

# Digenetic Trematode Parasites in Two Fresh Water Fishes *Ophiocephalus Punctatus* and *Xenentodon Cancila* From North West Himalayas

Sukanya Rajput (✉ [sukanyarajputjmu@gmail.com](mailto:sukanyarajputjmu@gmail.com))

University of Jammu <https://orcid.org/0000-0002-2748-5787>

Seema Langer

University of Jammu


---

## Research Article

**Keywords:** Trematode, metacercariae, Jammu, digenetic, *Ophiocephalus punctatus*, *Xenentodon cancila*

**Posted Date:** November 17th, 2021

**DOI:** <https://doi.org/10.21203/rs.3.rs-271485/v1>

**License:**  This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

---

**Version of Record:** A version of this preprint was published at Journal of Parasitic Diseases on March 6th, 2022. See the published version at <https://doi.org/10.1007/s12639-022-01473-7>.

## Abstract

The study was conducted during September 2018-August 2019 to study the digenetic trematode infection in fresh water fishes of some of the water bodies viz. Gho-manhasan, Chakrali and Chadwal of Jammu region of J&K union territory. A total of 220 fishes comprising *Ophiocephalus punctatus* and *Xenentodon cancila* belonging to families Channidae and Belontiidae respectively were examined. A total of 4 digenetic trematode parasites belonging to 4 different families i.e., *Euclinostomum heterostomum* (Clinostomidae Luhe, 1901); *Phyllodistomum tripathi* (Gorgoderidae Looss, 1901); *Genarchopsis piscicola* (Hemiuridae, Luhe, 1901), and *Bucephalopsis karvei* (Bucephalidae Poche, 1907) were detected. The overall prevalence of digenetic trematode infection was 65.90% and the mean intensity was 3.58. Among these *Genarchopsis piscicola* showed the highest prevalence (40.38%) with mean intensity 2.95 in the host fish *Xenentodon cancila*, while in other species the prevalence ranged between 26.23% and 34.62%. Present study authenticates the presence of several species of digenetic trematode parasites in the fishes inhabiting freshwater of J&K union territory.

## Introduction

Fish constitutes an important source of food, nutrition, income and livelihood for millions of people around the world. Moreover, fish continues to be one of the most traded food commodities worldwide with more than half of fish exports by value originating in developing countries. Fishes provide a potential habitat to metacercariae of digenetic trematodes. Digenetic trematodes are a diverse group of parasites that use more than one host to complete their life cycle. Avian digenetic trematodes use fishes as secondary intermediate hosts to complete their life-cycles (Bullard and Overstreet 2008). Trematodes are the most diverse group of fish parasite and are present in larval or adult forms in majority of fish species and most of them exist as endoparasites. Digenetic trematode infections cause low weight gain, high mortality and immarketability of the infected fish. Currently, fish-borne zoonotic trematodes are the cause of health problems and also affect the public health in many Asian countries (Murrell *et al.* 2007; Tran *et al.* 2008; Phan *et al.* 2010). The present study was therefore undertaken to ascertain the spectrum of digenetic trematodes from fresh water fishes *Ophiocephalus punctatus* and *Xenentodon cancila* in Jammu region.

## Materials And Methods

A total of 220 fish samples were collected from different freshwater bodies of Jammu region; Gho-manhasan, Chakrali and Chadwal. Collected fish samples were brought alive to laboratory. The gastrointestinal tract, muscle tissue and other internal organs of the host fish were teased in 0.8% saline and examined for the recovery of the metacercarial or adult stage of trematode parasites. Trematode parasites were flattened between two slides or under slight pressure of slide and coverslip, post-fixed in AFA (Alcohol, Formalin and Acetic acid in 85:10:5) and stained with Borax carmine. Afterwards, specimens were dehydrated in ascending series of ethanol, cleared in xylene and finally mounted on glass slides using DPX. Photomicrographs of stained specimens were studied and photographed using microscope Leica M205 C and identified by following the standard literature (Yamaguti 1971; Bray *et al.* 2008; Pandey and Agrawal, 2013). The prevalence of infection and mean intensity were calculated following Bush *et al.* (1997).

No. of hosts infected

Prevalence = \_\_\_\_\_ × 100

Total no. of hosts examined

No. of parasites recovered

Mean Intensity = -----

Total no. of infected hosts

## Results & Discussion

Based on morphological and morphometric criteria the recovered trematode parasites were identified as belonging to genera *Euclinostomum* (Rudolphi, 1809) Travassos, 1928 (Family Clinostomidae Luhe, 1901); *Phyllodistomum* Braun, 1899 (Family Gorgoderidae Looss, 1901); *Genarchopsis* Ozaki, 1925 (Family Hemiuridae (Looss, 1899, Luhe, 1901) and *Bucephalopsis* Diesing, 1855 (Family: Bucephalidae Poche, 1907) all of which are redescribed.

1. *Euclinostomum heterostomum* (Rudolphi, 1806) Travassos, 1928 (Figs)

Host: *Ophiocephalus punctatus* Bloch

Site of infection: Liver, Coelomic cavity, muscles

Locality: Gho-manhasan, Chakrali

Prevalence: 33.62% (39 infected out of 116 host)

Mean intensity: 4.68 (182 parasites were recovered from 39 infected host)

### Description

Cysts of *E. heterostomum* were yellowish and spherical, excretory vesicle, intestinal caeca brownish and are observed on the external surface; excysted metacercariae body elongated, linguiform after fixing measures 4.36-6.54mm×2.18-2.49mm; anterior end of the body truncated and posterior end is rounded; oral sucker sub-terminal, small surrounded by collar-like fold 0.19-0.38mm×0.16-0.27mm; ventral sucker large well developed, almost round measuring 0.712-0.872mm×0.625-0.721mm; Pharynx rudimentary; oesophagus short bifurcates in front of acetabulum; intestinal caeca long with 7-12 lateral diverticulate branching; anterior testis U-shaped 0.115-0.159×0.36-0.462mm; posterior testis Y-shaped 0.218-0.320×0.253-0.374mm; cirrus sac oval, intertesticular; ovary small, round to oval, intertesticular 0.121-0.146×0.140-1.28mm; uterine sac elongated and club shaped; excretory pore subterminal.

### Remarks

The genus *Euclinostomum* was established by Travassos, 1928 which have well developed diverticulated caeca. Moreover, *Euclinostomum* is the type genus of subfamily Euclinostominae, found in the buccal cavity and in the oesophagus of piscivorous birds, primarily herons and egrets. Many reports of metacercarial and adult forms of *E. heterostomum* from freshwater fishes have been studied by several workers across the world (Jhansilakshmi & Madhavi 1997, Britz et al. 1984, Taher 2009, Purivirojkul and Sumontha 2012, Suanyuk et al. 2013, Senapin et al. 2014, Abro et al. 2016, Mansour 2019) from different host fishes. Present fluke exhibits similarities with *E. heterostomum* Rudolphi, 1809, *E. bhagavantami* Jaiswal, 1957, *E. minutus* Bhutta and Khan, 1975 and *E. reticulatum* Sudan, 1979 (Table no.2). In the present fluke oral sucker is subterminal closely resembles to *E. reticulatum* but smaller than *E. bhagavantami* and *E. minutus*. The number of intestinal diverticulae differs in *E. bhagavantami* (9-12), in *E. minutus* (12-15) whereas resembles *E. reticulatum* with 7-12 diverticula. The size of ovary, however show resemblance to *E. minutus* which is quite smaller than that of *E. bhagavantami* and *E. reticulatum*. Thus the present fluke differs from *E. bhagavantami*, *E. minutus* and *E. reticulatum* in body size, size of ovary and testes. The present form closely resembles *Euclinostomum heterostomum* in size and shape of body and various organs which is reported from host fish *Ophiocephalus punctatus* of Jammu region.

### 2. *Phyllodistomum tripathi* Motwani & Srivastava, 1961 (Fig.b)

Host: *Xenentodon cancila* Hamilton

Site of infection: Intestine

Locality: Chadwal

Prevalence: 34.62% (36 infected out of 104 host)

Mean intensity: 2.83 (102 parasites were recovered from 36 infected host)

### Description

Body dorsoventrally flattened, spatulate 1.58-3.72mm long, 0.72-2.04mm maximum width at level of middle region of hindbody; fore-body narrow, elongated 0.89-0.94mm×0.43-0.75mm; hind-body expanded nearly with feebly developed semicircular puckering present on the lateral sides of hind body, 0.95-0.98mm×0.78-0.80mm in size; oral sucker terminal, oval 0.19-0.26×0.20-0.28mm; ventral sucker rounded, pre-equatorial slightly larger and wider than oral sucker 0.22-0.28mm×0.24-0.33mm; prepharynx and pharynx absent; oesophagus straight, narrow 0.12-0.17mm long bifurcates into well developed two intestinal caeca which terminate close to hind body end; testes deeply lobed, intercaecal, post-ovarian; right testis post-equatorial 0.16-0.20×0.14-0.17mm; left testis equatorial 0.22-0.24×0.18-0.20mm; genital pore median, pre-acetabular; ovary submedian, lobed, pretesticular, 0.07-0.12mm×0.06-0.08mm; two compact vitelline glands, right vitelline gland 0.06-0.07mm×0.03-0.04mm and left vitelline gland 0.07-0.08mm×0.04-0.05mm; eggs oval, non-operculate 0.02-0.03×0.01-0.02mm.

## Remarks

The genus *Phyllodistomum* was erected by Braun (1899) for *Distomum folium* Olfers, 1816 as its type species. Based on the narrow and tubular anterior region and spatulated hind body our specimen belonged to the genus *Phyllodistomum*. Different species of the genus *Phyllodistomum* have been reported by several workers (Cribb, 1987; Helt, 2003; Mendoza-Garfias *et al.* 2005; Ho *et al.* 2014) from fishes all over the world including that from India (P.loossi Kaw, 1950; P. indianum Jaiswal, 1957; P. tripathi Motwani and Srivastava, 1961; P. srivastavi Rai, 1964; P. cameroni Agarwal, 1966; P.megacotyle Fotedaar, 1969; P.mansari Sudan, 1979; P. triangulata Sarwat, 2011; P.betwaensis Sen, 2014; P.punctatai Jithila and Prasadana, 2018). The present species resembles with P.loossi in the relative size of suckers, shape and position of vitellaria, uterus and genital pore. It however differs in the absence of any papillae in suckers and the size of eggs which are smaller and more slender in present form. The present species shows similarities with P.betwaensis but different from P.betwaensis in size of body, size of oral and ventral sucker and position of Vitelline glands with respect to ovary (Table no. 3). The present species differ further from P.punctatai, a species reported from urinary bladder of *Channa punctata* in ratio of body length to width, size of oral and ventral sucker and various morphological and morphometry features. Present species resembles P.tripathi in having the lateral margins of hindbody provided with indentations, however differs in some morphological features and morphometry like length to width ratio of body, size and shape of ventral sucker and size of testes and ovary. Since, most of the characteristics of the present species bear a close resemblance with P.tripathi hence the identified as P.tripathi reported from freshwater fish *Xenentodon cancella* of Jammu.

### 3. *Genarchopsis piscicola* Srivastava, 1933 (Fig.c)

Host: *Xenentodon cancella* Hamilton

Site of infection: Stomach

Locality: Chakrali, Chadwal

Prevalence: 40.38% (42 infected out of 104 host)

Mean intensity: 2.95 (124 parasites were recovered from 42 infected host)

## Description

Body cylindrical, more or less fusiform, 1.28-2.57×0.42-0.79mm; oral sucker oval, sub-terminal 0.24-0.38×0.26-0.47mm; ventral sucker equatorial, highly muscular and well developed 0.56-0.79×0.58-0.80mm; prepharynx absent; pharynx 0.03-0.07×0.09-0.12mm; oesophagus absent; testes two, roughly triangular or oval in outline, extra-caecal; right testis 0.16-0.17×0.12-0.14mm; left testis 0.15-0.17×0.13-0.14mm; pars-prostatica tubular and well developed; metraterm absent; genital pore present below pharynx near intestinal bifurcation; ovary 0.13-0.18×0.09-0.15mm posttesticular, oval, median or dextrally placed between testes and vitelline glands two, oval, compact 0.15-0.20×0.08-0.012mm; eggs oval, operculated bear long filaments 0.032-0.035×0.009-0.016mm.

## Remarks

The genus *Genarchopsis* was erected by Ozaki (1925) with *G. goppo* as the type species from the intestine of *Mogurnda obscura*, Japan. Several species of *Genarchopsis* have been reported viz. *G. ovocaudata* Srivastava, 1933 from *Ophiocephalus punctatus*; *G. piscicola* Srivastava, 1933 from *Channa punctatus*; *G. anguillae* Yamaguti, 1938 from *Anguilla japonica* *G. folliculate* Bhadauria and Dandotia, 1954 from *Mastacembelus* sp. and *Channa* sp.; *G. thapari* Dwivedi, 1965 from *Bufo melanostictus*; *G. punctatai* Agarwal, 1966 from *Ophiocephalus punctatus*; *G. cameroni* Kakaji, 1969 from *Mystus seenghala*; *G. cuchiai* Kakaji, 1969 from *Amphipnous cuchia*; *G. avitellarium* Varma and Sahay, 1983 from *Ophiocephalus punctatus*; *G. kalriai* Bilquees and Khan, 1990 from *Channa marulius*; *G. fellicola* Shimazu, 1995 from *Rhinogobius brunneus*; *G. gibsoni* Shaikh *et al.*, 2011 from *Ophiocephalus striatus*. The present parasite resembles closely with *G. piscicola*, *G. goppo* and *G. gibsoni* (Table no. 4). The present form differ markedly from Ozaki's species *G. goppo* in larger body size, size and ratio of suckers, position of genital pore, absence of oesophageal pouch, location of gonads, position of vitellaria and position of ventral sucker. It differs from *G. gibsoni* in various morphological features and morphometry in body size, size of oral and ventral sucker, position and shape of testes and ovary. But the present form shows comes very close to *G. piscicola* in position of oral sucker, size and ratio of suckers, absence of oesophagus, shape and disposition of testes and position of genital pore. The present species is redescribed as *G. piscicola* and reported from different host *Xenentodon cancella* of Jammu region.

### 4. *Bucephalopsis karvei* Bhalerao, 1937 (Fig.d)

Host: *Xenentodon cancella* Hamilton

Site of infection: Intestine

Locality: Chadwal

Prevalence: 26.93% (28 infected out of 104 host)

Mean intensity: 3.92 (110 parasites were recovered from 28 infected host)

## Description

Body small pear-shaped with broader anterior end and a pointed posterior end measuring 0.57-0.98mm×0.31-0.52mm; tegument covered with spines; rhynchus (anterior sucker) large, spherical, terminal, 0.11-0.23mm×0.13-0.20mm; pharynx muscular, oval 0.05-0.06mm×0.04-0.07mm; esophagus tubular opens into digestive cecum; cecum globular sac-like, median 0.06-0.09mm×0.06-0.01mm; testis oval, unequal, anterior testis 0.12-0.14mm×0.08-0.09mm, posterior testis 0.11-0.13mm×0.07-0.09mm; cirrus sac cylindrical, extent from level of testis to posterior of body 0.24-0.28mm×0.05-0.07mm; pars prostatica opens into short ejaculatory duct; ovary oval, pre-testicular, 0.06-0.08×0.07-0.09mm; egg numerous oval, 0.017-0.018×0.009-0.012mm.

## Remarks

Diesing (1855) erected *Bucephalopsis* as subgenus of *Bucephalus* Von Baer, 1827 for *Bucephalus hairreanus* Lacaze-Duthiers, 1834 and was later raised to full generic status by Laebour (1908). Srivastava and Chauhan (1973) treated Bucephaloidea as a junior synonym of Prosorhynchoides and transferred Bucephaloidea sp. to the Genus Prosorhynchoides based on the presence of simple sucker (rhynchus) and a pretesticular ovary in it. Several species of Genus Bucehalopsis (Prosorhynchoides) have been reported from India; these include *P.fusiformis* (Verma, 1936) Srivastava and Chauhan 1973; *P.garuai* Verma, 1936; *P.magnum* Verma, 1936; *P.karvei* (Bhalerao, 1937) Srivastava and Chauhan 1973; *P.thapari* (Dayal, 1948) Bott and Cribb, 2005. Maurya et al., (2018) synonymized *P.lateroporus*, *P.gaurii*, *P.chauhani*, *N.(P.) jhansiansis* and *P.canciliansis* with *P.karvei*. The present form belongs to the genus *Bucephalopsis* Diesing, 1855. Bhalerao (1937) reported *B. karvei* from the intestine of *Xenentodon cancila*. The present adult worms were also recovered in large number from the intestine of *Xenentodon cancila* and closely resemble *B.karvei* in body shape, position of testes and ovary, but differ in some morphological and morphometric characters. The present adult worms differs from *P.garuai*, *P.fusiformis* and *B. thapari* in various morphological and morphometric characters size and shape of body, size of rhynchus, position of ovary and testes and also size and disposition of cirrus sac and uterus (Table no.5). This bucephalid is new locality record observed for the first time in Jammu region, J&K.

## Declarations

**Conflict of interest:** The authors declare that there is no conflict of interest.

**Ethical approval:** No approval by an ethical committee was required to achieve the goals of the present study.

## References

1. Abro MM, Dharejo AM, Khan MM, Birmani NA (2016) *Euclinostomum heterostomum* (Rud., 1809) Travassos, 1928 (Trematode: Clinostomidae: Euclinostominae): A new record in avian host little cormorant (Aves: Phalacrocoracidae) of Pakistan. Journal of advances in Biology and Biotechnology 8(1):1–5
2. Bhalerao GD (1937) Studies on the Helminths of India. Trematoda IV Jour Helminth 15:97–124
3. Bhutta SM, Khan D (1975) Digenetic trematodes of vertebrates from Pakistan. Bulletin of Department of Zoology, University of Punjab (New Series). Pk ISSN, 0079-8045
4. Bray RA, Gibson DI, Jones A (2008) Keys to the Trematoda, vol 3. Natural History Museum, CABI, UK
5. Britz J, Saayman JE, Van JG (1984) Anatomy of the metacercaria and adult of *Euclinostomum heterostomum* (Rudolphi, 1809) (Trematoda: Clinostomatidae). South African Journal of Zoology 19(2):91–96
6. Bullard SA, Overstreet RM (2008) Digeneans as enemies of fishes. In: Eiras JC, Segnar H, Wahli T, Kapoor BG (eds) Fish diseases, vol 2. Science Publishers, Enfield, pp 817–976
7. Bush AO, Lafferty KD, Lotz JM, Shostak AW (1997) Parasitology meets ecology on its own terms: Margolis et al. revisited. J Parasitol 83:575–583
8. Cribb TH (1987) A new species of *Phyllodistomum* (Digenea: Gorgoderidae) from Australian and New Zealand freshwater fishes with notes on the taxonomy of *Phyllodistomum* Braun, 1899. J Nat Hist 21:1525–1538

9. Diesing KM (1855) Neuzehn arten von Trematoden. Akademie Wissenschaften in Wien Mathematisch Naturwissenschaftliche Class 32:307–390
10. Gupta BK (2011) *On some metacercariae and adult trematodes of fishes. Ph.D. Thesis submitted to University of Lucknow, Lucknow.*
11. Helt J, Janovy J, Ubelaker J (2003) *Phyllodistomum funduli* n. sp. (Trematoda: Gorgoderidae) from *Fundulus sciadicus* cope from cedar creek in western Nebraska. J Parasitol 89(2):346–350
12. Ho HW, Bray RA, Cutmore SC, Ward S, Cribb TH (2014) Two new species of *Phyllodistomum* Braun, 1899 (Trematoda: Gorgoderidae Looss, 1899) from Great Barrier Reef fishes. Zootaxa 3779:551–562
13. Jaiswal GP (1957) Studies on the trematode parasites of fishes and birds found in Hyderabad State. Part I–IV. Zool Jber 85:1–72
14. Jhansilakshmi K, Madhavi R (1997) *Euclinostomum heterostomum* (Rudolphi, 1809) (Trematoda): life-cycle growth and development of the metacercaria and adult. Sys Parasitol 38:51–64
15. Jithila PJ, PK Prasad (2018) Prevalence, intensity, mean abundance and description of *Phyllodistomum punctati* n. sp. (Digenea: Gorgoderidae) from the urinary bladder of *Channa punctata* (Bloch) from the Western Ghats, India. Int J Fish Aquat Stud 6:01–05
16. Kaw BL (1950) Studies in Helminthology: Helminth parasites of Kashmir. Part- I Trematoda. Ind J Helminth 2:67–126
17. Mansour RM (2019) First record of *Euclinostomum heterostomum* from the naturally infected heron *Ardeola ralloides* in Egypt: A light and scanning electron microscopy. Egyptian Journal of Zoology (EJZ) 72:22–31
18. Maurya R, Gupta R, Saxena AM (2018) Taxonomic redescriptions and a review of the status of *Prosorhynchoides* spp. (Digenea; Bucephalidae) infecting some freshwater fishes of India
19. Mendoza-Garfias B, de Perez-Ponce G (2005) *Phyllodistomum centropomi* sp. n. (Digenea: Gorgoderidae), a parasite of the fat snook, *Centropomus parallelus* (Osteichthyes: Centropomidae), in the Papaloapan River at Tlacotalpan. Veracruz State, Mexico Zootaxa 1056:43–51
20. Motwani MP, Srivastava CB (1961) On two *Phyllodistomum* from urinary bladder of silurid fishes (Trematoda: Gorgoderidae). Indian J Helminthol 13:93–99
21. Murrell KD, Fried B (2007) World class parasites, vol. 11. Food-borne parasitic zoonoses. Fish and plant-borne parasites. Springer, New York, NY
22. Ozaki Y (1925) On a new genus of fish trematodes, Genarchopsis, and a new species of Asymphyllodora. Japanese Journal of Zoology 1:101–108
23. Pandey KC, Agrawal N (2013) Metacercarial Fauna of India, Rec. zool. Surv. India, Gcc. Paper No., 349: 1-310, (Published by the Director, Zool. Surv. India, Kolkata)
24. Phan TV, Ersboll AK, Bui TQ, Nguyen HT, Murrell D, Dalsgaard A (2010) Fish-borne zoonotic trematodes in cultured and wild-caught freshwater fish from Red River delta, Vietnam. Vector Borne Zoonotic Dis. 10:861–6Suppl 9
25. Purivirojkul W, Sumontha M (2012) *Euclinostomum heterostomum* (Rudolphi, 1809) Metacercarial infection in three osphronemid fish species walailak. Journal of Science and Technology 10(1):97–102
26. Rudolphi CA (1809) Entozoorum sive vermium intestinalium. Historia naturalis. 1, (Amsteold.)
27. Sarwat MS (2011) A new species of genus *Phyllodistomum* (Braun, 1899), (Digenea: Gorgoderidae, Looss, 1901) from freshwater fish *Mastacembelus armatus* Aurangabad (M.S.) India. Recent Res Sci Technol 3:11–13
28. Sen JM (2014) On a New Species of *Phyllodistomum* Braun, 1899 (Digenea: Gorgoderidae), A Parasite of Freshwater Fish, *Channa Punctatus* (BL.) From Betwa River, Bundelkhand Region Jhansi, U.P, India. Current World Environment. ; 9(1):207-209
29. Senapin S, Phiwasaiya K, Laosinchai P, Kowasupat C, Ruenwongsa P (2014) Phylogenetic analysis of parasitic trematodes of the genus *Euclinostomum* found in Trichopsis and Betta fish. J Parasitol 100:368–371
30. Shaikh GS, Khan A, Bilqees FM (2011) A new trematode of the genus Genarchopsis Ozaki, 1925 from freshwaterfish of Sindh, Pakistan. Pakistan J Zool 43(5):903–907
31. Srivastava HD (1933) On new trematodes of frogs and fishes of the United provinces, India Part I Distomes of the family: Hemiuridae from North Indian Fishes and frogs and a systematic discussion on the family Halipegidae and the Genera *Vitellotrema* Guberlet and *Genarchopsis* Ozaki. Bull Acad Sci U P Agra Oudh Allahabad 3(1):41–60
32. Suanyuk N, Mankhakhet S, Soliman H (2013) *Euclino-stomum heterostomum* infection in guppies *Poecilia reticulata* cultured in southern Thailand. Dis Aquat Organ 104(2):121–127
33. Sudan OS (1979) *On studies on trematode fauna of Jammu Province. Ph.D. Thesis submitted to the University of Jammu*
34. Taher GA (2009) Some studies on metacercarial infection in *Oreochromis niloticus* in Assiut Governorate and their role in transmission of some trematodes to dogs. Ass Univ Bull Environ Res 12:63–79

35. Tran TKC, Dalsgaard A, Turnbull JF, Tuan PA, Murrell KD (2008) Prevalence of zoonotic trematodes in fish from a Vietnamese fish-farming community. J Parasitol 94:4238

36. Yamaguti S (1971) Synopsis of digenetic trematodes of vertebrates, vol 1. 2. Keigaku, Tokyo

## Tables

**Table 1: Digenetic trematodes recovered, their host, site of collection and prevalence of infection from Jammu region.**

Name of Host Fish	Name of parasites recovered	Site of host collection	Site of infection	Number of Host Fish		No. of parasites recovered	Prevalence (%)	Mean intensity
				Examined	Infected			
<i>Channa punctatus</i> Bloch	Family: Clinostomidae Luhe, 1901	Gho-manhasan,	Liver, Coelomic cavity, muscles	116	39	182	33.62	4.68
	<i>Euclinostomum heterostomum</i>	Chakrali stream						
<i>Xenentodon cancila</i> Hamilton	Family: Gorgoderidae Looss, 1901	Chadwal stream	Intestine	104	36	102	34.62	2.83
	<i>Phyllodistomum tripathi</i>							
	Family: Hemiuridae Luhe, 1901	Chakrali & Chadwal stream	Stomach	104	42	124	40.38	2.95
	<i>Genarchopsis piscicola</i>							
	Family: Bucephalidae Poche, 1907	Chadwal stream	Intestine	104	28	110	26.93	3.92
	<i>Bucephalosis sp.</i>							
				220	145	518	65.90	3.58
	Total							

**Table 2: Comparative measurements of *Euclinostomum heterostomum* with other species of *Euclinostomum* (in mm).**

Characters	<i>E. bhagavantami</i> (Ukoli, 1966)	<i>E. minutus</i> (Bhutta and Khan, 1975)	<i>E. reticulatum</i> (Pandoh, 1992)	<i>E. heterostomum</i> (Purivirojkul and Sumontha 2013)	<i>E. heterostomum</i> Present species
Mean body size	12.7×3.37	4.484-6.66×1.66-2.424	6.40-10.08×1.76-3.26	5.78-7.77×2.25-2.73	4.36-6.54× 2.18-2.49
Oral sucker	0.53×0.38	0.235-0.302×0.245-0.392	0.19-0.32×0.24-0.48	0.199×0.264	0.19-0.38×0.16-0.27
Ventral sucker	-	0.235-0.392×0.245-0.39	0.96-1.47×0.96-1.76	0.978×0.930	0.712-0.872×0.625-0.721
Number of diverticula	9-12	12-15	6-13	10-12	7-12
Ovary	0.6×0.26	0.245-0.333×0.235-0.393	0.09-0.20×0.08-0.24	0.179×0.149	0.121-0.146×0.140-1.28
Anterior testes	-	-	0.48-1.20×0.08-0.24	0.13×0.179	0.115-0.159×0.36-0.462
Posterior testes	-	-	0.40-1.12×0.19-0.40	0.530×0.680	0.218-0.320×0.253-0.374mm
Hosts	-	Bird	<i>Channa punctatus</i>	<i>Trichopsis vittata, Betta splendens, Betta imbellis</i>	<i>Ophiocephalus punctatus</i>
Locality	-	Pakistan	Jammu (J&K) India	Israel	Jammu (J&K) India

**Table 3: Comparative measurements of *Phyllodistomum tripathi* with other species of *Phyllodistomum* (in mm).**



Characters	<i>P.tripathi</i> Motwani & Srivastava, 1961	<i>P.cameroni</i> Agrawal, 1966	<i>P. betwaensis</i> Sen, 2014	<i>P.punctati</i> Jithila & Prasadan, 2018	Present Species <i>P.tripathi</i>
Mean body size	1.55-4.58×0.74- 2.02	4.23×2.23	1.4-1.6×0.41- 0.43	1.54-6.13×1.03- 4.32	1.58-3.72×0.72- 2.04
Length to width ratio of body	2.22:1	1.89:1	3.57:1	1.48:1	1.92:1
Fore-body	0.9-2.7×0.53-0.8	1.8×1.10	0.81- 0.83×0.19-0.21	0.62-2.57×0.63- 2.16	0.89-0.94×0.43- 0.75
Hind-body	0.69- 2.0×0.74- 2.02	2.52×2.23	0.61- 0.63×0.41-0.43	0.89-4.00×1.31- 4.32	0.95-0.98×0.78- 0.80
Oral sucker	0.19-0.50×0.19-0.45	0.5	0.15- 0.17×0.11-0.13	0.33-0.82×0.35- 0.76	0.19-0.26×0.20- 0.28
Ventral sucker	0.3-0.6	0.5	0.23-25×0.17- 0.19	0.28-0.77×0.35- 0.76	0.22-0.28×0.24- 0.33
Esophagus	0.11-0.45	0.19×0.08	0.09- 0.11×0.03-0.05	0.06-0.37×0.05- 0.08	0.12-0.17
Anterior testis (Right testis)	0.20-0.48×0.20-0.60	0.53×0.40	0.13-0.15×0.1- 0.12	0.12-0.52×0.07- 0.32	0.16-0.20×0.14- 0.17
Posterior testis (Left testis)	0.25-0.55×0.20-0.50	0.44×0.42	0.11- 0.130×0.08- 1.0	0.09-0.68×0.11- 0.33	0.22-0.24×0.18- 0.20
Ovary	0.10-0.25×0.09-0.25	0.42×0.30	0.09- 0.11×0.06-0.08	0.11-0.43×0.11- 0.37	0.07-0.12×0.06- 0.08
Right vitelline gland	0.03-0.12×0.11-0.31	0.10×0.028	0.08- 0.01×0.03-0.05	0.09-0.29×0.06- 0.27	0.06-0.07×0.03- 0.04
Left vitelline gland	0.03-0.10×0.11-0.32	0.1×0.029	0.05- 0.07×0.02-0.04	0.09-0.32×0.05- 0.30	0.07-0.08×0.04- 0.05
Eggs	0.0512-0.0752×0.0259- 0.0492	0.0391-0.0522× 0.0194-0.0325	0.02- 0.04×0.01-0.02	0.020- 0.029×0.012-0.20	0.02-0.03×0.01- 0.02
Host	<i>Bagarius yarrellii</i> <i>Pseudeutropius garua</i>	<i>Rita rita</i>	<i>Channa punctatus</i>	<i>Channa punctatus</i>	<i>Xenentodon cancila</i>
Location	Lucknow	Lucknow	Jhansi	Western Ghats	Jammu

**Table 4: Comparative measurements of *Genarchopsis pisicola* with other species of *Genarchopsis*.**

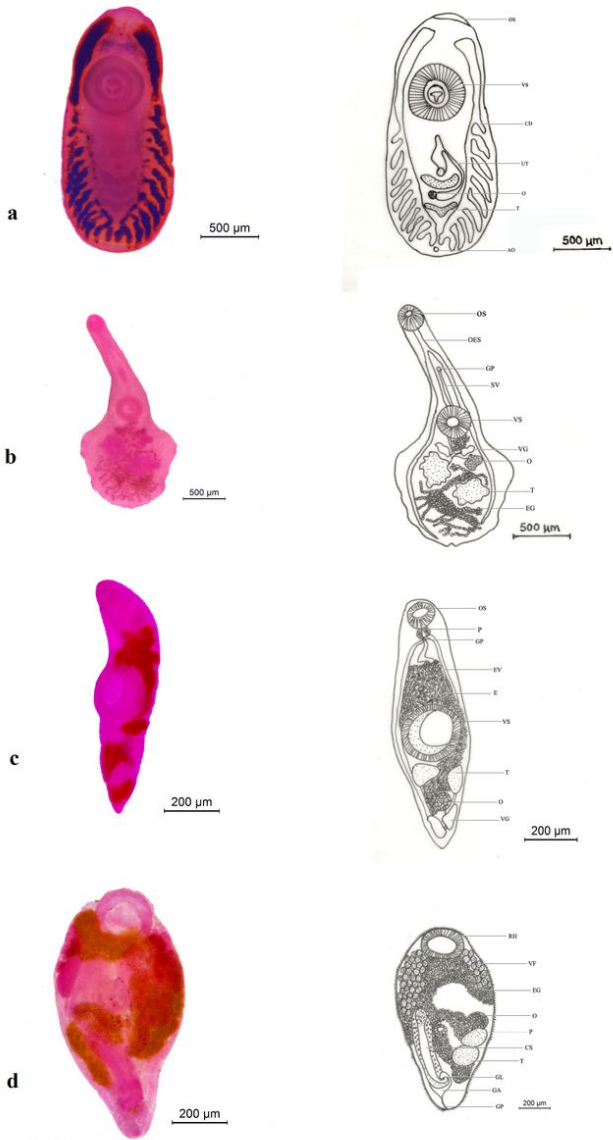
**Table 5: Comparative measurements of *Bucephalopsis (Prosrhynchoides) karvei* with other species of *Bucephalopsis (Prosrhynchoides)***

Characters	<i>Genarhopsis piscicola</i> Srivastva, 1933	<i>Genarchopsis goppo</i> Ozaki, 1925 Described by Shimazu, 1995	<i>Genarhopsis gibsoni</i> Shaikh <i>et al.</i> , 2011	Present species <i>Genarchopsis piscicola</i>
Mean body size	3.3-3.4×1-1.2	0.99-1.68×0.38-0.61	1.74-1.77×0.65-0.67	1.28-2.57×0.42-0.79
Oral sucker	0.33-0.34	0.10-0.17×0.12-0.21	0.25-0.27×0.27-0.29	0.24-0.38×0.26-0.47
Ventral sucker	0.66-0.68	0.23-0.42×0.22-0.42	0.55-0.59×0.47-0.49	0.56-0.79×0.58-0.80
Oesophagus	absent	oesophageal pouch present	absent	absent
Testes	oval, situated a little obliquely behind acetabulum, extracaecal	22-0.30×0.12-0.23,	0.06-0.07×0.15-0.16	right testis 0.16-0.17×0.12-0.14; left testis 0.15-0.17×0.13-0.14
Ovary	situated inter-caecally to the right, close behind right testis	0.05-0.15×0.05-0.11	0.06-0.09×0.06-0.08	0.13-0.18×0.09-0.15
Vitelline glands	Vitellaria consist of two large, compact glands, situated asymmetrically in the extreme posterior end	0.08-0.16×0.04-0.09	Vitellaria consist of two very small, dark, elongate masses 0.021-0.032	vitelline glands two, oval, compact 0.15-0.20×0.08-0.012
Eggs	0.048×0.015 with a polar filament, 0.04 long	51-65×24-30 with opercular filament present, measuring up to 1.20	0.006-0.008×0.004-0.006	0.032-0.035×0.009-0.016
Genital pore	Genital pore situated ventrally, at the level of pharynx	Genital pore usually opening wide but rarely puckered, median to submedian, ventral to pharynx	Genital opening at the level of posterior margin of the pharynx	genital pore present below pharynx near intestinal bifurcation
Hosts	<i>Ophiocephalus punctatus</i>	<i>Mogurnda obscura</i>	<i>Channa (Ophiocephalus) striatus</i>	<i>Xenentodon cancila</i>
Locality	Allahabad	Japan	Keenjhar Lake, Pakistan	Jammu, J&K

(in mm)

## Figures

Characters	<i>Prosorhynchoides garui</i> (Verma, 1936)	<i>P.fusifformis</i> (Verma, 1936)	<i>P.karvei</i> (Bhalerao, 1937)	<i>P.karvei</i> Present species
Body size	5.73-6.20×1.38-1.90	1.24-2.52×0.39-0.84	0.5-0.96×0.27-0.57	0.57-0.98×0.31-0.52
Rhynchus (anterior sucker)	0.56-0.69×0.58-0.69	0.17-0.24×0.18-0.24	0.16-0.24×0.142-0.227	0.11-0.23×0.13-0.20
Pharynx	0.25-0.29×0.25-0.33	0.07-0.08×0.07-0.084	0.044-0.06×0.044-0.06	0.05-0.06×0.04-0.07
Cecum	0.75-1.26×0.21-0.50	0.21-0.46×0.18-0.23	0.68-0.09×0.68-0.09	0.06-0.09×0.06-0.01
Anterior testis	0.71-0.86×0.38-0.66	0.18-0.29×0.17-0.26	0.108-0.120×0.082-0.09	0.12-0.14×0.08-0.09
Posterior testis	0.58-0.67×0.42-0.54	0.16-0.25×0.15-0.21	0.108-0.120×0.082-0.09	0.11-0.13×0.07-0.09
Cirrus sac	0.60-0.92×0.30-0.35	0.46-0.71×0.10-0.14	0.23-0.29×0.056-0.063	0.24-0.28×0.05-0.07
Ovary	0.46-0.67×0.29-0.42	0.14-0.21×0.15-0.19	0.056-0.082×0.056-0.082	0.06-0.08×0.07-0.09
Eggs	0.023-0.028×0.015-0.017	0.013-0.023×0.008-0.015	0.018-0.002×0.009-0.013	0.017-0.018×0.009-0.012
Host	<i>Silonia silondia</i>	<i>Eutropiichthys vacha</i>	-	<i>Xenentodon cancila</i>
Location	Allahabad	Allahabad	-	Jammu (J&K)



**Figure 1**

a. *Euclinostomum heterostomum* (Rudolphi, 1806) Travassos, 1928. b. *Phyllodistomum tripathi* Motwani & Srivastava, 1961. c. *Genarchopsis piscicola* Srivastava, 1933. d. *Bucephalopsis karvei* Bhalerao, 1937