Metazoan parasites of *Mystus vittatus* (Bloch) of River Godavari with description of a new species of Acanthocephala, *Raosentis godavarensis* sp. nov.

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Abstract A total of 9 metazoan parasitic species were identified from *Mystus vittatus* (Bloch) in river Godavari during 2005–2007 including 2 monogeneans, 2 digeneans, 3 acanthocephalans and 2 copepods. Two species of monogeneans (*Bifurcohaptor indicus* and *Thaparocleidus tengra*), digeneans (*Haplorchoides macrones* and metacercariae of *Isoparorchis hypselobagri*), an acanthocephalan (*Raosentis podderi*) found during the present study are of common occurrence in this fish. *M. vittatus* constitutes a new host record for an acanthocephalan, *Raosentis thapari* and 2 copepods, *Argulus striatus* and *Lamproglana hospetensis*. The occurrence of *A. striatus* represents unusual for *M. vittatus*. A new species of acanthocephala, *Raosentis godavarensis* sp. nov is reported, described and illustrated.

Keywords Bagridae, Hypodermic nuclei, *Mystus vittatus*, Proboscis, *Raosentis godavarensis*

Introduction

River Godavari is well known for its dynamic environment, rich nutrients, high productivity and prospective field to accomplish fishery research (ICAR 2000). A diversified array of teleostean fauna inhabits Godavari River and these

piscian fauna in turn offers a diversified and favorable habitat to the metazoan parasites. *Mystus vittatus* (Bloch) of family Bagridae serves as an excellent host for a variety of metazoan parasites. These fishes, locally known as ‘jella’ are highly relished in southern India due to their rich protein content and delicacy. There is a requisite to study parasitic fauna of fishes since fishes act as a source of serious human parasitic infectious diseases (Dubios and Pearson 1963; Schnurrenberger, 1975; El-Dally 1988; El-Reid 1994). In the present study, a total of nine parasitic species from four parasitic groups were encountered from *M. vittatus*, of which a new species of acanthocephalan, *Raosentis godavarensis* sp. nov has been reported and described.

Materials and methods

A survey was conducted during 2005–07 to know the parasitic fauna of *M. vittatus* from River Godavari at Rajahmundry. Out of 93 *M. vittatus* were examined, 46 were found to be infected. After examining the hosts for ectoparasites, various organs of the host were separated, washed in physiological saline to remove excess of mucus and were cut open with a longitudinal incision. The parasites obtained were carefully collected in cavity blocks filled with saline solution. Copepod parasites were fixed in 10% formalin and cleared in lactic acid for 12–24 hours. Trematodes, cestodes and acanthocephalans were flattened between two slides or under the slight pressure of coverslip over the slide, post-fixed in AFA (Alcohol, Formalin and acetic acid in

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85:10: 5) and stained with alum carmine. Conventional techniques were employed for permanent whole mount preparations (Hiware et al. 2003 and Madhavi et al. 2007). Genus and species identification was done with the aid of standard books of Yamaguti (1954, 1958, 1963a, 1963b, 1971, 1975) and Pillai (1969, 1985) and by the review of the recent literature (Rizvi 1971; Pande and Shukla 1976; Gupta; Govind 1985). Figures were drawn with the aid of camera lucida. Measurements are given in millimeters. Holotypes and paratypes of the parasites were preserved and stored in Museum of Zoology Department, Andhra University, Visakhapatnam (ZDAU).

Results and discussion

A total of 9 metazoan parasitic species from 4 different parasitic groups including 2 species of monogeneans, *Bifurcohaptor indicus* and *Thaparocleidiu tengra*; 2 of digeneans, *Haplorchoides macrones* and metacercariae of *Isoparorchis hypselobagri*, 3 of acanthocephalans, *Raosentis podderi*, *R. thapari* and *R. godavarensis* n.sp and 2 of copepods, *Argulus striatus* and *Lamproglena hospetensis* were collected from the *M. vittatus*. Two species each of monogeneans and digeneans and an acanthocephala (*Raosentis podderi*) found during the present study are of common occurrence in this fish. *M. vittatus* constitutes a new host record for an acanthocephala, *Raosentis thapari* and 2 copepods, *Argulus striatus* and *Lamproglena hospetensis*. The occurrence of *A. striatus* represents unusual for *M. vittatus*. An acanthocephalan, *Raosentis godavarensis* sp. nov is reported, for the first time. Redescriptions are briefly discussed and the description of new species is given in detail.

Monogenea

***Bifurcohaptor indicus* Jain, 1958** (Plate-1, Fig-1)

Habitat. Gill filaments

No. of hosts infected. 20

No. of specimens. 25

Measurements

Body $0.38\text{--}0.50 \times 0.04\text{--}0.05$; pharynx $0.03\text{--}0.0325 \times 0.03$; opisthohaptor $0.15\text{--}0.16 \times 0.10\text{--}0.11$; dorsal anchor $0.12\text{--}0.122$; ventral anchors 0.02×0.012 ; ventrolateral bars $0.03\text{--}0.04$; larval hooklets $0.012\text{--}0.013$; testes 0.10×0.02 ; ovary 0.072×0.032 and eggs $0.03\text{--}0.04 \times 0.015\text{--}0.016$.

Discussion

The parasite resembles *B. indicus* Jain (1958) in all morphological characters except for slight variations in measurements. Hence, the parasites are considered as *Bifurcohaptor indicus* Jain, 1958.

***Thaparocleidiu tengra* (Tripathi, 1959)** Lim, 1996 (Plate-1, Fig-2)

Habitat. Gill filaments

No. of hosts infected. 54

No. of specimens. 85

Measurements

Body $0.26\text{--}0.34 \times 0.04\text{--}0.06$; pharynx $0.02\text{--}0.03 \times 0.02\text{--}0.04$; dorsal anchors $0.04\text{--}0.05$; middle dorsal bar $0.02\text{--}0.03 \times 0.01\text{--}0.015$; small anchors $0.02\text{--}0.03$; lateral bars $0.01\text{--}0.02$; testis $0.07\text{--}0.08 \times 0.04\text{--}0.05$ and ovary $0.03\text{--}0.035 \times 0.01\text{--}0.015$.

Discussion

Jain (1952) proposed the genus *Thaparocleidiu* with *T. wallagonius* as its type-species from *Wallago attu*. This species was earlier described under a different genus *Neomurraytrema* as *N. tengra* from the freshwater fish, *Mystus gulio* by Tripathi (1959). Gussev (1973, 1978) included this species under the genus *Silurodiscoides* and named it as *S. tengra*. Later, Dubey et al. (1992) named the same species as *Parancylodiscoides tengra* under the genus *Parancylodiscoides*. Lim (1996) synonymized all the three genera, *Neomurraytrema*, *Silurodiscoides* and *Parancylodiscoides* with the genus *Thaparocleidiu* and reassigned the species as *T. tengra*. The present parasites come closer to *T. tengra* in all characters and are considered as *Thaparocleidiu tengra* (Tripathi, 1959) Lim, 1996.

Digenea

***Haplorchoides macrones* (Dayal, 1949)** Yamaguti, 1958 (Plate-1, Fig-3)

Habitat. Intestine

No. of hosts infected. 68

No. of specimens. 89

Measurements

Body $0.59\text{--}0.68 \times 0.22\text{--}0.35$; oral sucker $0.03\text{--}0.04 \times 0.03\text{--}0.06$; pre-pharynx $0.07\text{--}0.12$; pharynx $0.02\text{--}0.04 \times 0.02\text{--}0.03$; oesophagus 0.01 in length; testes $0.10\text{--}0.15 \times 0.11\text{--}0.19$; ovary $0.05\text{--}0.07 \times 0.06\text{--}0.07$; Seminal receptacle $0.045\text{--}0.06 \times 0.047\text{--}0.06$ and eggs $0.015\text{--}0.025 \times 0.007\text{--}0.013$.

Discussion

The parasite resembles *H. macrones* in all morphological characters except for a few variations in the measurements and termination of the intestinal caeca in the anterior extremity of testes as erected and redescribed by Dayal (1949) and Yamaguti (1958).

Metacercaria *Isoparorchis hypselobagri* Billet, 1898 (Plate-1, Fig-4)

Habitat. Air bladder

No. of hosts infected. 30

No. of specimens. 38 parasites

Measurements

Body $2.66\text{--}3.68 \times 0.99\text{--}1.24$; oral sucker $0.23\text{--}0.50 \times 0.10\text{--}0.29$, pharynx $0.04\text{--}0.09 \times 0.04\text{--}0.14$ and acetabulum $0.39\text{--}0.57 \times 0.38\text{--}0.57$.

Plate-1

Fig. 1: *Bifurcohaptor indicus* Jain 1958

Fig. 2: *Thaparocleidus tengra* (Tripathi, 1959) Lim, 1996

Fig. 3: *Haplorchoides macrones* (Dayal, 1949) Yamaguti, 1958

Fig. 4: *Metacercaria Isoparorchis hypselobagri* Billet, 1898

Discussion

There are reports of this parasite in its immature and adult form by Bhalerao (1936), Wu (1938), Chauhan (1955), Dollfus (1959), Yamashita & Nishida (1955), Gupta (1961) and Rai & Pande (1965) from a number of freshwater fishes across the world. Rai and Pande (1965) reported juveniles of these parasites from *Mystus seenghala* and *M. vittatus*. Present parasites were collected from *M. vittatus* and resemble metacercaria of *Isoparorchis* in all characters. Hence they are described as *Metacercaria* of *Isoparorchis hypselobagri* Billet, 1898.

Acanthocephala

***Raosentis podderi* Datta, 1947** (Plate-2, Fig-1)

Habitat. Intestine

No. of hosts infected. 4

No. of specimens. 2 male and 5 female parasites

Measurements

Body $1.70\text{--}2.76 \times 0.37\text{--}0.47$; proboscis $0.32\text{--}0.42 \times 0.07\text{--}0.075$; large hooks 0.66; smaller hooks 0.01; leminsci $0.38\text{--}0.42 \times 0.04\text{--}0.07$; testes $0.25\text{--}0.28 \times 0.20\text{--}0.24$; cement gland $0.32\text{--}0.52 \times 0.16\text{--}0.35$; cement reservoir $0.15\text{--}0.23 \times 0.12\text{--}0.16$ and eggs $0.04\text{--}0.05 \times 0.02\text{--}0.022$.

Discussion

The genus *Raosentis* was erected by Datta (1947) with *R. podderi* as its type-species from the small intestine of *Mystus cavassius*. The recorded parasite resembles *R. podderi* in all morphological characters. So they are considered as *Raosentis podderi* Datta, 1947.

***Raosentis thapari* Rai, 1967** (Plate-2, Fig-2)

Habitat. Intestine

No. of hosts infected. 10

No. of specimens. 8 male and 15 female parasites

Measurements

Body $1.18\text{--}1.58 \times 0.27\text{--}0.32$; proboscis $0.28\text{--}0.32 \times 0.07\text{--}0.21$; larger hooks 0.06; smaller posterior hooks $0.01\text{--}0.02$; leminsci $0.30\text{--}0.38 \times 0.09\text{--}0.10$; testes $0.15\text{--}0.27 \times 0.13\text{--}0.18$; cement gland $0.28\text{--}0.33 \times 0.13\text{--}0.20$; cement reservoir $0.11\text{--}0.16 \times 0.09\text{--}0.15$; eggs $0.03\text{--}0.04 \times 0.02\text{--}0.022$.

Discussion

The species *Raosentis thapari* was reported by Rai (1967) from the freshwater eels, *Mastacembelus armatus*. Present

parasites resemble *R. thapari* in all morphological characters except the host. Hence, are considered as *Raosentis thapari*, 1967 with a new host record.

***Argulus striatus* Cunningham, 1913** (Plate-2, Fig-3)

Habitat. Skin

No. of hosts infected. 2

No. of specimens. 3 male parasites

Measurements

Body $2.65\text{--}2.79 \times 1.8\text{--}1.95$; carapace $1.84\text{--}1.95$ and abdomen $1.03\text{--}1.08 \times 0.42\text{--}0.45$.

Discussion

Argulus striatus was first reported by Cunningham (1913) from South Africa. Later, there are reports of this species from many freshwater fishes. Rushton-Mellor (1994) redescribed this species. In the present study, only male

parasites are collected. Present parasites come closer to *A. striatus* in many characters and are considered as *Argulus striatus* Cunningham, 1913. The unusual occurrence of the copepod, *A. striatus* in *M. vittatus* constitutes new host record.

***Lamproglana hospetensis* Manohar, Seenappa & Venkateshappa, 1992** (Plate-2, Fig-4)

Habitat. Gills

No. of hosts infected. 15

No. of specimens. 28 female parasites

Measurements

Body $1.40\text{--}1.54 \times 0.34\text{--}0.38$; cephalon $0.30\text{--}0.38 \times 0.27\text{--}0.29$; genital segment $0.13\text{--}0.15 \times 0.19\text{--}0.20$; eggs $0.04\text{--}0.05 \times 0.09\text{--}0.11$; abdomen $0.51\text{--}0.52 \times 0.18\text{--}0.20$ and caudal rami $0.03\text{--}0.04 \times 0.03$.

PLATE - 2

Plate-2

Fig. 1: *Raosentis podderi* Datta, 1947

Fig. 2: *Raosentis thapari* Rai, 1967

Fig. 3: *Argulus striatus* Cunningham, 1913

Fig. 4: *Lamproglana Hospetensis* Manohar, Seenappa & Venkateshappa, 1992

PLATE - 3

Plate-3

Figs 1A, 1B & 1C: *Raosentis godavarensis* sp. nov

Discussion

Lamproglana hospetensis was first proposed by Manohar et al. (1992) from the gills of the fish, *Silundia sykesi* from Karnataka. However, in the present study these parasites were collected from the gills of *M. vittatus*. It is the new host record for the parasite. It resembles *L. hospetensis* in all the characters. Hence, the present parasites are considered as *Lamproglana hospetensis* Manohar, Seenappa & Venkateshappa, 1992.

***Raosentis godavarensis* sp.nov** (Plate-3, Figs 1A-1C)

Family: Quadrigyridae Van cleave, 1929

Genus: *Raosentis* Datta, 1947

Males. Body small, creamy white and fusiform measuring $1.49\text{--}1.63 \times 0.31\text{--}0.42$. Proboscis short, with four circles of hooks-anterior two circles with seven long hooks each, while the posterior two with eight small hooks each, with a space devoid of spines in between the second and third row of hooks. Proboscis measures $0.28\text{--}0.34 \times 0.18\text{--}0.19$. Proboscis sheath single-layered measuring $0.79\text{--}0.81 \times 0.21\text{--}0.24$. Leminisci two, of equal size, slightly longer than proboscis sheath. Anterior region of trunk with twelve rows of 30–40 rose-thorn shaped body hooks extending near to the anterior region of testis.

Five dorsal and two ventral hypodermic nuclei observed on the body. Sexual dimorphism distinct. Males smaller than females. Testes two, oval and tandem in position; in the anterior half of the body. Anterior testes, larger ($0.52\text{--}0.63 \times 0.23\text{--}0.44$) than the posterior (0.52×0.49). Cement gland well-developed, syncytial, elongated, lay immediately posterior to posterior testis; with 8–10 nuclei and measures $0.78\text{--}0.80 \times 0.49\text{--}0.52$. Cement reservoir round, posterior to cement gland, devoid of nucleus and continues into a duct passing along with seminal vesicle and opens into the anterior region of the elongated bursa.

Females. Longer than males and measure $2.20\text{--}2.29 \times 0.45\text{--}0.53$. Females are gravid. Entire body cavity is filled with characteristically embryonated eggs and a few enter the uterine bell. Very few ovarian balls present and measure $0.30\text{--}0.35$. Uterus with two sphincters. Eggs measure $0.01\text{--}0.04 \times 0.02$.

Species: *Raosentis godavarensis* sp.nov

Habitat. Intestine

No. of hosts infected. 5

No. of specimens. 6 male parasites and 2 female parasites

Material examined. *Holotype*. Male: INDIA: Andhra

Table 1 Comparison of *Raosentis godavarensis* n.sp with other related species of genus *Raosentis*

Sl.No	Body characters	<i>Raosentis podderi</i> Datta, 1947	<i>Raosentis thapari</i> Rai, 1967	Present species
1	Host	<i>Mystus vittatus</i>	<i>Mastacembelus armatus</i>	<i>Mystus vittatus</i>
2	Size	$1.70\text{--}2.76 \times 0.37\text{--}0.47$	$1.18\text{--}1.58 \times 0.27\text{--}0.32$	$1.49\text{--}1.63 \times 0.31\text{--}0.42$
3	Proboscis size	$0.32\text{--}0.42 \times 0.07\text{--}0.075$	$0.28\text{--}0.32 \times 0.07\text{--}0.21$	$0.28\text{--}0.34 \times 0.18\text{--}0.19$
4	Proboscis Hooks			
	a) Long hooks on first & second rows each	6	6	7
	b) Small hooks on third & fourth rows each	7	8	8
5	No. of rows of trunk spines on body	16–17	9	12
6	Hypodermic nuclei			
	Dorsal	2	3	5
	Ventral	1	3	2
7	Body size	fusiform, very small	fusiform, longer than the other two	Fusiform, small
8	Testes position	posterior half of the body	Anterior half of body, little posterior to proboscis sheath	Anterior half of body, lies close to proboscis sheath
9	Anterior testis & Posterior testis	Both small, nearly equal in size	Anterior testis smaller than posterior	Anterior testis larger than posterior testis

Pradesh, Rajahmundry, Godavari River, Andhra University Campus, Coll. Anu prasanna.V, 22.viii.2006 (ZDAU). *Paratype*. 5 males, 2 females, INDIA: Andhra Pradesh, Rajahmundry, Godavari River, Andhra University campus.

Etymology. The species name is named after the River Godavari.

Discussion

Only two species *R. podderi* Datta, 1947 from *Mystus cavassius* and *R. thapari* Rai, 1967 from *Mastacembelus armatus* have been so far reported from this genus. In the present study, these parasites are distinct. These parasites resemble *R. podderi* in having 8–10 nuclei on its cement gland but differ from it in number and arrangement of spines on the proboscis rows; forward position of testes and the number of hypodermic nuclei i.e. five dorsal and two ventral. It resembles *R. thapari* in having eight hooks each on third and fourth rows and forward position of testes but differs from it in size and number of hooks on proboscis. A table comparing the new species with the two species of the genus is given in Table 1. The present species differs from these two species mainly on the basis of proboscis hooks which is an identification character, number of hypodermic nuclei, size of parasites. Hence, it is justified to erect it as a new species and proposed to name as *Raosentis godavarensis* after the name of the river *Godavari*.

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References

- Bhalerao GD (1936) Studies on the helminths of India. Trematoda. IV. *Journal of Helminthology*, 14(4):181–206
- Chauhan BS (1955) On the taxonomic position and distribution of trematode genus *Isoparorchis* Southwell, 1913. *J Zool Soc India*, 7:87–90
- Cunnington WA (1913) Zoological results of the Third Tanganyika Expedition, conducted by Dr. WA. Cunningham, 1904–1905. Report on the Branchiura. *Proceedings of the Zoological Society of London*, 37:262–283
- Datta MN (1947) Acanthocephala from India. III. A new genus of Acanthocephala parasites of the family Quadrigyridae from Calcutta fish, *Mystus cavassius*. *Records of Indian Museum* 44:363–365
- Dayal J (1949) Trematode parasites of Indian Fishes. Part II. *Indian Journal of Helminthology*, 1(2):93–116
- Dollfus RP (1959) On a trematode (Genus: *Isoparorchis*) pathogenic agent of the “ink spot disease” in fish of Vietnam. *Bull. Àe la Soc de Path Exotique*, 52:791
- Dubey A, Gupta AK, Agarwal SM (1992) Studies on monogenean parasites of freshwater fishes at Raipur. VIII. Validity of *Parancylodiscoides* Achmerow, 1964 (*Silurodiscoides* Gussev, 1974) and two new species from Raipur. *Indian Journal of Helminthology*, 44:9–16
- Dubios G, Pearson J (1963) Les Strigeidia (Trematoda) de l’ Egypt. *Ann Parasitol*, 38:91–92
- El-Dally K (1988) The role of fish as intermediate host for transmitting some parasites of zoonotic importance, in Behaira Governorate. M.Sc. Zoonoses, Diss. Faculty of Veterinary Medicine, Alexandria, Egypt.
- El-Reid A (1994) Role of marine fish in transmission of some parasites to animals and birds. Ph.D. Thesis (Parasitology), Faculty of veterinary medicine., Zagaiag University, Egypt.
- Gupta PC, Govind H (1985) Three species of trematode parasite of the genus *Haplorchoides* Chen, 1949 from freshwater fishes of Kanpur, India. *Indian Journal of Parasitology*, 9(1):35–39
- Gupta SP (1961) Redescription and early development of *Isoparorchis hypselobagri*. *Indian J Helminthol*, 13:35
- Gushev AV (1973) Freshwater Indian Monogeneoidea, principles of systematics, analysis of the world faunas and their evolution. *Indian Journal of Helminthology*, 25–26:1–241
- Gushev AV (1978) Monogeneoidea of Freshwater fishes. Principles of systematics, analysis of world fauna and its evolution. *Parazitologia Sbornik* 38:96–198 (In Russian)
- Hiware CJ, Jadhav BV, Mohekar AD (2003) *Applied Parasitology. A practical manual*. Mangaldeep Publications.
- Jain SL (1952) Monogenea of Indian freshwater fishes. I. *Haplocleidus gomtius* n. sp. (Sub-Family: Tetraonchinae) from the gills of *Wallagonia attu* (Bloch), from Lucknow. *Indian Journal of Helminthology*, 4:37–42
- Jain SL (1958) Monogenea of freshwater fishes. VII. *Bifurcohaptor*, a new genus from the gill filaments of two fishes from Lucknow. *J Parasitol*, 30:73–90
- Lim LH (1996) *Thaparocleidus* Jain, 1952, the senior synonym of *Silurodiscoides* Gussev, 1976 (Monogenea; Ancylo-discoidinae). *Systematic Parasitology*, 35:207–215
- Madhavi R, Vijayalakshmi C, Shyamasundari K (2007) *Collection, staining and identification of different helminth parasites*. A manual of the workshop on fish parasites- Taxonomy Capacity Building, Andhra University Press.
- Manohar L, Seenappa D, Venkateshappa T (1992) *Lamproglana hospetensis* n.sp from the fish *Silundia sykesi*. *Indian Journal of Parasitology*, 16(2):127–130
- Pande BP, Shukla RP (1976) *Haplorchoides* Chen, 1949 (Haplorchinae: Heterophyidae) in freshwater fishes. *Journal of Helminthology*, 50(3):181–192
- Pillai NK (1969) Notes on some copepod parasites of South Indian fishes. *Parasitology*, 58:9–36
- Pillai NK (1985) Parasitic copepods of marine fishes. In: *The Fauna of India*. Calcutta: Zoological Survey of India 900 pp.

- Rai P (1967) On four acanthocephalan genera parasitic in freshwater fishes with description of three new species. *Ind J Helminth*, 19(1):27–44
- Rai P, Pande BP (1965) Isoparorchid infection in some hitherto unrecorded fish species. *Current Science*, 20:586–588
- River Godavari, environment and Fishery (2000) Central Inland Capture Fisheries Research Institute, *Indian Council of Agricultural Research*, (Barrackpore).
- Rizvi SSH (1971) Digenea of Pakistan freshwater fishes. I. *Haplorchoides indicus* n.sp. (Family: Cryptogonimidae) from the intestine of *Mystus aor* (Ham). Sukkur, West Pakistan. *Pakistan J Sci Indust*, 14:518–520
- Rushton-Mellor SK (1994) The genus *Argulus* (Crustacea: Branchiura) in Africa: Redescriptions of type-material collected by WA Cunnigton during the Lake Tanganyika expedition in 1913, with notes on *A. gigantius* Lucas and *A. arcassonensis* Cuenot. *Systematic Parasitology*, 28(1):33–49
- Schnurrenberger P (1975) Diseases transmitted from animals to man. Springfield, Illinois, USA 646–677
- Tripathi YR (1959) Monogenetic trematodes from fishes of India. *Ind. J. Helm* 9(1–2):1–149
- Wu K (1938) On the occurrence of *Isoparorchis* among fishes in China (Trematoda: Isoparorchidae). *Peking Natural History Bulletin*, 12(4):273–277
- Yamaguti S (1954) Parasitic copepods from fishes of Celebes and Borneo. *Publs Seto Mar Biol Lab*, 3:375–398
- Yamaguti S (1958) *Systema helminthum*, Vol-I. The digenetic trematodes of vertebrates. Interscience Publishers Inc., New York
- Yamaguti S (1963a) *Systema helminthum*, Vol-IV. *Monogenea* and *Aspidocotylea*. Interscience Publishers Inc., New York & London
- Yamaguti S (1963b) *Systema helminthum*, Vol-V. *Acanthocephala*. Interscience Publishers Inc., New York & London
- Yamaguti S (1971) Synopsis of digenetic trematodes of Vertebrates. Vol-I., part-I & II. *Kigaku Publ. Co.*, Tokyo, Japan
- Yamaguti S (1975) A synoptic review of life histories of digenetic trematodes with special reference to the morphology of their larval forms. Tokyo: Keigaku Publishing Co.
- Yamashita J, Nishida H (1955) On the occurrence of *Isoparorchis trisimilitubis* Southwell, 1913. *Memoirs of the Faculty of Agriculture.*, Hokkaido University, 2:160