40 – 43 vs 47.6 – 54.3 μ m) and shorter tail (115 – 138 vs 140 – 209 μ m).

Etymology

The specific epithet is derived from the Lori word Girch meaning hawthorn (*Crataegus aronia* L.), the plant which the *P. girchi* sp. nov. was collected from its rhizosphere for the first time.

***Prionchulus muscorum* (Dujardin, 1845) Wu & Hoeppli, 1929** (Fig. 2)

Measurements

See Table 2.

Description:

Female

Body medium sized, open 'C'-shaped upon fixation, more curved in tail region. Cuticle smooth, 3 – 4 μ m thick in mid body, Cuticular small pores, arranged along the body (excluding tail). Lip region rounded, 43 – 49.5 μ m wide, offset by a slightly depression, small labial and cephalic papillae, slightly raised, labial papillae are the

same size as head papillae. Buccal cavity barrel-shaped, 43 – 48 $\times$ 24 – 27 μ m. Dorsal tooth 9 – 10.2 μ m long, its apex located at 11 – 13.8 μ m from the anterior end of the buccal cavity, subventral ridges with 10 – 12 well-developed denticles each. Amphidial aperture 5.5 – 6 μ m wide, located at the level of anterior end of buccal cavity, 14 – 16 μ m from anterior end. Pharynx cylindroid and muscular, 23 – 25 % of the body length, nerve ring at 30 – 38 % of the neck length. Reproductive system didelphic, amphidelphic, ovaries reflexed. Vulva post-equatorial, a transverse slit with sclerotized *pars refringens*. Tail conical, ventrally bent, tail tip weakly rounded, caudal glands and spinneret absent.

Male: Not found.

Distribution

Robat Namaki village, Robat area, Khorramabad County, Lorestan province, Iran, (GPS coordinates: N 33° 36' 31" E 48° 18' 16", altitude 1332 m a.s.l.), in the rhizosphere of Hawthorn (*Crataegus aronia* L.), and Imanabad village, Azna area, Khorramabad County, Lorestan province, Iran, (GPS coordinates: N 33° 23' 11" E 48° 36' 16", altitude 1661 m a.s.l.), in the rhizosphere of Oak (*Quercus libani* L.).

Remarks

Prionchulus muscorum is a very well-known species with worldwide distribution reported from many countries of Europe, Africa, America, Asia and Australia (Andrassy, 2009). In Iran, this species was first observed by Loof *et al.* (1990) in the rhizosphere of Oak; later on, this species obtained from different localities in the country from the rhizosphere of different plants. The present Iranian females fit well with described population by Jiménez Guirado *et al.* (1997) except for having smaller c ratio (13 – 16 vs 16 – 18) and shorter tail (117 – 168 vs 142 – 211.5 μ m). The main features of the specimens, also fit perfectly to those populations described by Winiszewska & Susulovsky (2003) except for shorter buccal cavity (43 – 48 vs 47.6 – 54.3 μ m) and shorter tail (117 – 168 vs 140 – 209 μ m).

***Prionchulus fagi* Zell, 1985**

(Fig. 2)

Measurements

See Table 2.

Distribution

Hamvar-e Kulivand village, Bastam area, Selseleh County, Lorestan province, Iran, (GPS coordinates: N 33° 44' 34" E 48° 10' 04", altitude 1875 m a.s.l.), in the rhizosphere of Hawthorn (*Crataegus aronia* L.).

Remarks

P. fagi was first described by Zell, 1985. It was later redescribed based on the type material by Winiszewska & Susulovsky, 2003. In Iran, this species was first observed by Naghavi *et al.* (2016) from Lorestan and Ardabil provinces. The present survey lorestanian population perfectly fit with described specimens by Winiszewska & Susulovsky, 2003.

Conflict of Interest

Authors state no conflict of interest.

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