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Ahmed Malik Jumaah
Department of Plant Protection, College of Agriculture, University of Misan, Iraq

Corresponding Author:
Ahmed Malik Jumaah
Department of Plant Protection, College of Agriculture, University of Misan, Iraq

First record of the species *Criconemoides informis* (Micoletzky, 1922) taylor, 1936 (Nematoda: Criconematoidae*)* in Iraq

Ahmed Malik Jumaah

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Abstract
Known species of plant-parasitic nematodes belonging to the family Criconematidae were identified for the first time during a survey in Misan Province, located in southern Iraq. This study examines and illustrates the morphometric and morphological traits of Iraqi populations of the rediscovered species. It is based on morphological and morphometric data, as well as essential qualities that can aid in taxonomic classification. The Iraqi population of *Criconematoides informis* is characterized by having a R value of 77-79, Rst value of 10-12, VL/VB ratio of 1-1.3, a value of 9.4-10.6, body length ranging from 495.8-560.2 µm, stylet length ranging from 72.2-80.2 µm, labial disc slightly elevated and directed anteriorly, vulval lips bulging but not protruding above the body contour. The morphometric and morphological characteristics of the species match those found in the original descriptions.

Keywords: First record, *Criconematoides informis*, morphometric, morphological, plant-parastic nematodes

Introduction
Ziziphus spina-christi (L.) jujube trees belong to the buckthorn family (Rhamnaceae), which includes about 58 genera, including three important genera, the most important of which is the buckthorn genus. This plant is considered one of the important plants in Asia and Iraq in particular, where there are many species in different regions, and it has an important economic value in some regions of Iraq. Its fruits are edible and it also has other benefits, including using the leaves as fodder, the branches for fencing, and the wood as fuel, for construction and furniture making, and in folk medicine as well (Saied *et al*., 2007) [12].
Plant-parastic nematodes about 15% of nematodes are plant parasites that can feed on different plant organs, only less than 0.01 of the species diversity of these organisms has been described (Abebe *et al*., 2011) [1]. The average annual damage caused by plant parasitic nematodes is estimated at around 12% (Oliveira and Neilson, 2006) [14]. The genus *Criconemoides* belongs to the Criconematidae family, nematodes of this family are external parasites of plant roots. *Criconemoides informis* species have been reported with a wide range of host plants, including cultivated plants, forests, and pastures (Geraert, 2010) [5].

Materials and Methods
Soil samples were collected near the roots of the jujube plant, which is widespread in the agricultural research station affiliated with the College of Agriculture in Misan province. Southeastern Iraq during the year 2023-2024. Where nematodes were extracted from the soil after collecting samples to extract nematodes from the soil, using the tray method (Whitehead and Hemming, 1965) [15].
After nematode extraction, the collected samples were killed with a hot 4% formaldehyde solution, and transferred to anhydrous glycerin according to De Grisse (1967) [3] Method. The nematodes were then attached to one very small drop of glycerin on permanently Slides. Observations and measurements were taken this was done using an Optika-LUX optical microscope equipped with a drawing tube. The good samples containing the preserved nematode specimens were photographed using an Olympus CX21 digital microscope connected to a specialized camera.

By using important features such as the shape of the head and its position in relation to the body, the shape of the stylet and its knots and other features, as well as the most important morphometric and morphometric indices used to identify nematodes at the species level (Geraert, 2010) [5].

Results and Discussion

Criconematoides informis (Micoletzky, 1922) Taylor, 1936 (Figs 1)

Measurements see (Table 1)

Description female: After stabilization, the body bends slightly towards the stomach. The cuticular annuli retrorse with rounded edges, ranging in thickness from 6-10 µm. The females head is round has two rings, be most Anterior loop variant, often directed laterally, the submedian lobes are relatively distinct large and the angle of the labial disc is slightly elevated above the lobes and often absent. Lip region of anteriorly flattened and comprised often of two annuli and second labial annulus larger than the first one. First annulus (22.7-24.5) µm, second annulus (24.9-27.5) µm in diam. The stylet strong and knobs thick, anteriorly concave, also with marginal processes directed anteriorly ,its conical part covers more than three-fourths of the total stylet length. The primary esophageal tube is fused with the mid-esophageal bubble, the middle bubble with a distinct valve, the secondary tube is short, and the terminal bubble is small. Excretory pore 1-2 annuli posterior to pharyngeal bulb base. The reproductive system has an ovary that extends towards the front of the body, the end of the ovary does not reach the esophagus, the genital opening is closed, the direct vagina is an empty sperm storage bag. Tail tapering to a narrow tip and with two or three irregular indistinct lobes.

Male: Not found.

Juvenile: Two juveniles found good for measuring. The body of the larva is similar to that of the female. The cuticular annuli has large rings, their surface is slightly convex and not completely smooth.

Remarks

Micoletzky (1922) described *Criconematoides informis* from the soil around the roots of aspen (Populus Tremuloides Michx.) at Idaho Springs, Clear Creek, and Colorado. Various authors have frequently reported the species across North America, Europe, and Asia. Hosseinvand *et al*. (2023) [7] identified different species within the Criconemoides informis group: *C. informis*, *C. amorphous* De Grisse, 1967 [3]; *C. parainformis* Munawar *et al*., 2020 [10]; *C. neoinformis* Hosseinvand *et al*., 2023, and *C. geraerti* Munawar *et al*., 2020 [10]. The morphological and morphometric characteristics of the rediscovered species *Criconematoides informis* (Micoletzky, 1922) Taylor, 1936, match those of the original description. The morphological and morphometric traits of the examined population were analyzed using the identification key for species of the genus *Criconemodies* sp. provided by Geraert in 2010 [5]. The population of iraqin is identified by a round head with two rings. The head is mostly anteriorly rounded with variable annuli. The female has a stylet length of 69.3-76.2 µm, while juveniles have a length of 76.4-78.3 µm. The height of the stylet knob is 4.4-5.1 µm with a width of 8.3-8.9 µm in females, and 4.1-4.8 µm in height and 8.0-8.6 µm in width for juveniles. When comparing the Iraqi population of *Criconematoides informis* with the same species from other countries, similarities were observed in characteristics and measurements. It can be differentiated from *C. amorphous* De Grisse, 1967 [3] by the tapered shape of the tail, which has a narrow tip and two or three irregular indistinct lobes, as opposed to a unilobed or multi-lobed terminus. Describe *C. amorphous* De Grisse, 1967 [3] based on the R ratio (77-97 vs 55-76) and the range of Rex ratio (23-24 vs 17-22). Additionally, Munawar *et al*. (2020) [10] noted differences between *C. geraerti* specimens with juveniles present versus absent, including variations in pharynx length ratio (125-127 vs 100-109) and stylet length (69.3-76.2 vs 57.0-62.7). The species *Criconematoides informis* was found in 7.26% of soil samples taken from the rhizosphere of *Ziziphus spina-christi* (L.) jujube trees, consisting of 6 females and 2 juveniles. The species under investigation was obtained from an agricultural research station associated with the College of Agriculture in Misan province, Southeastern Iraq. The GPS coordinates are 31.8088306°N, 47.2393417°E. This study is the first to reveal the presence of the species *Criconematoides informis* in Iraq. Additionally, it is the first documented case of this species being isolated from jujube trees worldwide.

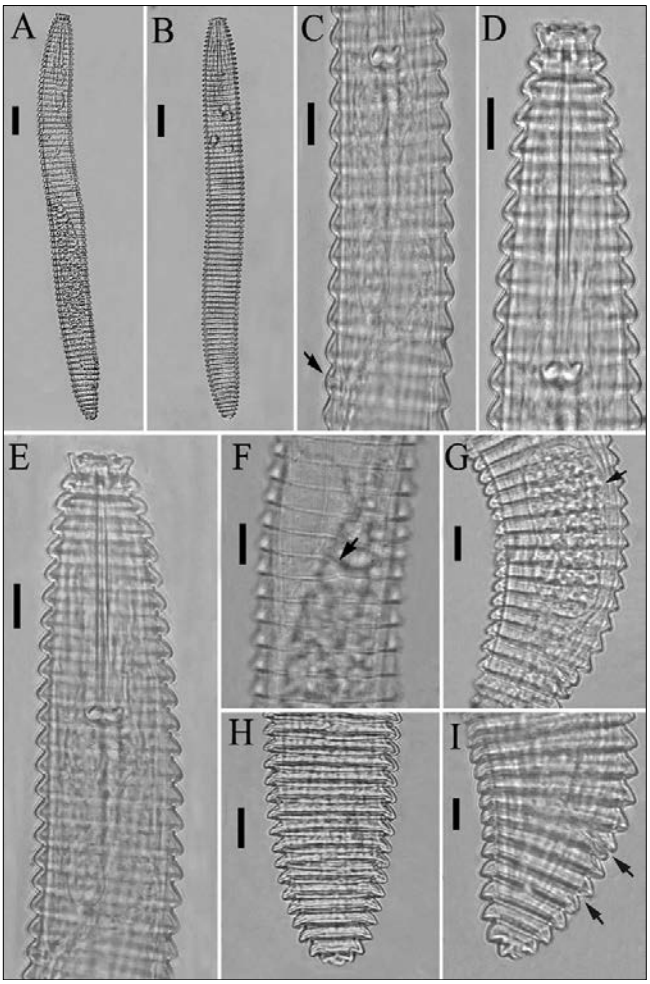

Fig 1: Light microscopy of *Criconematoides informis* (Micoletzky, 1922) Taylor, 1936 from Iraq. (A) Female entire body; (B) Juvenile entire body; (C, D) Anerior body region; (E) Median bulb and terminal bulb (the arrow indicates the excretory pore); (F, G) Mid-body; (H, I): Posterior body region. (Scale bars: A and B, 50 µm; C-I, 10 µm).

Table 1: Morphometrics of *Criconematoides informis* (Micoletzky, 1922) Taylor, 1936 from Misan province, Iraq. All measurements are in micrometer and in the form: mean ± s.d. (range)

Characters	*C. informis* Present study Tabolin *et al*., (2020) [13]		
	Females	Juvenile Females	
n	6	2	12
L	532.2±23.7 (495.8-560.2)	(523.8-550.2)	454.6±53.9 (390-540)
a	9.8±0.6 (9.4-10.6)	(10.4-11.2)	8.7±0.8 (8.0-10.4)
b	3.5±0.3 (3.3-3.9)	(3.8-4.2)	3.5±0.3 (3.1-3.8)
c	19.7±0.9 (18.4-21.2)	(19.8-20.4)	18.4±2.1 (15.6-21.4)
o	6.7±0.7 (6.2-7.8)	(6.4-6.8)	-
DGO	6.1±0.3 (5.7-6.5)	(6.2-6.6)	-
V	86.4±0.5 (82.4-88.7)	(6.2-6.6)	-
Stylet length	77.6±2.4 (72.2-80.2)	(80.8-81.4)	77.3±3.5 (69.0-87.5)
m	79.2±2.4 (77.2-81.6)	(75.3-76.4)	-
Stylet Knob height	4.8±0.2 (4.4-5.2)	(4.1-4.8)	-
Stylet Knob width	8.6±0.2 (8.3-8.8)	(8.0-8.6)	-
Excretory pore from anterior end	180.6±4.2 (176.5-185.7)	(172.2-173.8)	-
Diam at mid- body	50.2±1.8 (48.3-51.5)	(50.0-50.6)	-
Diam at anus (ABD)	33.1±0.6 (32.2-35.4)	(30.2-30.8)	-
Diam at vulva	41.3±0.6 (40.8-42.9)	-	-
First lip annulus diam	12.9±0.2 (12.2-13.9)	(11.2-11.4)	-
Second lip annulus diam	17.3±0.6 (16.2-18.5)	(15.2-15.8)	-
First body annulus width	23.8±0.6 (22.7-24.5)	(20.4-20.9)	-
Second body annulus width	26.8±1.6 (24.9-27.4)	(23.2-23.5)	
Pharynx length	127.8±0.6 (125.7-128.5)	(127.3-127.8)	-
Annulus width	10.2±0.6 (9.7-10.8)	(8.8-9.0)	-
Tail length	20.8±0.6 (19.8-21.9)	(18.7-19.2)	25.0±2.1 (20.0-27.5)
R	78.0±0.9 (77-79)	(76)	63.6±0.9 (62-65)
RSt	10.6±0.8 (10-12)	(11)	11.3±0.8 (10-13)
ROes	14.8±0.4 (13.8-15.7)	(11-12)	19.2±0.9 (17-20)
Rex	21.5±0.6 (21-22)	(22)	20.9±0.6 (20-21)
RV	7.2±0.7 (6-8)	-	6.5±0.7 (6-8)
RVan	2.6±0.3 (2-3)	-	-
Ran	3.5±0.5 (3-4)	(3)	3.5±0.5 (3-4)
VL/VB	1.2±0.1 (1.1-1.3)	-	1.2±0.1 (1.1-1.3)
St % L	15.1±0.2 (14.6-15.2)	(13.2-13.4)	-

Conclusion

The discovery and subsequent study of plant-parasitic nematodes from the family Criconematidae in Misan Province, southern Iraq, mark a significant milestone in the field of nematology and biodiversity. This research not only expands our knowledge on the geographic distribution of *Criconematoides informis* but also provides a detailed account of its morphometric and morphological features specific to the Iraqi populations. By comparing these characteristics with those outlined in the original species descriptions, this study reaffirms the taxonomic placement of *C. informis* and highlights the consistency of its defining traits across different geographical regions. The identification of such species within Iraq not only contributes to the global catalog of biodiversity but also emphasizes the importance of regional studies in understanding the complex interactions between parasitic nematodes and their plant hosts. This work lays the groundwork for future research on the ecological impacts and management strategies of plant-parasitic nematodes, thereby aiding in the development of more sustainable agricultural practices.

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