PART-A
ACKNOWLEDGEMENTS

This thesis that attempts to the taxonomy, morphology and ecology of cestode parasites is possible only with the unselfish collaboration of the many who contributed to the instant consequence of this challenging task.

The present work has been carried out in the P.G. Department of Zoology, Bipin Behari P.G. College, Jhansi under the able supervision of Dr. A.K. Srivastav, M.Sc., D.Phil., F.A.Z., F.H.S., F.Z.S.I. The author express deep gratitude and indebteness to her supervisor for his untiring and kind interest in this project. Dr. Srivastav not only suggested the problems but also guided me at all stages of this work. His constant inspiration, and cordial treatment are greatly acknowledged.

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The author has no words to express his heartfelt gratitude to Smt. Chhavikala Srivastav for her constant inspiration and affectionate treatment during the research period.
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DATE 22nd July 1992

NOOPUR MATHUR
INTRODUCTION

A number of fresh water and marine fishes constitute highly nutritive food for human beings. Some of them are considered as delicacies. These edible fishes are known to harbour a number of cestode, nematode, trematode and acanthocephala parasites which cause deterioration in their health, hence their nutritive and market value is affected. The curiosity of the author to know about the helminth parasites found in such fishes lead her to undertake the present project. In the present thesis the author has restricted herself to the nature of infection of cestode parasites only. With a view to know the nature and extent of cestode infection, regular studies were under taken to record the nature of parasitism in fresh water cat fish, Heteropneustes fossilis (Bloch.) for two successive years. To have the idea of the state of infection in some fresh water and marine fishes the survey was conducted in different parts of district-Jhansi, Banda Kanpur, Raebareli, Puri (Orissa), Bombay (Maharashtra) and Goa. The present thesis deals with some of the interesting cestodes obtained during the survey which include the description of three new genera, one new subgenus, nine new species and redescription of one old species.

The new genera, new subgenus and new species belong
to the family Amphilinidae of the order Amphilinidea of the subclass Cestodaria, Lytocestidae and Capingentidae of the order Caryophyllidea, Ptychobothriidae of the order Pseudophyllidea, Phyllobothriidae of the order Tetraphyllidea, Proteocephalidae and Monticellidae of the order Proteocephalidea of the subclass Euccestoda.

A brief review relating to the cestode genera described in the thesis is given below.

The author in the present work divides the genus Gigantolina Poche, 1922 into two subgenera on the basis of shape of ovary viz. Gigantolina (Gigantolina) n.subgenus and Gigantolina (Unilobulata) n.subgenus. The first and only report of the genus pertains to that of Gigantolina magna Poche, 1922 in Diagramma crassispinum. The present new species Gigantolina (Unilobulata) raebareliensis n.sp. represents the first report of the subgenus from the Indian subcontinent and oriental region.

The genus Monobothrioides Fuhrmann et Baer, 1925 is currently represented by four species from whole world, the first report of the genus pertains to Monobothrioides cunningtoni Fuhrmann et Baer, 1925 from Aucheroglanis orientalis in Tanganyika. All the species of this genus reported from continental region. Monobothrioides species is first time reported from Indian subcontinent and the oriental region.
The new genus *Bilobulata* n.g. represents the family Lytocestidae Hunter, 1927 of the order Caryophyllidea Beneden in Carus, 1863. So far only fifteen genera have been reported from the family Lytocestidae Hunter, 1927 from the whole world. Out of them seven genus have been reported from the oriental region having five from Indian subcontinent. The present new genus is the sixth from Indian subcontinent.

The new genus *Mystoides* represents the family Capingentidae Hunter, 1930 of the order Caryophyllidea Beneden in Carus, 1863. So far only eight genera have been reported from the family Capingentidae from the whole world. Out of them four genera have been reported from the oriental region and Indian subcontinent. The present new genus is the fifth from Indian subcontinent.

The genus *Pseudolytocestus* Hunter, 1929 is currently represented by two species from the Indian subcontinent and oriental region and three from the whole world. The first report of the genus pertains to *Pseudolytocestus differtus* Hunter, 1929 in U.S.. The first report from the Indian subcontinent is that of *Pseudolytocestus clariae* Gupta, 1961 in *Clarius batrachus*. Present two new species are third and forth species of the genus from Indian subcontinent.

The new genus *Pseudoadenoscolex* represents the
family Capingentidae Hunter, 1930 of the order Caryophyllidea Beneden in Carus, 1863. So far only eight genera have been reported from the family Capingentidae from the whole world. Out of them four genera have been reported from the oriental region and Indian subcontinent. The present new genus is the fifth from Indian subcontinent.

The genus *Circumoncobothrium* Shinde, 1968 is currently represented by five species from the oriental region and Indian subcontinent. None is reported from continental region. The first report of the genus pertains to *Circumoncobothrium ophiocephali* Shinde, 1968. From *Ophiocephalus leucopunctatus* in India. *Circumoncobothrium capoori* n.sp. described here with represents the sixth species of the genus from Indian subcontinent and oriental region.

The genus *Senga* Dollfus, 1934 is currently represented by five species from oriental region and three from Indian subcontinent. None is reported from continental region. The first report of the genus pertains to *Senga besnardi* Dollfus, 1934 from *Ophiocephalus gachua* in India. *Senga jhansiensis* n.sp. described here with represents the forth species of the genus from Indian subcontinent.

The genus *Anthobothrium* Beneden, 1850 is currently represented by nine species from oriental region, out of them seven
from Indian subcontinent and nineteen form continental region. The first report of the genus pertains to *Anthobothrium cornucopia* Beneden, 1850 from marine sharks of Atlantic and Mediterranean sea. Other workers in the oriental region who have contributed to the knowledge of this cestode genus are Shipley (1900), Shipley et Hornell (1909), Subhapradha (1957), Shinde, Jadhav et Mohekar (1981), Srivastav et Capoor (1980) and Srivastav et Srivastava 1988.

The genus *Gangesia* Woodland, 1924 is currently represented by eight species from oriental region out of them seven from Indian subcontinent and four from continental region. The first report of the genus pertains to *Gangesia bengalensis* (Southwell, 1913) Woodland, 1924 from *Ophiocephalus striatus, Labeo rohita, Wallago attu* in India and Pakistan. *Gangesia Chauhani* n.sp. described here with represents the seventh species of the genus from Indian subcontinent.

The genus *Nomimoscolex* Woodland, 1934 is currently represented by seven species from continental region. The first report of the genus pertains to *Nomimoscolex piraeeba* Woodland, 1934 from *Brachyplatystoma filamentosum* in Amazon river. *Nomimoscolex shrotrii* n.sp. described here with represents the first species of the genus from oriental region and Indian subcontinent.

With a view to discover the cestode host relation
ships, examination of the fresh water cat fish *Heteropneustes fossilis* (Bloch.) has been performed for two successive years. The prevalence, mean intensity and relative density of cestode infection has been worked out, in relation to the body weight, sex of the host and cloacal temperature of the host.
HISTORICAL


Southwell's contribution has been classical. Apart from his classical volume of "Fauna of British India", his pioneering contributions include the descriptions of many new species. In 1913 Southwell reviewed the cestode material then existing in the Indian museum collection. The review included the description of twenty species and the redescription of some known species *Anthobothrium lintoni* (1911), *Calycobothrium typicum*
(1911), *Echinobothrium boisii* (1911), *Hexacanalis abruptus* (1911),
*Hexacanalis variabilis* (1911), *Onchobothrium formeri* (1911),
*Pithnophorus tetrablobus* (1911), *Tetraphyrnchus spinuliferum* (1911),
*Acanthobothrium herdmanni* (1912), *Otobothrium linstowi* (1912),
*Phyllobothrium floriforme* (1912), *Gangesia bengalensis* (1913),
*Gigantolina magna* (1915), *Poecilancistrum ilisha* (1918 with Prasad),
*Phyllobothrium compactum* (1920 with Prasad), *Acanthobothrium macracanthum* (1925),
*Balanobothrium parvum* (1925) *Echinobothrium longicolle* (1925),
*Phyllobothrium centrarium* (1925), *Tylocephalum minutum* (1925),
*Tylocephalum yorkei* (1925), *Phyllobothrium dagnallium* (1927),
*Phyllobothrium microsomum* (1929 with Hilmy).

The other important contribution of Southwell from fish hosts include
*Otobothrium balli* (1929), *Tentacularia macfieyi* (1929),
*Tentacularia obesa* (1929), *Tentacularia pillersri* (1929),

It will not be an exaggeration to say that his contributions gave
great stimulus and a direction to the study of cestodes in this
subcontinent and its neighbourhood.

The important contribution of Woodland comprise
*Amphilina paragonopora* (1923), *Lytocestus filiformes* (1923),
*Wenyonia virilis* (1923), *Wenyonia acuminata* (1923), *Wenyonia minuta*
(1923), *Caryophyllaeus chalmersiius* (1924), *Gangesia macrons* (1924),
*Gangesia wallago* (1924), *Senga pycnomere* (1924), *Marsipocephalus
heterobranchnus* (1925), *Anthobothrium karuatayi* (1934),

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Anthobothrium piramutab (1934), Anthobothrium pristis (1934),
Endorchis piraeeba (1934), Megathylocus jandia (1934),
Proteocephalus jandia (1934) Myzophorus admonticellia (1934),
Nomimoscolex piraeeba (1934), Nomimoscolex kaparari (1935),
Nomimoscolex lenha (1935), Nomimoscolex piractinga (1935),
Nomimoscolex sudobim (1935), Endorchis mandube (1935),
Proteocephalus kuyukuyu (1935), Myzophorus dorad (1935),
Myzophorus pirara (1935), Myzophorus sudobim (1935), Stocksia
punjehuni (1937), Stocksia lezera (1937), Proteocephalus
bivittellatus (1937).

The important contribution of Dollfus comprise
Senga besnardi (1934), Senga ophiocephalina (1934), Senga
pycnomera (1934), Eutetrarhynchus leucomelanus (1942),
Pterobothrium platycephalum (1942), Pterobothrium rubromaculatum
(1942) and Nybelinia alloiolica (1960).

Subhapradha's voluminous work includes species of
cesodes from fishes collected from Indian sea coasts, viz.
Polypocephalus affinis (1951), Polypocephalus caronatus (1951),
Polypocephalus lintoni (1951), Polypocephalus rhinobatidis (1951),
Polypocephalus rhynchobatidis (1951), Polypocephalus vitellaris
(1951), Oncodiscus fimbriatus (1955), Acanthobothrium indicum
(1957), Acanthobothrium rhynchobatidis (1957), Acanthobothrium
southwelli (1957), Anthobothrium crenulatum (1957),

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Anthobothrium septatum (1957), Anthobothrium spinosum (1957),
Cephalobothrium rhinobatidis (1957), Echeneibothrium filamentosum
(1957), Echeneibothrium verticillatum (1957), Eulacistorhynchus
chilocyllius (1957), Otobothrium minutum (1957), Phyllobothrium
chiloscyllii (1957), Phyllobothrium minimum (1957), Phyllobothrium
typicum (1957), Pithophorus musculosus (1957). He established two
new genera viz. Anteropora and Eulacistorhynchus.

Gupta, S.P. described many known and unknown cestodes
from U.P. His important contribution are Lucknowia follilisi
(1961), Capingentoides batrachii (1961), Pseudolytocestus clariae
(1961), Pseudocaryophyllaeus indica (1961), Capingentoides
batrachii (1961), and Capingentoides heteropneusti (1980 with
sinha).

Shinde, G.B. described a number of known
and unknown cestodes. His important contributions are
Circumoncobothrium ophiocephali (1968), Lytocestoides
aurangabadensis (1970), Circumoncobothrium raoii (1976 with
Jadhav), Uncibilocularis southweli (1976 with Chinholikar),
Circumoncobothrium khamii (1977), Circumoncobothrium shindei
(1977 with Chinholikar), Scyphophyllidium arabiansis (1977 with
Chinholikar), Pithophorus yamagutii (1978), Flupocephalum
saurashtri (1979 with Deshmukh), Pedibothrium lintoni (1980),
Pedibothrium vervalensis (1980 with Jadhav and Deshmukh),

The investigations of Zaidi and Khan ranged over Pakistan. His important contributions comprise Bovienia ilishai (1976), Hornelliella palasoorahi (1976), Senga taunsaensis (1976), Thysanocephalum karachii (1976), Pithophorus pakistanensis (1976) and Vermaia sorarakowahi (1976).

Srivastav, A.K. with Capoor, V.N. describes Phyllobothrium bombayensis (1979), Acanthobothrium mylobatinus (1979),

Bilquees’ contribution from Pakistan includes Myrmillorhynchus pearsoni (1980), and three species of Acanthobothrium. Shah with Bilquees in 1979 described Nybelinia elongata.

MATERIAL AND METHODS

The alimentary canal of the host was removed and cut open in normal saline water in troughs or petridishes. It was lightly shaken and the contents decanted several times. The intestine and its contents containing parasites were examined thoroughly under a binocular microscope to ensure that none of the parasite is left behind. In some cases, as the scolices were deeply embedded, it was found necessary to take them out by scraping the mucosa of the intestine with a sharp scalpel or by releasing the scolices with a pair of needles. Later, portion of the mucosa attached to the cestode body was removed by shaking the body of the cestode in the normal saline water. The worms were stretched in luke warm water and in case of larger worms, by lifting them with the help of needles or forceps against the edges of petridishes repeatedly for several times and later on fixed in 5% formalin or alcoholic Bouin's fluid. Fixed and washed worms were stored in 5% formolin till needed for study.

The whole mounts were stained in either Borax carmine or Mayer's Haemalum. The Mayer's Haemalum proved to be the best stain for cestodes. Whole mounts were either cleared in xylol or clove oil. For sectioning, the material was cleared in xylol, embedded in histowax and cut at 0.006-0.008mm, stained with Delafield's Haematoxyline and Eosin and mounted in canada balsam.
The worms have also been studied in living conditions.

Only camera lucida drawings were made. All the measurements have been given in millimeters unless otherwise stated. Averages taken on the basis of the study of five to ten worms except in cases where still fewer worms were obtained.

During the course of study the total number of hosts thus examined was 225. The hosts examined belong to 19 species of fishes.

For the study of cestode host relationship, the "singhi" fish *Heteropneustes fossilis* (Bloch.) was selected. The live fishes were obtained through local fish catchers. A thorough study of five fishes were made in a month. This was continued for two successive years from February 1989 to January 1991.

Following process was used in the study of cestode host relationship.

(a) Live fishes were weighed individually.

(b) The strings of fish was removed with the help of bone cutter and quickly dissected to find out the sex by locating the testes or ovary.

(c) The alimentary canal of the fish was cut open in the normal saline solution in a petridish.

(d) The four kinds of parasites viz. cestodes, nematodes, trematodes and acanthocephala were collected and counted
separately in each infection.

e) The morphological studies of the cestodes, thus obtained were performed and their diagnosis completed on the basis of the study of permanent stained slides.

A total number of 112 *Heteropneustes fossilis* (Bloch.) were examined and 32 of them were found infected. Eighty fishes were found negative for helminth infection. The total number of 88 helminth parasites were obtained which included 26 cestodes, 20 nematodes, 2 trematodes and 40 acanthocephala.

During the ecological studies prevalence, mean intensity and relative density were calculated the definitions given by Morgolis et al., 1982 were followed.

1. **PREVALENCE**: Number of individuals of a host species infected with a particular parasite species divided by number of hosts examined.

\[
\text{prevalence} = \frac{\text{Number of hosts infected}}{\text{Number of hosts examined}}
\]

2. **MEAN INTENSITY**: Total number of individuals of a particular parasite species in a sample of a host species divided by number of infected individuals of the host species in the sample.

\[
\text{Mean intensity} = \frac{\text{Total number of cestodes obtained}}{\text{Total number of hosts infected}}
\]
3. **RELATIVE DENSITY**: Total number of individuals of a particular parasite species in a sample of host divided by total number of individuals of the host species.

\[
\text{Relative density} = \frac{\text{Total number of cestodes obtained}}{\text{Total number of hosts examined}}
\]

Prevalence, Mean intensity and Relative density of cestode parasites were calculated, annual, season wise and month wise in relation to the following parameters.

(a) Body weight of the host.

(b) Sex of the host.

(c) Cloacal temperature of the host.
### HOST PARASITE LIST

<table>
<thead>
<tr>
<th>Hosts</th>
<th>Number examined</th>
<th>Number infected</th>
<th>Cestodes obtained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bugarius bugarius</td>
<td>4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Channa marulius</td>
<td>10</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Channa punctatus</td>
<td>5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Channa striatus</td>
<td>8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Clarius batrachus</td>
<td>14</td>
<td>5</td>
<td>Bilobulata georgievi n.g., n.sp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pseudolytocestus pandei n.sp.</td>
</tr>
<tr>
<td>Heteropneustes fossilis</td>
<td>112</td>
<td>12</td>
<td>Nomimoscolex shrotrii n.sp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pseudoadenoscolex fossilis n.g., n.sp.</td>
</tr>
<tr>
<td>Lobeo calbasu</td>
<td>4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Labeo gonius</td>
<td>6</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mastacembelus armatus</td>
<td>10</td>
<td>4</td>
<td>Circumoncobothrium capoori n.sp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Senga jhansiensis n.sp.</td>
</tr>
<tr>
<td>Mystus aor</td>
<td>6</td>
<td>2</td>
<td>Mystoides bundelkhandensis n.g., n.sp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Pseudolytocestus dayali n.sp.</td>
</tr>
<tr>
<td>Species</td>
<td>Code</td>
<td>Quantity</td>
<td>Genus/Species Description</td>
</tr>
<tr>
<td>-------------------------</td>
<td>------</td>
<td>----------</td>
<td>--------------------------------------------</td>
</tr>
<tr>
<td>Mystus tengra</td>
<td>2</td>
<td>1</td>
<td>Gigantolina (Unilobulata)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>raebareliensis n.subg., n.sp.</td>
</tr>
<tr>
<td>Notopterus notopterus</td>
<td>4</td>
<td>1</td>
<td>Monobothrioides woodlandi</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mackiewicz and Beverly Burton 1967.</td>
</tr>
<tr>
<td>Ompak bimaculatus</td>
<td>4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Puntius sarana</td>
<td>5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Rita rita</td>
<td>3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Scoliodon sorakowah</td>
<td>12</td>
<td>4</td>
<td>Anthobothrium puriensis n.sp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Anthobothrium srivastavai n.sp.</td>
</tr>
<tr>
<td>Wallago attu</td>
<td>4</td>
<td>2</td>
<td>Gangesia chauhani n.sp.</td>
</tr>
<tr>
<td>Xenantodon cancella</td>
<td>8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Zygaena blochii</td>
<td>4</td>
<td>1</td>
<td>Anthobothrium blochii n.sp.</td>
</tr>
</tbody>
</table>
CLASSIFIED LIST OF CESTODE PARASITES
DESCRIBED IN THE THESIS

Class : Cestoda
Subclass : Cestodaria Monticelli, 1891
Order : Amphilinidea Poche, 1922
Family : Amphilinidae Claus, 1879
Genus : Gigantolina Poche, 1922
Subgenus : Unilobulata n.Subg.
Species : Gigantolina (Unilobulata) raehareliensis n.subg.,n.sp.
Subclass : Euccestoda Southwell, 1930
Order : Caryophyllidea Beneden in Carus, 1863
Family : Lytocestidae Hunter, 1927
Genus : Monobothrioides Fuhrmann et Baer, 1925
Genus : Bilobulata n.g.
Species : Bilobulata georgievi n.g.,n.sp.
Family : Capingentidae Hunter, 1930
Genus : Mystoides n.g.
Species : Mystoides bundelkhandensis n.g.,n.sp.
Genus : Pseudolytocestus Hunter, 1929
Species : Pseudolytocestus dayali n.sp.
Species : Pseudolytocestus pandei n.sp.
Genus : Pseudoadenoscolex n.g.
Species: *Pseudoadenoscolex fossilis* n.g., n.sp.

Order: Pseudophyllidea Carus, 1863

Family: Ptychobothriidae Luhe, 1902

Genus: *Circumoncobothrium* Shinde, 1968

Species: *Circumoncobothrium capoori* n.sp.

Genus: *Senga* Dollfus, 1934

Species: *Senga jhansiensis* n.sp.

Order: Tetraphyllidea Carus, 1863

Family: Phyllobothriidae Braun, 1900

Genus: *Anthobothrium* Van. Beneden, 1850

Species: *Anthobothrium blochii* n.sp.

Species: *Anthobothrium puriensis* n.sp.

Species: *Anthobothrium srivastavai* n.sp.

Order: Proteocephalidea Mola, 1928

Family: Proteocephalidae La Rue, 1911

Subfamily: Gangesiinae Mola, 1929

Genus: *Gangesia* Woodland, 1924

Species: *Gangesia chauhani* n.sp.

Family: Monticellidae La Rue, 1911

Subfamily: Zygobothriinae Woodland, 1933

Genus: *Nomimoscolex* Woodland, 1934

Species: *Nomimoscolex shrotrii* n.sp.