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Three known species of the genus *Parahadronchus* – First report from Mizoram, India

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Abstract: Mononchs play a vital role in reducing phytophagous nematode population. The present study deals with the diversity of *Parahadronchus* in Mizoram. Various soil samples were collected from different parts of Mizoram along with the GPS location. Upon processing and examination, three known species of the genera *Parahadronchus* were found, viz., *Parahadronchus siroii*, *Parahadronchus marami* and *Parahadronchus shakili*. *P. siroii* is distinguishable from *P. shakili* in its smaller body, short oesophagus, lesser number of vulval papillae, small lip, etc. *P. marami* has narrower buccal cavity, thinner body with three subventral denticles. *P. shakili* has larger body, broader buccal cavity with 3-6 subventral teeth.

Keyword: Mononchida, *Parahadronchus*, Mizoram, India

I. INTRODUCTION

Jairajpuri proposed the order Mononchida based on its strongly developed feeding apparatus, cylindrical pharynx, etc **[1]**. *Parahadronchus* of the family Iotonchidae and subfamily Hadronchinae was coined by Mulvey, characterized by barrel shaped buccal cavity with dorsal tooth at posterior half of buccal cavity, tuberculate pharyngo-intestinal junction and long tail **[1, 2, 3]**. In the present study, species of the genus *Parahadronchus*, collected from various soil samples from different parts of Mizoram, India are reported.

The paper is organised into five sections. Section – I is concerned with introduction while Section – II involves related work. Methodology followed during the study is grouped in section – III. Section – IV contain results and discussion while Section – V includes conclusion and future scope.

II. RELATED WORK

The relationship of plant nematodes to the soil and their diversity are potential bio-indicators **[4]**. Plant-parasitic nematode diversity and population dynamics in mulberry plants was well studied in Manipur **[5]**. Mononchid nematodes represent predatory forms feeding on plant-parasitic nematodes **[6]**. Toxicity in *Parahadronchus shakili* by components like pH and biomolecules such as amino acids were well studied **[7]**. Similarly population dynamics of *Parahadronchus shakili* was also performed **[8]**.

III. METHODOLOGY

About 500gm of soils from each locality were collected from different parts of Mizoram tagged with GPS location and other required information. The samples were then processed in the laboratory by sieving and decanting method as given by Cobb **[9]**. It was followed by Thorne's modified Baermann's funnel technique **[10]**. Live nematodes were then collected, removed excess water then fixed in warm FA (4:1). Dehydration was then performed by rapid glycerine method given by Seinhorst **[11]**. Photographs were taken by means of Nikon Eclipse E200.

IV. RESULTS AND DISCUSSION

After careful and thorough examination, following species of *Parahadronchus* were observed.

1. *Parahadronchus shakili* (Table 1 & Figure 1) **[1, 2]**

Description:

Female: Body arcuate ventrally with length 2.54-2.7(2.63±0.05)mm and width 71.13-86.44 (79.71±5.51)µm. Body cuticle 2.23-2.97(2.45±0.3)µm. Lip region width is 45.2-51.37 (47.64±2.27)µm and height 12.31-16.79(15.32±1.77)µm. Buccal cavity is sclerotized and large with the dimension of 53.98-58.83(56.52±1.89)µm in length and 40.13-44.71 (42.45±1.74)µm in width. Dorsal tooth apex at 22.42-26.61(23.74±1.67)µm from base of the stoma or at 40-45% of the buccal length, from anterior end to nerve ring at 160.09-173.25 (168.59±5.05)µm. Oesophago-intestinal junction tuberculate and at 21-22% of the body length from anterior end. Vulva at 55-56% of body length. Vulva with 0-3 pre and 0-3 post papillae. Reproductive system is amphidelphic with reflexed ovary. Rectum length is similar to the length of anal body length, 44.03-51.53(46.80±2.9)µm. Tail long and filiform and about 11-13 times that of ABD. Caudal gland is tandem with ventrally opening spinneret.

Male: Body description similar to that of females. Tail however is shorter, 408.71-487.78 (454.76±33.57)µm. Spicule 76.72-83.20(80.52±2.76)µm, lateral guiding piece between 8.39-13.19 (10.2±2.12)µm, gubernaculum 6.91-14.37 (11.03±3.09)µm and supplements 9.

Habitat and locality:

Collected from around the roots of *Ananas* sp. from Lungleng, 23°39'31.9"N 92°40'43.1"E, *Vigna* sp. from Tlang roadside, 23°43'04.2"N 92°41'04.4"E, unknown grass from lungleng, 23°39'56.6"N 92°39'40.8"E of Aizawl district and from around the roots of *Ageratum* sp. from Lunglei, 22°39'34.6"N 92°40'04.5"E, Lunglei district, Mizoram, India.

Specimens:

Females on slide MZ2PSH 1-4 and males on slides MZ2PSHM 1-3 were submitted in the repositories of Nematode Collection Centre, Parasitology Section, Zoology Department, Manipur University, Canchipur, Imphal, Manipur, India.

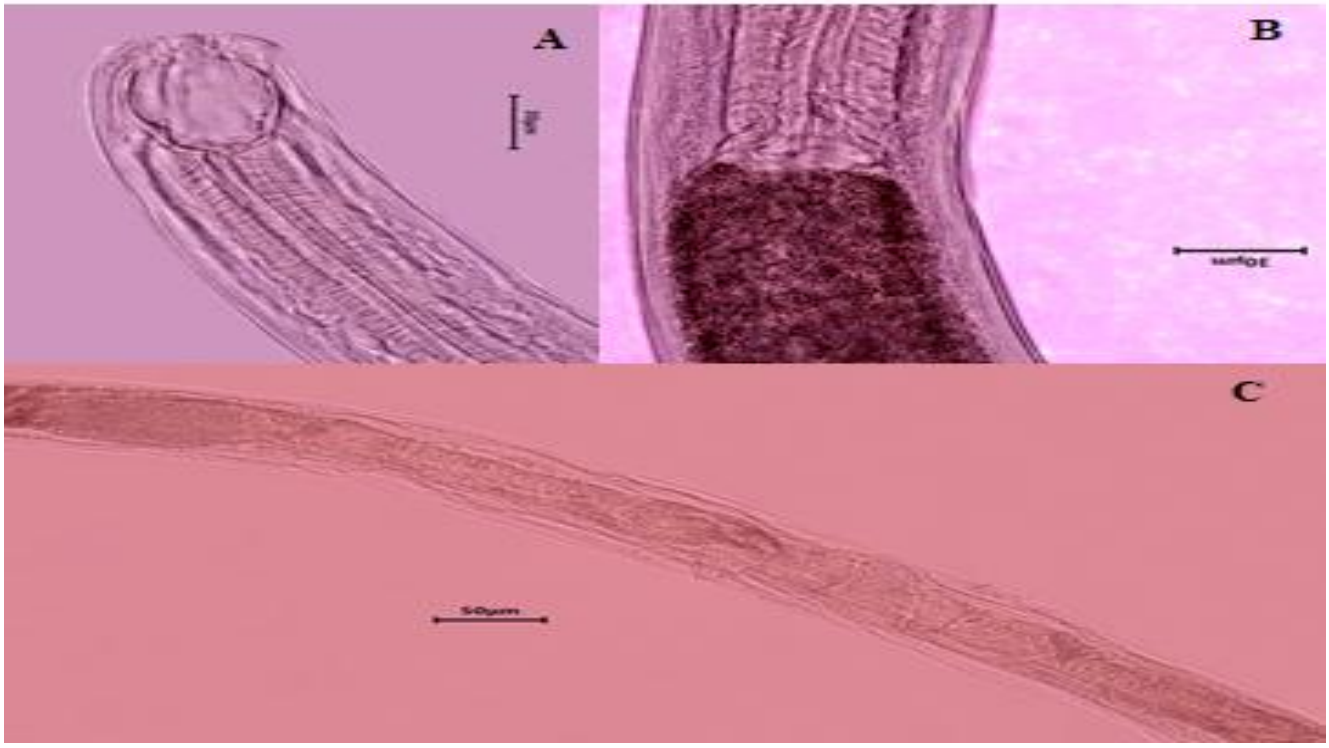
Remarks:

The above body description matches with that of the original description of *Parahadronchus shakili*. However, lip region is slightly smaller than the original description. In males, spicule is slightly shorter and supplement is lower in number than the original description. These deviations in characters may be due to differences in habitat, topology and climatic conditions.

Table 1: Parameters of *Parahadronchus shakili*

Sl. No.	Character	Female	Male
1	N	4	3
2	L	2.54-2.7 (2.63±0.05)	2.21-2.36 (2.29±0.06)
3	a	31.34-35.76 (33.2±1.61)	25.44-33.78 (30.24±3.51)
4	b	4.45-4.63 (4.52±0.06)	4.06-4.71 (4.35±0.26)
5	c	4.76-4.95 (4.84±0.07)	4.77-5.42 (5.07±0.26)
6	c'	10.95-12.64 (11.65±0.61)	6.93-9.44 (8.48±1.1)
7	G_1	11.75-12.10 (11.9±0.12)	
8	G_2	8.22-10.24 (9.44±0.76)	
9	V	55.83-56.80 (56.36±0.35)	
10	Body width	71.13-86.44 (79.71±5.51)	68.95-87.18 (77.01±7.58)
11	Anterior end to oesophago-intestinal junction	548.98-601.05 (582.82±20.08)	493.93-551.27 (530.35±25.85)
12	Anterior end to vulva	1432.06-1512.64 (1486.93±32.02)	
13	Anterior gonad length	307.83-322.81 (314.06±5.56)	
14	Posterior gonad length	222.86-271.17 (248.84±17.19)	
15	Tail length	513.14-564.45 (543.99±19.58)	408.71-487.78 (454.76±33.57)
16	Rectum	41.46-44.80 (42.82±1.23)	52.70-59.36 (54.96±3.10)
17	ABD	44.03-51.53 (46.80±2.9)	51.49-58.96 (54.02±3.49)

(All measurements in µm except L in mm)



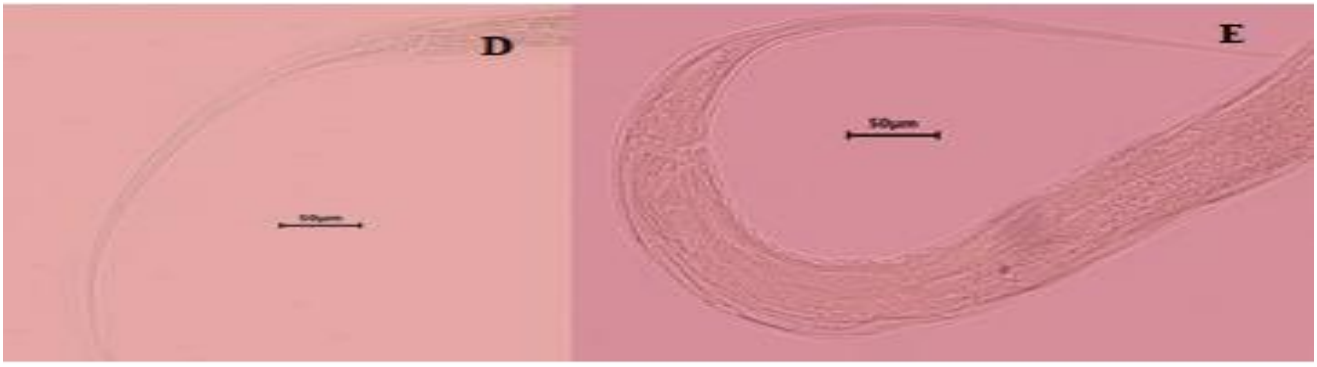


Figure 1: *Parahadronchus shakili.* A – Female anterior end, B – Female oesophago-intestinal junction, C – Female reproductive system, D –Female tail, E – Male tail

Parahadronchus siroii (Table 2 & Figure 2) **[12]**

Description:

Female:
The fixed specimens are ventrally arcuate with body length 2.18-2.65 (2.47±0.21)mm and width 67.41-71.28(69.02±1.64)µm. Body cuticle is smooth 1.86-2.96(2.42±0.44)µm. Sclerotized buccal cavity present with dorsal tooth at posterior half of buccal cavity. Buccal cavity has a dimension of 48.81-52.98(50.39±1.84)µm in length and 31.28-36.67 (33.38±2.35)µm in width. Dorsal tooth apex from stoma base at 22.89-23.55(23.27±0.28)µm or between 44-47% of the buccal cavity length from stoma base. 3-4 small denticles are arranged in two ridges on ventral wall of the buccal cavity. Nerve ring from anterior end is at 147.78-172.78(157.27±11.05)µm. Transverse vulva with short and thick vagina, amphidelphic system, sphincter between oviduct and uterus, reflexed ovaries present. Length of rectum almost similar to length of anal body width, 36.52-44.75(40.8±3.36)µm. Tail long and filiform with a length of 567.07-594.61(581.88±11.33)µm. Caudal gland in tandem with terminal spinneret.

Male: Body posture similar to that of female. Subventral wall of buccal cavity bears 4 small denticles arranged in two ridges. Spicule with a length of 72.31µm, lateral guiding piece is 12.16 µm long, gubernaculum 21.47 µm long and ventromedian supplements are 9.

Habitat and Locality:

Soil samples were collected from around the roots of *Hyparrhenia* sp., 23°41'17.8"N 92°35'45.1"E of Reiek, Mamit district, roots of *Piper* sp. from Sellind, Sitauwl district, 23°43'49.5"N 92°47'43.3"E and unknown grass from lungleng, 23°39'56.6"N 92°39'40.8"E of Aizawl district, Mizoram, India.

Specimens:
Females on slides MZ2PS1-3 and male on slide MZ2PSM1 were submitted in the repositories of Nematode Collection Centre, Parasitology Section, Zoology Department, Manipur University, Canchipur, Imphal, Manipur.

Remarks:
The characters mentioned above are similar to that of *Parahadronchus siroii*. Body length slightly shorter, longer buccal cavity, longer dorsal tooth apex than the original description. Rectum and ABD are also longer than original description. These deviations may be due to differences in habitat, topographical features and climatic conditions.

Table 2: Parameters *of Parahadronchus siroii*

Sl. No	Characters	Female	Male
1	N	3	1
2	L	2.18-2.65 (2.47±0.21)	1.9
3	a	32.43-38.14 (35.95±2.51)	34.24
4	b	4.26-4.82 (4.55±0.220	4.38
5	c	3.85-4.47 (4.26±0.28)	4.56
6	c'	12.10-16.28 (14.19±1.7)	12.09
7	G_1	12.3-16.54 (13.81±1.920	
8	G_2	12.61-16.45 (13.98±1.74)	
9	V	53.40-57.24 (55.69±1.65)	
10	Body width	67.41-71.28 (69.02±1.64)	55.56
11	Anterior end to oesophago-intestinal junction	512.11-580.38 (544.47±27.98)	433.50
12	Anterior end to vulva	1169.05-1500.33 (1387.46±154.47)	
13	Anterior gonad length	326.98-361.80 (339.29±15.94)	
14	Posterior gonad length	335.31-359.88 (343.93±11.28)	
15	Tail length	567.07-594.61 (581.88±11.330	416.99
16	ABD	36.52-44.75 (40.8±3.36)	34.49

(All measurements in µm except L in mm)

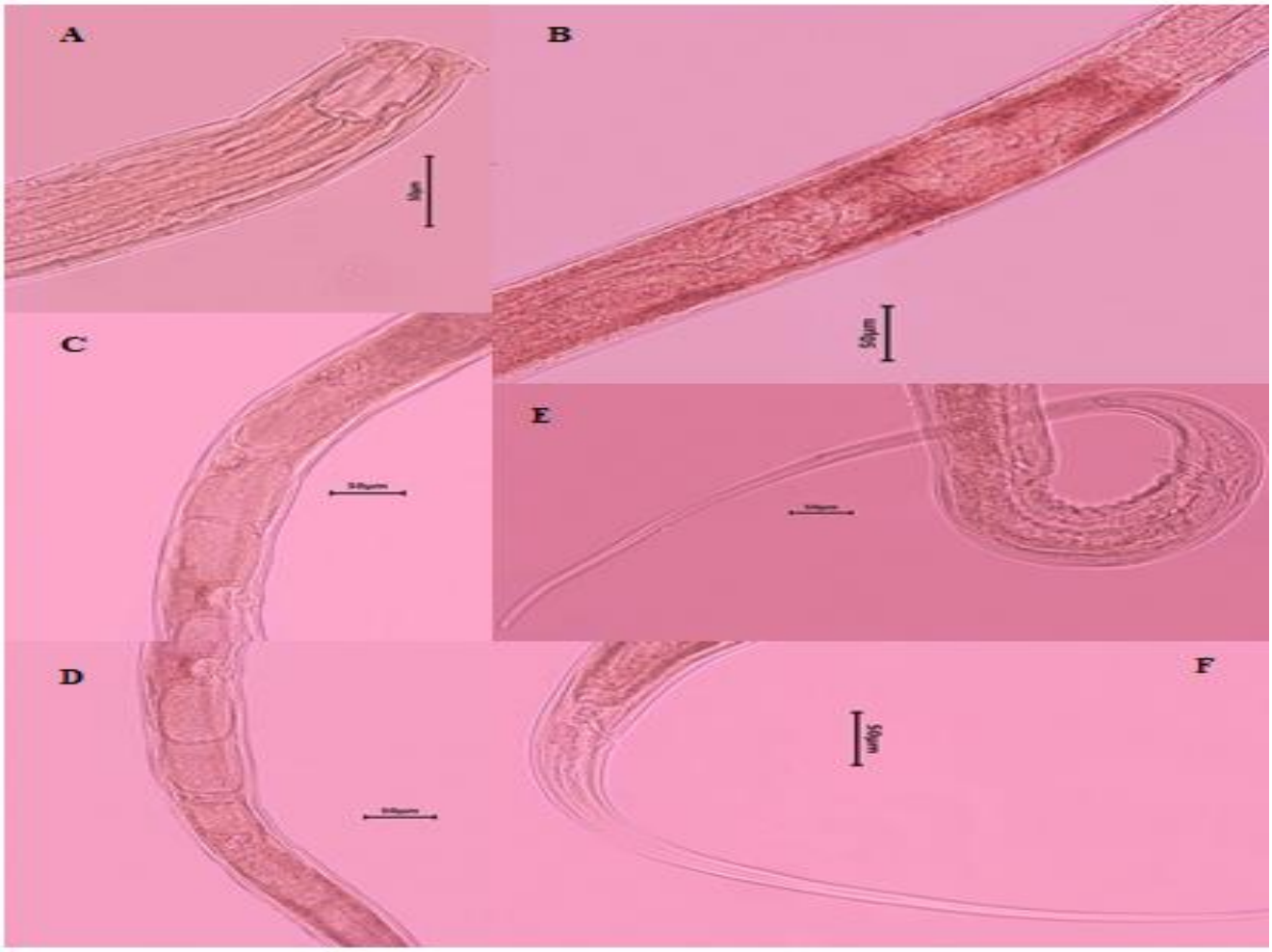


Figure 2: *Parahadronchus siroii*. A – Female anterior end, B – Intestine with digested nematodes, C – Anterior gonad, D – Posterior gonads, E – Male tail region, F – Female tail region

Parahadronchus marami (Table 3 & Figure 3) **[12]**

Description:

Female:

Upon fixation body becomes ventrally arcuate with length 2.03-2.36 (2.21±0.13)mm, body thickness of 61.23-73.42(68.62±5.3)µm and smooth cuticle 1.49-3.86 (2.54±0.98)µm. Lip region slightly larger than adjoining body parts, its width 37.20-41.50 (39.79±1.86)µm and height 12.07-15.27(13.28±1.41)µm. Buccal cavity large, measuring 45.10-51.08(49.02±2.77) µm in length and 31.09-37.16(33.64±2.57)µm. The apex of the dorsal tooth from base of stoma 19.25-23.78(22.2±2.08) µm or at 45-46% of the length of buccal cavity from stoma base. 3 denticles or teeth present on subventral walls arranged along two ridges. Nerve ring from anterior end at 154.96-179.41(164.84±10.51)µm. Excretory pore has a diameter of 2.29-3.73(3.15±0.62)µm and situated 8.59-9.53(9.04±0.38)µm from the nerve ring. Transverse vulva with thick-walled vagina present. Amphidelphic reproductive system is also characterized by presence of reflexed ovaries. Rectum almost similar to ABD, 40.84-46.84 (43.19±2.61)µm. Tail long 453.02-501.29(482.77±21.24)µm, filiform with tandem caudal organ and subventral spinneret.

Male: Not found

Habitat and locality:

The specimens were obtained from around the roots of *Ananas* sp., from Lunleng, 23°39'31.9"N 92°40'43.1"E, roots of an unknown tree from Mizoram University Campus near Multipurpose Hall, 23°44'17.2"N 92°40'02.8"E of Aizawl district and roots of *Saccharum* sp. from 23°43'38.1"N 92°48'11.2"E of Sitauwl district, Mizoram, India.

Specimen:

Females on slide MZ2PM1-3 were submitted in the repositories of Nematode Collection Centre, Parasitology Section, Department of Zoology, Manipur University, Canchipur – 795003, Manipur, India.

Remarks:

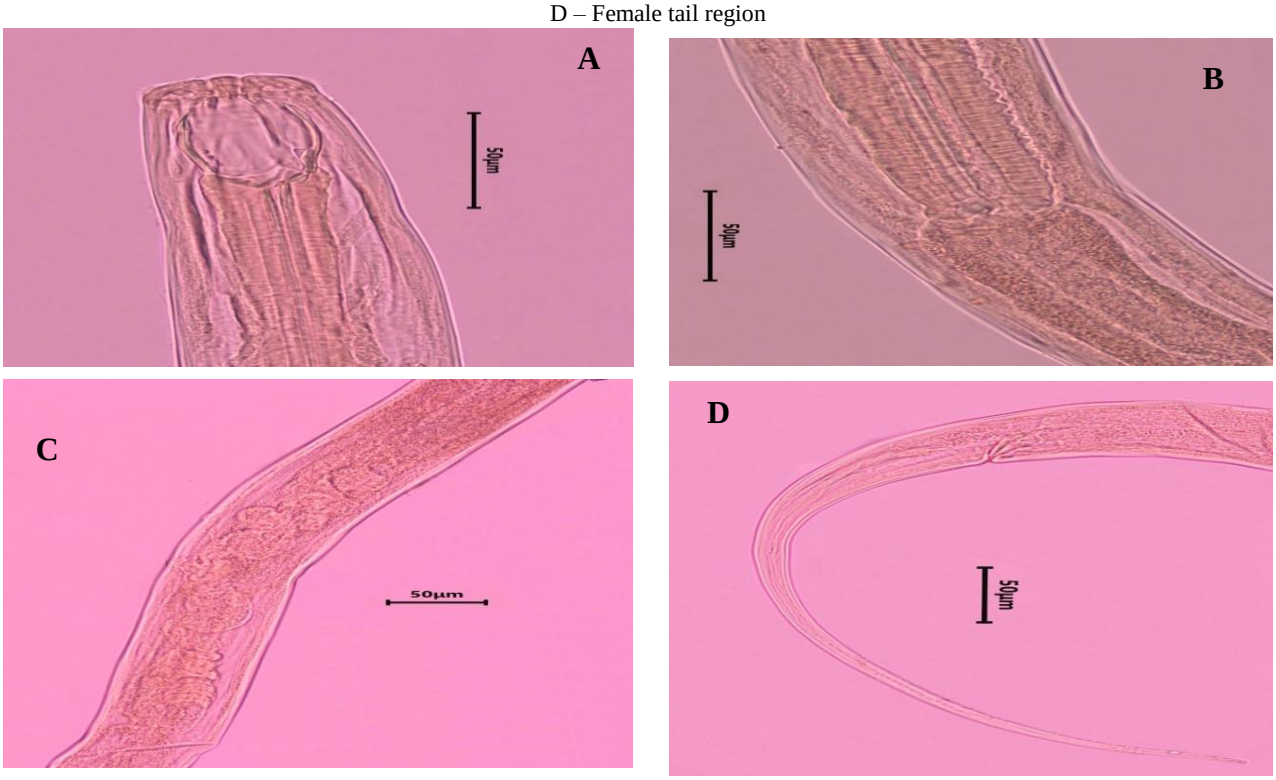
The above description matches the characters of *Parahadronchus marami*. However body width is slightly larger, nerve ring location from anterior end is shorter and tail slightly longer than its original description. These differences may be due to differences in habitat, topography and climate conditions.

Table 3: Dimensions of *Parahadronchus marami*

Sl. No	Characters	Female
1	N	3
2	L	2.03-2.36 (2.21±0.13)
3	a	28.64-36.62 (32.47±3.260
4	b	4.37-4.50 (4.41±0.04)
5	c	4.5-4.71 (4.58±0.09)
6	c'	10.70-11.78 (11.19±0.44)
7	G_1	10.95-12.25 (11.41±0.59)
8	G_2	10.92-11.22 (11.11±0.13)
9	V	54.91-56.11 (55.35±0.53)
10	Body width	61.23-73.42 (68.62±5.3)
11	Cuticle	1.49-3.86 (2.54±0.98)
12	Anterior end to oesophago-intestinal junction	466.30-524.42 (497.06±23.84)
13	Anterior end to vulval opening	1120.14-1325.58 (1226.67±84.04)
14	Anterior gonad length	223.52-289.46 (253.46±27.250
15	Posterior gonad length	222.86-265.21 (246.55±17.65)
16	Tail length	453.02-501.29 (482.77±21.24)
17	Rectum	40.29-41.52 (40.93±0.5)
18	ABD	40.29-41.52 (43.19±2.61)

(All measurements in µm except L in mm)

Figure 3: *Parahadronchus marami.* A – Female anterior end, B – Female oesophago-intestinal junction, C – Female reproductive system, D – Female tail region



Discussion:

The dimensions and descriptions of *Parahadronchus shakili*, *Parahadronchus siroii* and *Parahadronchus marami* with slight deviations matches with the original descriptions given by the respective authors. Deviation in *P. shakili* includes smaller lip region, shorter spicule and lesser number of supplements. Also in *P. siroii* body length is shorter and buccal cavity, rectum and ABD are longer. Similarly in *P. marami* body width is larger, nerve ring location shorter and longer tail is present. Topological features like altitude, hill slope, edaphic factors like soil pH, soil components, etc., host plant, temperature, water availability, etc., may attribute to such deviations.

V. CONCLUSION AND FUTURE SCOPE

Three known species of *Parahadronchus* reported as first record from Mizoram. Morphological characters supported with photomicrographs are also presented. The characters are in conformity with those given by **[1,2,7]**. The study shows the rich diversity of mononchid nematodes in Mizoram. However, there is greater chance of discovering other diverse forms of mononchs in Mizoram with further studies.

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AUTHORS CONTRIBUTION

All authors in the present study made substantial contributions towards collection of soil samples, analysis of the collected samples, identification, classification, acquisition of data and interpretation.

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AUTHORS PROFILE

S. Sushilkumar, M.Sc. (Zoology), SLET-NE, Research Scholar, Department of Zoology, Manipur University has extensively worked in the field of Nematology for the past few years. He has travel to various parts of India in pursuit of new research and scientific work. He has presented oral and poster presentation in few National Seminars and Symposiums. S. Sushilkumar has also participated in few hands-on-training programs and workshops related to his research works.

S. Mexico completed his M.Sc. (Zoology) in 2014 and received the coveted Dr. Th. Gobardhan Singh memorial Gold Medal for securing highest mark in Zoology. He is currently pursuing Ph.D degree under the supervision of Prof. N. Mohilal in the field of Nematology. S. Mexico has travelled and participated few training programs and workshops. He has presented few research related oral and poster presentations in National Seminars and Symposiums.

Dr. N. Mohilal is currently serving as professor in the Department of Zoology, Manipur University, Canchipur, Manipur. He has also taught many undergraduate classes in few UGC recognised colleges of Manipur. Dr. N. Mohilal has participated in several National and International Conferences, Seminars, Workshops, etc. He has extensively worked in the field of Nematology and have in his credit more than 100 research articles in National and International Journals, more than 30 chapters in Books and Proceedings, 4 books, 2 monographs and several miscellaneous publications.

