

# *Paragnomoxyala papillifera* sp. nov. (Nematoda: Monhysterida) from the Bohai Sea, China\*

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Received Mar. 2, 2020; accepted in principle Apr. 9, 2020; accepted for publication May 16, 2020

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**Abstract** A new free-living marine nematode species of the family Xyalidae from Laizhou Bay of the Bohai Sea, China is described and illustrated herein. *Paragnomoxyala papillifera* sp. nov. is characterized by large funnel-shaped buccal cavity, circular amphidial fovea located posterior to buccal cavity, straight spicules with slightly curved distal end, gubernaculum absent, four papilliform precloacal supplements, tail conico-cylindrical with two ventral embossments in males and having longitudinal rows of cervical setae and subventral caudal setae in males. The new species is easily identified from other two recorded species in the genus by having papilliform precloacal supplements and ventral embossments along conical portion of tail of males. A pictorial key for three species of *Paragnomoxyala* and comparative table of three species with important characteristics are provided.

**Keyword:** free-living marine nematodes; taxonomy; new species; Laizhou Bay

## 1 INTRODUCTION

To date, the full scope of nematodes diversity in the sea areas of China is largely unknown due to insufficient investigations. Taxonomical studies on free-living marine nematodes in China have been carried out mainly in the Yellow Sea, the East China Sea and the South China Sea. Only few studies have been performed in the Bohai Sea. In order to study the biodiversity of free-living marine nematodes in the Bohai Sea, sediment samples were collected in many sites from intertidal to sublittoral regions in these habitats. Up to now, only 56 nematode species have been described in the Bohai Sea (Sun et al., 2019). Among these species, fourteen species were described as new to science. Recently, an unrecorded species was identified and is described here as *Paragnomoxyala papillifera* sp. nov.

Genus *Paragnomoxyala* was erected by Jiang and Huang (2015) based on diagnosed characters of cuticle striated, buccal cavity large, funnel-shaped and extended anteriorly, four cephalic setae, labial sensillum not setiform, amphidial fovea circular, spicules slightly straight, gubernaculum absent, tail

conico-cylindrical with three terminal setae. At present, two species, *Paragnomoxyala breviseta* Jiang & Huang, 2015 and *Paragnomoxyala macrostoma* (Huang & Xu) Sun & Huang, 2017 were recorded around the world (Bezerra et al., 2018).

## 2 MATERIAL AND METHOD

Undisturbed sediment samples were obtained from intertidal beach of Laizhou Bay using a sawn-off syringe with a 2.6-cm inner diameter in October 2016. The samples were taken to a depth of 8 cm and divided into three sections, (i.e. 0–2, 2–5, and 5–8 cm), then fixed with 10% formalin in seawater for long-term preservation.

In the laboratory, sorting and mounting of nematodes were carried out as already indicated in our previous papers (Huang et al., 2019; Qiao et al., 2020). The descriptions were made from glycerin

\* Supported by the National Natural Science Foundation of China (No. 41676146)

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**Table 1 Individual measurements of *Paragnomoxyala papillifera* sp. nov. (in  $\mu\text{m}$  except *a*, *b*, *c*, *c'*, and *V*%)**

Character	Holotype			Paratype		
	♂1	♂2	♂3	♀1	♀2	Juvenile
Total body length	831	849	851	909	898	865
Maximum body diameter	25.0	25.3	23.0	33.6	32.4	28.0
Head diameter	10.1	9.8	10.1	11.6	11.2	13.0
Length of cephalic setae	3.3	3.1	3.0	2.9	2.4	2.5
Diameter of amphid	4.4	4.9	4.1	3.1	4.1	4.0
Length of buccal cavity	7.0	7.0	6.5	7.0	6.0	7.0
Width of buccal cavity	7.0	6.5	6.5	6.0	5.5	7.0
Pharynx length	181	185	186	203	206	210
Body diameter at the base of pharynx	23.6	23.0	22.4	30.0	29.0	26.0
Nerve ring from anterior end	90.0	–	–	96.0	–	–
Body diameter at nerve ring	21.0	–	–	24.0	–	–
Length of spicule along arc	19.4	19.4	17.8	–	–	–
Cloacal or anal body diameter	18.8	18.8	19.0	22.7	22.0	20.0
Tail length	121	121	121	146	143	135
Vulva from anterior end	–	–	–	594	574	–
Vulva body diameter	–	–	–	33.6	32.4	–
<i>V</i> %	–	–	–	65.3	63.4	–
<i>a</i>	33.0	33.6	36.8	27.1	27.7	30.9
<i>b</i>	4.6	4.6	4.6	4.5	4.4	4.1
<i>c</i>	6.9	7.0	7.0	6.2	6.3	6.4
<i>c'</i>	6.4	6.4	6.4	6.4	6.5	6.8

*V*%: position of vulva from anterior end expressed as a percentage of total body length; *a*: body length / max. body diameter; *b*: body length / pharynx length; *c*: body length / tail length; *c'*: ratio of tail length to cloacal or anus body diameter; – means no data.

mounts using a differential interference contrast microscope (Leica DM 2500). Line drawings were made with the aid of a camera lucida. All measurements were taken using Leica LAS X version 3.3.3, and all curved structures were measured along the arc or median line. Type specimens were deposited in the Marine Biological Museum of the Chinese Academy of Sciences, Qingdao.

Variables of measurement used in this paper: *a*: the ratio of body length to maximum body diameter; *b*: ratio of body length to pharynx length; *c*: ratio of body length to tail length; *c'*: the ratio of tail length to cloacal or anus body diameter; *V*%: position of vulva from anterior end expressed as a percentage of total body length.

### 3 SYSTEMATICS

Order Monhysterida Filipjev, 1929

Family Xyalidae Chitwood, 1951

Genus *Paragnomoxyala* Jiang & Huang, 2015

Updated diagnosis. Xyalidae. Cuticle transversely striated; large funnel-shaped buccal cavity without teeth, lips extended anteriorly; labial sensilla papilliform, four cephalic sensilla setiform; amphidial fovea circular;

slender spicules slightly straight; gubernaculum absent; precloacal supplements present or absent; tail conico-cylindrical with three terminal setae.

*Paragnomoxyala papillifera* sp. nov. (Figs.1&2).

#### 3.1 Type material

Three males, two females and a juvenile were obtained from Laizhou Bay. Holotype ♂1 on slide WF-23-4-6. Paratypes ♂2 on slide LZW-9B2-2-12, ♂3 on slide LZW-9B1-1-3, ♀1 on slide WF-23-2-2, ♀2 on slide LZW-9B1-2-7 and juvenile on slide WF-23-4-6.

#### 3.2 Type locality and habitat

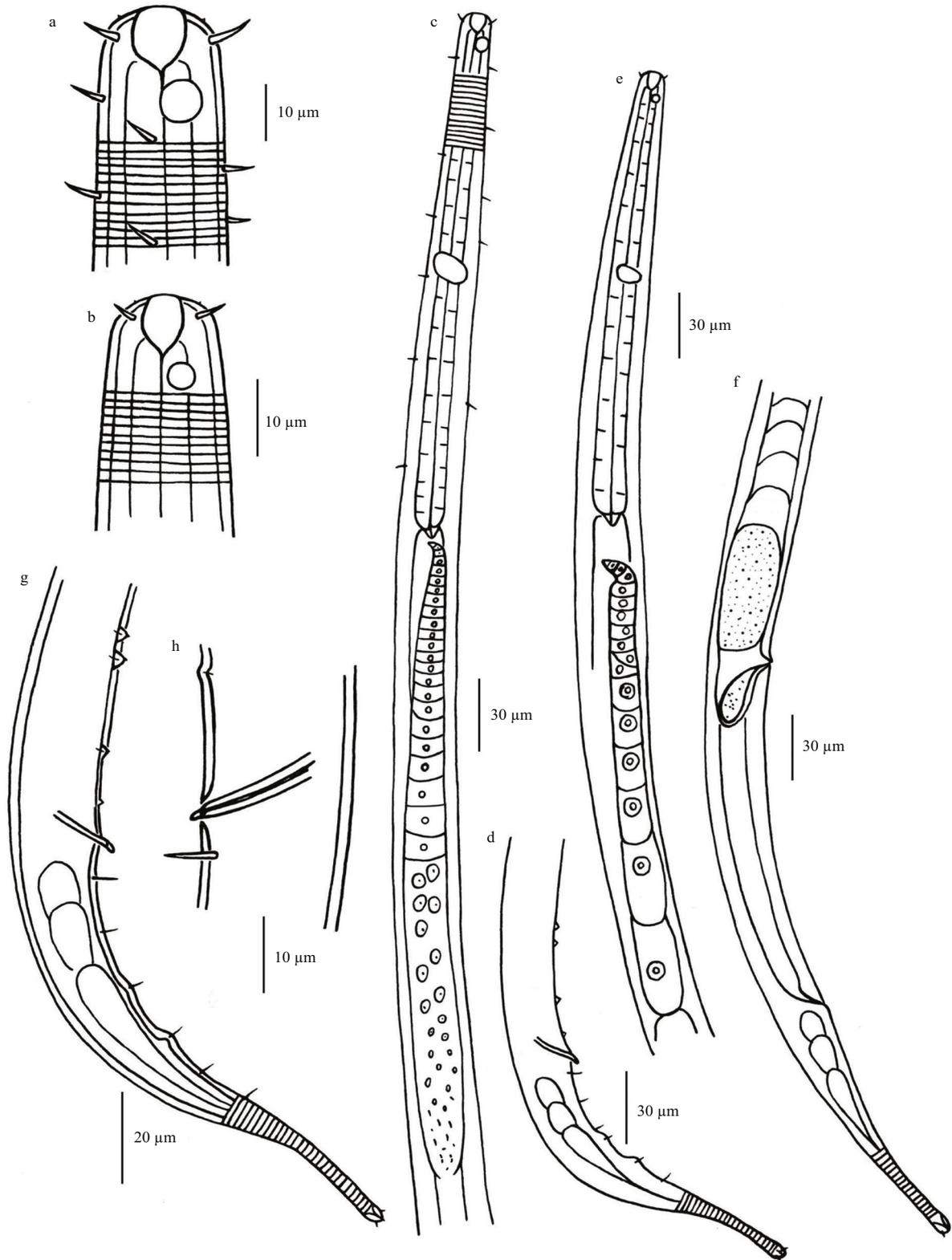
Specimens were collected from the intertidal silt sediment (0–2 cm surface layer) along the coast of Laizhou Bay (37°13'17"N, 119°10'34"E).

#### 3.3 Etymology

The species name is derived from the Latin *papillifera* and refers to having papilliform precloacal supplements in males.

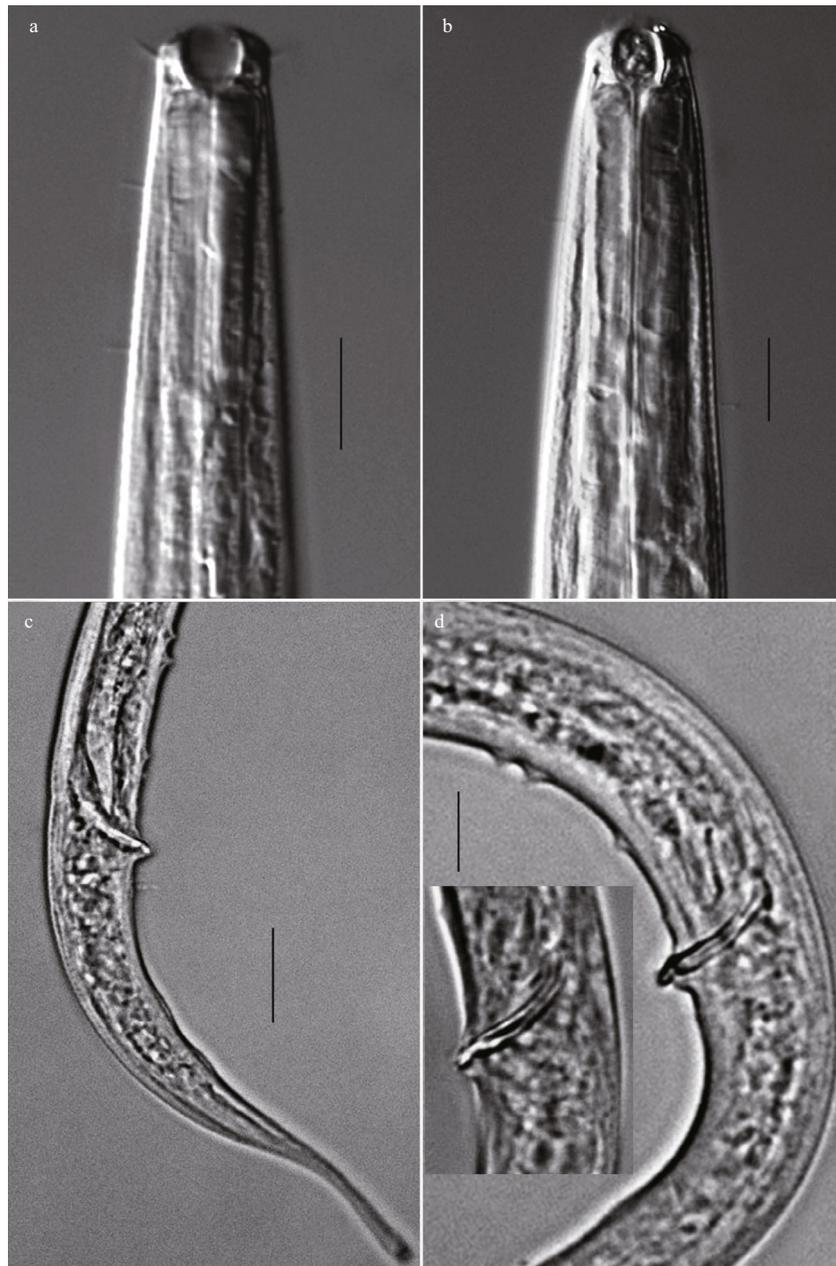
#### 3.4 Measurement

All measurement data are given in Table 1.



**Fig.1** *Paragnomoxyala papillifera* sp. nov.

a. anterior end of male, showing buccal cavity, cephalic setae, amphideal fovea and cervical setae; b. anterior end of female, showing buccal cavity, cephalic setae and amphideal fovea; c. entire view of male (anterior portion); d. entire view of male (posterior portion); e. entire view of female (anterior portion); f. entire view of female (posterior portion); g. tail end of male, showing spicules, precloacal supplements, caudal ventral embossments and caudal setae; h. cloacal region of male, showing spicules, precloacal supplements and postcloacal seta.



**Fig.2** *Paragnomoxyala papillifera* sp. nov.

a. anterior end of male, showing buccal cavity and cephalic setae; b. anterior end of female, showing buccal cavity; c. tail end of male, showing precloacal supplements and caudal ventral embossments; d. cloacal region of male, showing spicules and precloacal supplements (scales bar: a, b, d: 10  $\mu$ m; c: 20  $\mu$ m).

### 3.5 Description

**Males.** Body slender, cylindrical, gradually tapering towards both extremities. Total body length is 831–851  $\mu$ m, maximum diameter is 23.0–25.3  $\mu$ m. Cuticle transversely striated, beginning at base of buccal cavity and ending at tail tip. Inner and outer labial sensilla papilliform, four cephalic setae, 3.0–3.3- $\mu$ m long. In the pharyngeal region of the body some short setae more or less arranged in six longitudinal rows. Buccal cavity large, funnel-shaped with slightly

cuticularized walls, without tooth, 6.5–7- $\mu$ m long and 6.5–7- $\mu$ m wide (i.e. 60% of corresponding body diameter wide). Amphidial fovea circular, being 4.1–4.9  $\mu$ m in diameter (about 35% of corresponding body diameter), situated at 7  $\mu$ m from anterior end. Secretory-excretory system not observed. The nerve ring is located at the middle of pharyngeal length, and surrounded the pharynx at 48% of its length from the anterior. Pharynx cylindrical, slightly expanded towards the base, about 181–186- $\mu$ m long. Cardia small, conical. Tail conico-cylindrical, 121- $\mu$ m long,

with two ventral embossments along the conical portion. The two embossments are 12- $\mu\text{m}$  apart, and the proximal one is 37- $\mu\text{m}$  from the cloaca. Cylindrical portion of tail occupies a third of total tail length, with a swollen tip. Three terminal setae very short, 2- $\mu\text{m}$  long. Two longitudinal rows of subventral caudal setae present. The longest postcloaca setae is 6- $\mu\text{m}$  long. Three caudal glands well developed.

Reproductive system with monorchid, one anterior outstretched testis stretches forward to the pharyngeal base. Spicules are paired, equal and almost straight, only curved at distal end, about one cloacal or anal body diameter long. Gubernaculum is absent. Four papilliform precloacal supplements, uneven arrangement. The most proximal one is 44  $\mu\text{m}$  from the cloaca, the second one is 39  $\mu\text{m}$  from the cloaca, the third one is 17  $\mu\text{m}$  from the cloaca, and the distal one small, just in front of the cloaca.

Females. Similar to males in most morphological characters except with slightly smaller buccal cavity and amphid size, lacking cervical setae, tail without ventral embossments and caudal setae. Buccal cavity 7- $\mu\text{m}$  long and 6- $\mu\text{m}$  wide (i.e. 50 % of corresponding body diameter wide). Amphidial fovea is 3.1–4.0  $\mu\text{m}$  in diameter (i.e. 24%–31% of corresponding body diameter), situated at 8  $\mu\text{m}$  from anterior end. Reproductive system monodelphic, a single anterior outstretched ovary to the left side of intestine, and stretching forward close to the pharyngeal base. Vulva situated posterior to mid-body (63.4%–65.3% of body length from anterior end).

Juvenile. Similar to males in most morphological characters, especially in having large buccal cavity (7- $\mu\text{m}$  wide and 7- $\mu\text{m}$  long).

### 3.6 Differential diagnosis and discussion

*Paragnomoxyala papillifera* sp. nov. is characterized by having longitudinal rows of cervical setae and subventral caudal setae in males, large funnel-shaped buccal cavity, circular amphidial fovea located posterior to buccal cavity, straight spicules with slightly curved distal end, gubernaculum absent, four papilliform precloacal supplements, tail with two ventral embossments along conical portion of tail in males.

*Paragnomoxyala papillifera* sp. nov. is different from other known species in the genus mainly by precloacal papilliform supplements and caudal ventral embossments present or absent, cervical setae and caudal setae present or absent in males. *Paragnomoxyala papillifera* sp. nov. differs from *P. macrostoma* (Huang and Xu) Sun & Huang (2017) in having four papilliform precloacal supplements and two caudal ventral embossments (versus lacking of any supplements in *P. macrostoma*), cervical setae and caudal setae present in males (versus absent), amphid posterior to buccal cavity (versus amphid located at level with buccal cavity base). In the same way, the present species distinguishes *P. breviseta* Jiang & Huang, 2015 by lacking of any supplements and cervical, caudal setae and having large cylindrical buccal cavity in the latter species. Further difference between the new species and other congeners can be inferred from Table 2 and the pictorial key (Fig.3).

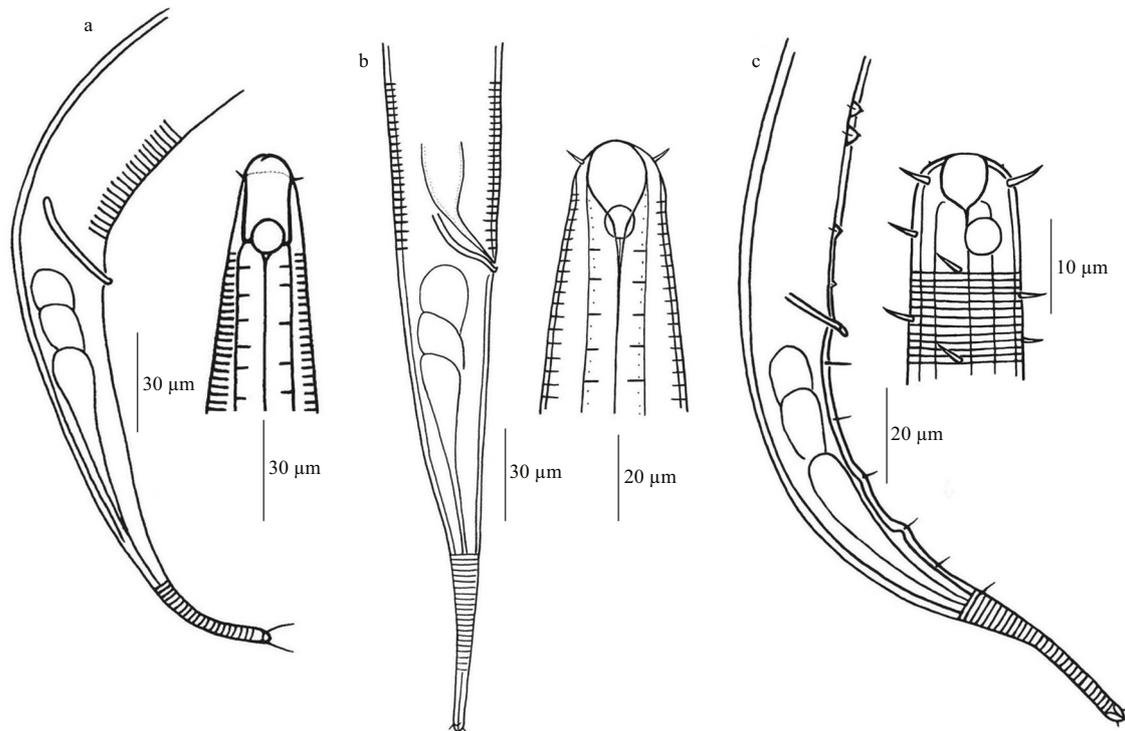
### 4 DATA AVAILABILITY STATEMENT

The authors declare that the data supporting the findings of this study are available within the article.

**Table 2 Comparative table of three species with important characteristics**

Item	<i>P. breviseta</i>	<i>P. macrostoma</i>	<i>P. papillifera</i> sp. nov.
Body length ( $\mu\text{m}$ )	720–1 140	1 045–1 348	831–909
Maximum body diameter ( $\mu\text{m}$ )	21–52	43–63	23–33.6
<i>a</i>	20.3–23	20.6–25	27.6–36.8
Oral shape	Cylindrical	Funnel-shaped	Funnel-shaped
Length of buccal cavity ( $\mu\text{m}$ )	11–26	14–16	6–7
Width of buccal cavity ( $\mu\text{m}$ )	5–11	12–16	6–7
Cervical setae	Absent	Absent	Present
Position of amphid	Level with oral base	Level with oral base	Poster to oral base
Length of spicules ( $\mu\text{m}$ )	25–30	25–30	17.8–19.4
Precloacal supplements	Absent	Absent	Present
Subventral caudal seta	Absent	Absent	Present

*a*: body length / maximum body diameter.



**Fig.3 Comparison of the morphological features of males for three species of *Paragnomoxyala***

a. *P. breviseta*; b. *P. macrostoma*; c. *P. papillifera* sp. nov.

The data will be available on request from the corresponding author.

## 5 ACKNOWLEDGMENT

The authors are greatly thankful to four anonymous referees for their reviewing and improving the manuscript.

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