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A new Notocotylid trematode *Paramonostomum bagodaroi* n .sp. (Trematode: Notocotylidae) in Mallard *Anas platyrhynchos* (Anseriformes: Anatidae) in Sindh, Pakistan.

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Abstract

A new Notocotylid tremtode *P. bagodaroi* n. sp. (Trematode: Notocotylidae) collected from the host *Anas platyrynchos* (Anseriformes: Anatidae) of Kambar Shahdadkot of Sindh, Pakistan. A total of five species of the genus *Paramonostomum* Luhe, 1909 including *P. bubaki* Birmani *et al*., 2013; *P. bilqeesae* Ghazi *et al*., 2013, *P. macrovesiculum* Dharejo *et al*., 2006; *P. kuntzi* Bhutta and Khan, 1975 and *P. orientalis* Bhutta and Khan, 1975 have been reported from Pakistan. Present species differs from its congeners on the basis of body shape, more elongated cirrus sac, postbifurcal genital pore, distribution of vitellaria and posttesticular space. Name of new species refers to locality of the host bird.

Keywords: Notocotylid trematode, *Paramonostomum bagodaroi*, *Anas platyrhynchos*, Sindh, Pakistan.

Introduction

Members of family Notocotylidae Lühe, 1909 are found in digestive tract of birds and mammals. Genus *Paramonostomum* has been subdivided in various ways. Lal (1936) separated it into two subgenera, coining the name *Paramonostomum* and *Neoparamonostomum*. Harwood (1939) and later authors have not accepted the validity of Lal's divisions. Yamaguti (1971) recognized two sub genera, *Paramonostomum* and *Paramonostomoide*s. Groschaft and Tenora (1981) did not accept these as valid because of overlapping characters. Jones, Bray and Gibson (2005) also followed Groschaft and Tenora (1981). The genus *Paramonostomum* is cosmopolitan in distribution occurring in intestinal tract of birds mainly Anseriformes, Ciconiiformes, Charadriiformes, Galliformes, Gruiformes and mammals (Jones, Bray and Gibson, 2005). Species of this genus report from Pakistan includes *Paramonostomum bubaki* (Birmani *et al*., 2013) collected from *Fulica atra*, *P. bilqeesae* (Ghazi *et al*., 2013) collected from *Anas crecca*; *P. macrovesiculum* (Dharejo *et al*., 2006) collected from *fulica atra*; *P.kuntzi* (Bhutta and Khan, 1975) from *Gallinula chloropus* and *P. orientalis* (Bhutta and Khan, 1975) collected from Kraig.

Trematodes of migratory birds are poorly known in Pakistan (Dharejo, Bilqees and Khan, 2006). Few are those of Bhutta and Khan, (1975), Bilqees *et al*., (2003), Birmani *et al.*, (2008, 2009, 2011a, 2011b, 2013a, 2013b, 2015), Dharejo *et al*., (2006) and Ghazi *et al*., (2013). The mallard (*Anas platyrhynchos*) is a member of order Anseriformes (ducks, geese and swans) and is generally bound to open waters and

wetland habitats. Mallard *Anas platyrhynchos* is migratory in nature depends upon variety of food items during migration from Siberia to Asian states. During its stopover habitats it shares variety of food items including small invertebrates, tadpoles, small fishes and all type of plant materials.

Materials and Methods

Live fifty seven Mallard *Anas platyrhynchos* Linnaeus (Anseriformes: Anatidae), collected from different water bodies of Kambar–Shahdadkot District of Sindh, Pakistan during winter season (2014–2015) and examined for the endohelminths. During examination of gut content and visceral organs a total of 30 Notocotylid trematodes belonging to genus *Paramonostomum* were collected from intestine of host birds. Trematodes were put into 0.9% saline, relaxed in hot water, fixed under slight cover glass pressure in alcohol–formaline–acetic acid (AFA), stained with borax carmine, dehydrated in graded series of ethanol solutions, cleared in clove oil and xylol and mounted in Canada balsam. Diagrams are made with help camera Lucida. All measurements are given in millimeter (mm).

Results

Family Notocotylidae Lühe, 1909
Genus *Paramonostomum* Lühe, 1909
Paramonostomum bagodaroi n.sp.

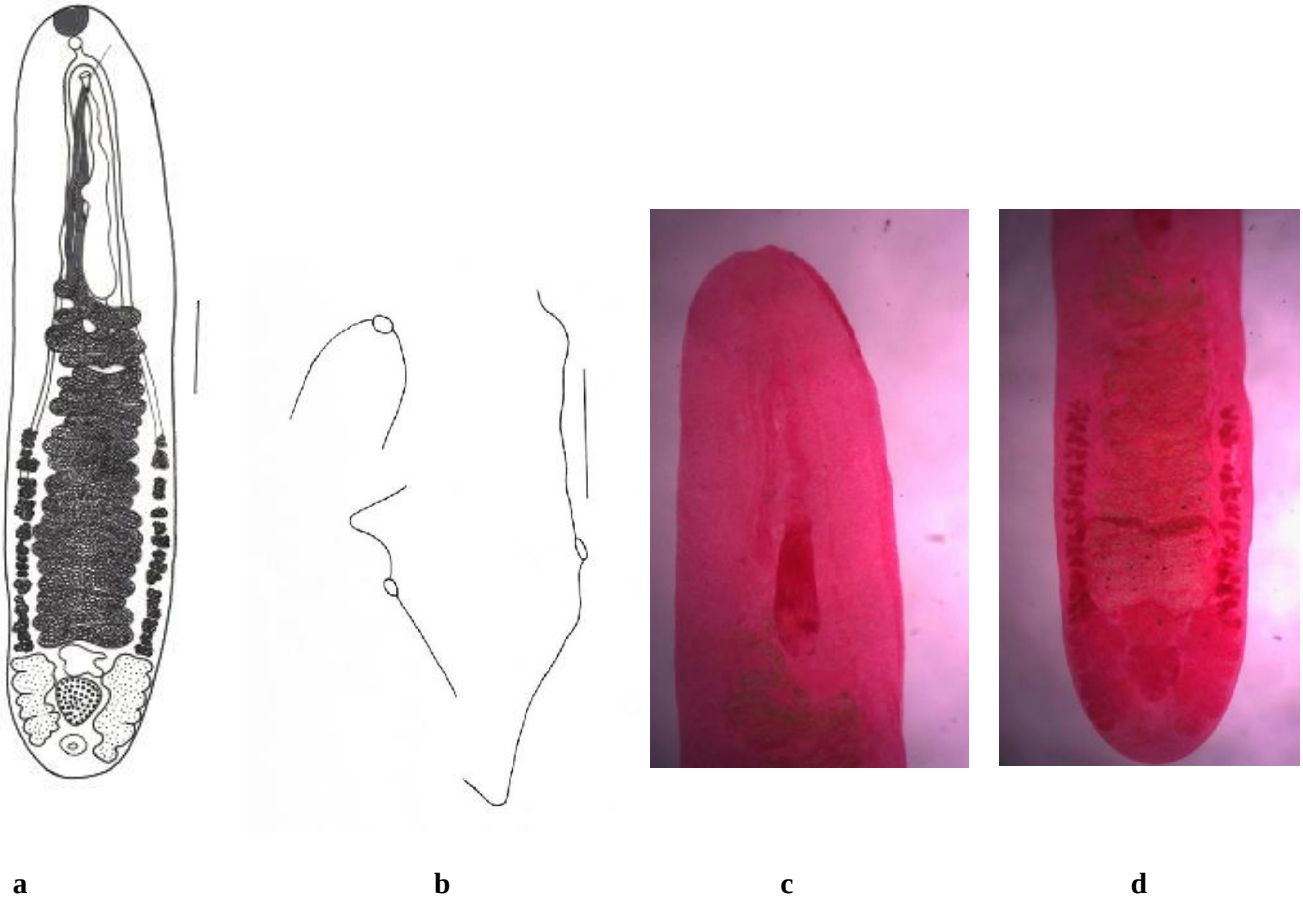

Figure1:*Paramonostomum bagodaroi* n.sp. (a) Entire worm; (b) Filamentous eggs; (c & d) Photographs of anterior and posterior parts of body. *Scale bar:* (a) 0.5mm; b. 0.1mm.

Table: Comparative morphological features of *Paramonostomum* species reported from Pakistan

Species	Present species	*P. bubaki* Birmnai *et al.*, 2013	*P. bilqeesae* Ghazi *et al.*, 2013	*P. macrovesiculum* Dharejo *et al.*, 2006	*P. kuntzi* Bhutta and Khan, 1975	*P. orientalis* Bhutta and Khan, 1975
Body size	1.474–3.964 X 0.408–0.875	2.24–3.26 X 0.80–1.22	1.181–1.94 X 0.35–0.48	1.88–1.98 X 0.71–0.74	1.727–2.575 X 0.696–1.121	2.03 X 1.06
Oral sucker	0.058–0.1607 X 0.091–0.1964	0.160–0.210 X 0.170–0.250	0.12–0.125 X 0.22–0.23	0.018–0.019	0.140–0.153X 0.140–0.160	0.137 X 0.166
Pharynx	0.041–0.089 X 0.041–0.089	0.040–0.110 X 0.030–0.090	Absent	Present	_	Absent
Esophagus	0.041–0.053	0.030–0.130	0.0 9–0.1	0.23–0.25	0.039–0.052	Present
Cirrus sac	0.642 X 0.178	0.740–0.870 X 0.130–0.220	0.11–0.12 X 0.068–0.069	0.23–0.26 X 0.11–0.13	0.313–0.343	0.490 X 0.117
Right testis	0.174–0.553 X 0.083–0.232	0.290–0.510 X 0.120–0.260	0.41–0.48 X 0.17–0.19	0.43–0.50 X 0.26	0.205–0.294 X 0.087–0.225	0.313–0.362 X 0.245–0.264
Left testis	0.166–0.464 X 0.099–0.232	0.270–0.450 X 0.170–0.260	0.31–0.33 X 0.18–0.19	0.45–0.50 X 0.23–0.25	_	_
Ovary	0.083–0.25 X 0.091–0.232	0.170–0.250 X 0.160–0.300	0.22–0.24 X 0.10–0.13	0.25–0.27 X 0.13–0.15	0.117–0.225 X 0.098–0.176	0.235 X 0.225
Seminal receptacle	0.178 X 0.25	0.080–0.210 X 0.120–0.300	0.05–0.07 X 0.09–0.1	Present	_	0.147–0.225
Vitellaria	Vitellaria follicular, situated in posterior half of body, reaching up to testicular level.	From anterior margins of testis up to middle of body.	Vitellaeria is present in posterior half of the body.	From anterior margins of testes up to level of last loops of uterus	Vitellaria occupying extra caecal fields extending anterior level of testes.	Vitellaria occupying extra caecal fields extending anterior level of testes.
Genital pore	Postbifurcal	Bifurcal	Postbifurcal	Postbifurcal	Postbifurcal	Postbifurcal
Uterine loops	23	16	Not mentioned	9–10	13 - 14	16–17
Eggs	0.5 with filmaments, 0.0179 without filament	0.190–0.210 X 0.009–0.0 11	0.025–0.031 X 0.01–0.01	0.07–0.148 X 0.010–0.013	0.018–0.020 X 0.010–0.015	0.015–0.017 X 0.010–0.012
Host	*Anas platyrhynchos*	*Fulica atra*	*Anas crecca*	*Fulica atra*	*Gallinula chloropus*	Kraig
Location	Intestine	Intestine	Intestine	Intestine	Intestine	Intestine
Locality	Pakistan	Pakistan	Pakistan	Pakistan	Pakistan	Pakistan

Description

The body of fluke is long cylindrical, dorsoventrally flattened, measuring 1.474–3.964 X 0.408–0.875 in size. Maximum width at uterine level. Oral sucker muscular, slightly broader than long, measuring0.058–0.1607 X 0.091–0.1964 in size. Esophagus very short, measuring 0.041–0.053 long. Pharynx rounded much smaller, measuring0.041–0.089 X 0.041–0.089 in diameter. Ventral sucker absent. Ovary intertesticular, triangular in shape, measuring0.083–0.25 X 0.091–0.232 in size, situated at the distance of 0.287–0.30 from posterior end. Seminal receptacle pre-ovarian in position, measuring 0.178–0.182 X 0.25–0.30 in size. Seminal vesicle 0.303–0.350 X0.196–0.20 in size. Vitellaria follicular, situated in posterior half of body, reaching up to level of last uterine loop. Uterus is extensive thrown in to 25 tightly packed transverse coils.

Testes irregular in shape longitudinally elongated with deeply indented margins. Right testis larger than left, measuring 0.174 – 0.553 X 0.083- 0.232 in size and left testis0.166–0.464 X 0.099–0.232 in size. Post testicular space is 0.066–0.125 in size. Cirrus sac very long, tubular, about one third of the body size, measuring 0.642–0.680 X 0.178–0.190 in size. Genital pore postbifurcal in position. Eggs small, filamentous, measuring 50–65 X 10–12 and eggs without filaments, measuring 17-18 X 7-12 in size.

Taxonomic summary

Type Host: Mallard *Anas platyrhynchos* (Anseriformes: Anatidae)
Type locality: Kambar Shahdadkot, Sindh, Pakistan
Site of infection: Intestine
Number of sp. recovered: 30 from 57 hosts.
Etymology: specific name refers to village Bagodaro, locality of host bird

Discussion

Genus *Paramonostomum* Lühe, 1909 was proposed to accommodate trematodes of birds. Type species is *Paramonostomum alveatum* (Mehlis in Creplin, 1846) Lühe, 1909 collected from hosts *Actitis macularia, Anas penelope, Anser anser, Branta bernicla, Charadrius wilsonia, Charadrius hiaticula, Clangula hyemalis, Cygnus* sp., *Nyroca marila, Oedemia* sp., and *Somateria mollisima* differs from present species in body shape, smaller size of body; oral sucker, cirrus sac and ovary smaller in size; testes wider; absence of pharynx; deeply lobed ovary and uterus have 6–11 loops.

Paramonostomum species reported from Pakistan include *P. bubaki* Birmani *et al*., 2013 collected from *Fulica atra* differs from present species in having smaller, somewhat lanceolate body; oral sucker, seminal receptacle larger, esophagus, pharynx testes and eggs smaller in size. Uterine loops 16 in number. *P.bilqeesae* Ghazi *et al*., 2013 collected from *Anas crecca* differs from present species in having smaller body size; oral sucker smaller; esophagus longer; pharynx absent; cirrus sac elongated with its anterior end being quite pointed but smaller in size; ovary lobed with irregular walls, smaller in size; seminal receptacle and testes smaller in size and eggs are larger; whereas uterine loops are not mentioned. *P. macrovesiculum* Dharejo *et al*., 2006 collected from *Fulica atra* differs from present species in shape and size of body; oral sucker terminal, smaller; pharynx very small; esophagus longer; testes broadly flattened anteriorly, tapering posteriorly, left testis is pear shaped, smaller; cirrus sac bulb-shaped, smaller; ovary irregular in shape, smaller in size and greater in width; eggs are smaller. *P. kuntzi* Bhutta and Khan, 1975collected from *Gallinula chloropus* differs from present species in oval shaped, smaller body, tapering anteriorly, much broader in between 1st and 2nd third of body; pharynx absent; esophagus, cirrus sac smaller; testes smaller not deeply lobed; ovary with four lobes, smaller in size; larger posttesticular space; ceca undulating; uterine loops 13–14 in number and eggs larger. *P. orientalis* Bhutta and Khan, 1975 collected from Kraig differs from present species in having oval-shaped smaller body, tapering anteriorly; oral sucker smaller, subterminal; pharynx absent; ceca undulating; ovary multilobed, smaller; testes with indented margins, smaller; cirrus sac smaller; larger posttesticular space and eggs smaller.

Other species of genus *Paramonostomum* reported outside Pakistan include *Paramonostomum* sp. reported by Foronda *et al*., 2003 collected from *Fulica atra* differs from present species in shape and body size, comparatively larger pharynx; much lobed smaller testes; ovary with indented margins; larger posttesticular space; distribution of vitellaria up to posterior margins of testes and uterine loops. *P. galli* Tanveer and Chishti, 2001 collected from *Gallus gallus domesticus* of India differs from present species in shape and larger body size; oral sucker rounded, larger, subterminal; pharynx absent; ovary trilobed, larger; testes larger, slightly lobed; genital pore bifurcal; larger post testicular space; number of uterine

loops 12 and eggs larger. *P. kherai* Gupta and Singh, 1985collected from *Casarca ferruginea* and *Dafila acuta* of India differs from present species in having smaller body, tapering anteriorly; oral sucker smaller; esophagus tubular, longer; pharynx absent; genital pore at posterior half of oral sucker; elongated and deeply lobed testes and ovary; shorter posttesticular space; uterine loops 20–23 in number and eggs smaller. *P. makundi* Gupta and Singh, 1985 collected from *Anser indicus* of India differs from present species in having shorter and broader body; pharynx absent; genital pore at posterior level of oral sucker; cirrus sac pear shaped, broader at base, tubular anteriorly; larger and deeply lobed testes; ovary lobed, bifid posteriorly; uterine loops 16–19 in number; shorter posttesticular space and eggs larger. *P. salimi* Gupta and Singh, 1985 collected from *Anas poecilorhyncha* and *Anas platyrhyncha* of India differs from present species in having smaller and broader body; pharynx absent; cirrus sac pear shaped with wavy margins; genital pore behind oral sucker; larger lobed testes and ovary; ceca with wavy margin; uterine loops 17–23 in number and eggs are larger. *P. indica* Gupta and Gupta, 1976 and *P. poecilorhynchai* Gupta and Gupta, 1976 collected from *Anser indicus* and *Anas poecilorhyncha* of India differ from present species in having larger bodies; genital pore behind oral sucker; pharynx absent; short esophagus; seminal receptacle absent; testes and ovary larger and lobed; shorter posttesticular space and uterine loops 17–18 in number. *P. thapri* Gupta and Gupta, 1976 collected from *Nettapus coromandelianus* and *Anser indicus*of India differs in having smaller body, tapering anteriorly and rounded posteriorly; absence of pharynx and seminal receptacle; esophagus short; genital pore behind oral sucker; ceca undulating; larger testes with entire smooth margins, rounded anteriorly and tapering posteriorly; uterine loops 17–19 in number and eggs smaller. *P. kanpurensis* Gupta and Gupta, 1976 collected from *Anser anser* of India differs from present species in having smaller body, tapering anteriorly and rounded posteriorly; esophagus short; pharynx absent; larger lobed testes with slightly indented margins; cirrus sac larger; ovary larger, multilobed; seminal receptacle absent; Uterine loops 19 in number and eggs larger. *P. signiensis* Jones and Williams, 1969 collected from chicks and ducks of South Orkney Island differs from present species in having spinose body; presence of pharynx; esophagus short; bifurcal genital pore; cirrus sac club-shaped; ovary elongated and posteriorly notched; uterine loops 12–15 in number and broad excretory bladder. *P. philippinensis* Velasquez, 1969 collected from chicks and ducks of brackish ponds on Luzon Island differs from present species in having smaller body; pharynx absent; short esophagus; prefurcal genital pore; smaller size and shape of testes and uterine loops 10–12 in number. *P. fulicai* (Baugh, 1958) reported by Tanveer and Chishti, 2001 collected from *Fulica atra* of India differs in having oval, smaller body; pharynx absent; esophagus short; testes elongated, without deep lobes, smaller in size; cirrus sac club shaped; ovary trilobed; uterine loops 12 in number and eggs are smaller.

On the basis of these differentiating characteristics including body shape, more elongated cirrus sac, postbifurcal genital pore, distribution of vitellaria and posttesticular space a new species *P. bagodaroi* is proposed. The name of new species refers to the village bagodaro of Kambar-Shahdadkot of Sindh, Pakistan from where the host was collected.

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