

ECOTAXONOMY OF LEECHES OF PUNJAB

Thesis

Submitted to the Punjab Agricultural University
in partial fulfilment of the requirements

for the degree of

MASTER OF SCIENCE

in

ZOOLOGY

(Minor : Biochemistry)

DUPLICATE

By

Rupinder Kaur

(L-91-BS-127-M)

95.15
96 E

Department of Zoology
College of Basic Sciences & Humanities
PUNJAB AGRICULTURAL UNIVERSITY
LUDHIANA-141 004

June, 1994

ECOTAXONOMY OF LEECHES OF PUNJAB

Thesis

Submitted to the Punjab Agricultural University
in partial fulfilment of the requirements

for the degree of

MASTER OF SCIENCE

in

ZOOLOGY

(Minor : Biochemistry)

By

Rupinder Kaur

(L-91-BS-127-M)



Department of Zoology
College of Basic Sciences & Humanities
PUNJAB AGRICULTURAL UNIVERSITY
LUDHIANA-141 004

June, 1994

1011-94 Dean / Head Dept H - Zoology PAU - Library

To My Parents

ACKNOWLEDGEMENTS

A precious debt as that of learning is the only debt that is difficult to repay except perhaps through gratitude. It is my great pride and privilege in expressing deep sense of gratitude and high indebtedness to my Major Advisor, Dr S.K. Battish, Professor of Zoology, for his excellent guidance, invaluable suggestions, perceptive enthusiasm and moral encouragement throughout the course of investigation.

I am thankful to the Head, Department of Zoology, PAU, Ludhiana for providing necessary research facilities.

I am grateful to Dr. V. C. Kapoor (Dean's nominee), Professor of Zoology, Dr M.L. Sood, Professor of Zoology and Dr. S. K. Munshi, Professor of Biochemistry for their keen interest, valuable criticism and timely help in the completion of the investigation.

My special thanks are due to Dr Ranjeet Sehdev, Assistant Zoologist (Fisheries) who helped me to give presentable form to my work, with his ever available help and encouragement during the period of investigation.

I find no words too complementary to acknowledge in so formal manner the sacrifices, love, help and constant encouragement rendered by my Manji, Mama, Papa, Mausiji and Mausaji. The blessings of whom have made me reach my destination. I owe a lot to my brothers Raju, Romi, Ashu, Shami, Jimmi, my sister Rimpi and Bhabiji for their deep affection, unfailing enthusiasm, encouragement and moral support.

Words alone are not sufficient to express my thanks to dear Mini Didi, Pinki Didi, Indu, Mrs and Mr Sehra, Dr K.C. Choudhary of their constant help and encouragement.

Cheerful acknowledgements are expressed to the sweet surroundings of my well wishers especially Sangeeta Didi, Neelam, Niti, Gurpeet, Prabjot, Sapna, Renu, Sanjay, Sandeep, Jolly Prit, Chander Kala, Inderpal, Karamjeet, Anju, Neeru, Simmi, Tejdeep and Aarti for their continuous inspiration and sharing of my odds and evens. I am thankful to dear Jaspreet, Neelam, Bhupinder Didi for their timely help.

I owe my thanks to Mr Chain Singh (Artist) and Mr Ramesh for typing my manuscript efficiently.

I would feel myself guilty in my duties if I do not express my thanks to lab staff, Sarvshri G.S. Manchanda, Milkhi, Yaspal and Rakesh. I wish to express my gratitude to those whom I could not mention, who have contributed in a very immediate way, through suggestion or criticism.

Above all, I am grateful to Almighty by whose benign blessings I have been able to clear another phase of my life.

Rupinder Kaur
Rupinder Kaur
(L-91-BS-127-M)

Dated: 3rd June, 1994

(Dr. S.S. Bhattal)
Professor of Zoology
Department of Zoology
Guru Jitendra Singh College
Ludhiana-141 004

(MAJOR ADVISOR)

CERTIFICATE I

This is to certify that this thesis entitled, "Ecotaxonomy of leeches of Punjab", submitted for the degree of Master of Science in the subject of Zoology (Minor subject: Biochemistry) is a bonafide research work carried out by Miss Rupinder Kaur (L-91-BS-127-M) under my supervision and that no part of this thesis has been submitted for any other degree.

The assistance and help received during the course of investigation have been duly acknowledged.

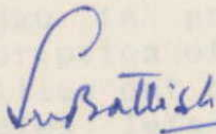
S. K. Battish


(Dr S.K. Battish) 3/6/94
Professor of Zoology
Department of Zoology
Punjab Agril. Univeristy
Ludhiana-141 004

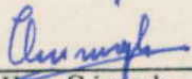
(MAJOR ADVISOR)

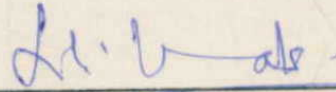
CERTIFICATE II

This is to certify that this thesis entitled, "Ecotaxonomy of leeches of Punjab", submitted by Miss Rupinder Kaur (L-91-BS-127-M) to the Punjab Agricultural University, Ludhiana in the fulfillment of the requirements for the degree of Master of Science in the subject of Zoology (Minor subject: Biochemistry) has been approved by the Students Advisory Committee after an oral examination on the same in collaboration with an External Examiner.


(Dr. S.K. Battish) 8/9/94
MAJOR ADVISOR


(Dr D. R. Singh) 14/9/94
HEAD OF THE DEPARTMENT


(Dr T. H. Singh) 10/10/94
DEAN, POST-GRADUATE STUDIES


8/9/94
EXTERNAL EXAMINER
Prof. L. K. Vats
Chairman
Deptt. of Zoology
Kurukshetra University
Kurukshetra

Title of thesis : ECOTAXONOMY OF LEECHES OF PUNJAB
Name and admission No. : Rupinder Kaur
of the student (L-91-BS-127-M)
Major subject : Zoology
Minor subject : Biochemistry
Name and designation : Dr S. K. Battish
of Major Advisor Professor of Zoology
Department of Zoology
Degree to be awarded : M.Sc.
Year of award of degree : 1994
Total number of pages in : 78 + i-xi(Lit.cited)
the thesis

ABSTRACT

Work on the systematics and ecology of leeches of Punjab is presented. The thesis embraces the illustrated description of nine leech species belonging to 5 genera and 2 families out of which one genus is new to the science and one species left indeterminate. The species are Herpobdelloidea indica Kaburaki, Foraminobdella heptomerata Kaburaki, Hirudinaria javanica Wahlberg, Hirudinaria manillensis Lesson, Hirudinaria granulosa Savigny, Hirudinaria viridis Moore, Hirudinaria sp. indt., Pseudohirudinaria assamensis, Haemadipsa zeylanica cochiniensis Moore and Pseudohirudinaria assamensis gen. et. sp. nov. Ecological findings are reported from the four selected habitats- Pond-1, Ladiari; Pond-2, Dasuya; Pond-3, Kizarpur and Pond-4, Gaira. Leech sp. indt. and Hirudinaria granulosa Savigny, Hirudinaria sp., indt. and Herpobdelloidea indica Kaburaki were studied in relation to the ecology. Ecological investigations of the seasonal changes in physico-chemical parameters namely temperature, pH, conductivity, dissolved oxygen, free carbon dioxide, depth and transparency were taken.

Rupinder Kaur
Signature of the student

S. K. Battish
3/6/94
Signature of Major Advisor

I N D E X

CHAPTER	CONTENTS	PAGES
I	INTRODUCTION	1- 4
II	REVIEW OF LITERATURE	5-18
III	MATERIAL AND METHODS	19-21
IV	SYSTEMATICS	22-51
IB	INTRODUCTION	52
IC	SITES OF STUDY	53-54
IIB	REVIEW OF LITERATURE	55-57
IIIB	MATERIAL AND METHODS	58-59
IVB	OBSERVATIONS	60-70
V	DISCUSSION	71-75
VI	SUMMARY	76-78
	LITERATURE CITED	i-xi

ABBREVIATION

a	atrium
al	annuli
a.s.	anterior sucker
b.m.l.	black marginal line
cl	clitellum
d.s.	dorsal stripes
e	eye
e.d.	ejaculatory duct
f.g.p.	female genital pore
i	intestine
l.c.	lateral caecae
m.g.p.	male gonopore
m.l.	median line
n	nephridia
n.c.	notochord
p	penis
ph	pharynx
p.ml.s	para marginal spots
p.m.s.	para median spots
p.s.	posterior sucker
pt.s.	pigmented spots
r	rectum
s.m.t.	supra marginal stripes
t.s.	testis sac
v	vagina

Chapter I

INTRODUCTION

The leeches form a relatively small but well defined group of segmented worms which are generally adapted to an ectoparasitic mode of life. Most of the members have a blood sucking (Sanguivorous) habit, attacking vertebrates especially cattle but some time man also. Some leeches are known to prey upon fishes and other animals in the sea. Curiously enough some leeches have been found to devour earthworms, insect larvae, tadpoles, crabs and even small fishes (Bhatia, 1977). Thus they are very harmful to the vertebrates and are remarkably adept at removing considerable quantity of blood from the hosts without being noticed. For this purpose leeches have a sharp precise equipment, the teeth and assisted by local anesthezing agent and anticoagulent hirudin.

The leeches belong to phylum Annelida and Order Hirudinea embracing more than 360 species of them. Because of their hard nature and structural plasticity leeches can inhabit a wide variety of habitats, fresh water, ponds, lakes, tanks, swamps, sluggish streams and still water standing in rice fields, sea water and land. As the leeches like other annelids depend upon water for their respiration,

the land leeches are compelled to remain near water. However, they take shelter under logs, stone, plants and other objects in shallow water. The terrestrial leeches like Haemadipsa spp. are found in tropics chiefly in the forests in damp places. In India they inhabit the lower slopes of Himalayas, Sikkim and Assam attached to tree leaves, bushes and shrubs. Leeches belong to order Hirudinea which is further grouped into four suborders which are further subdivided into families.

The sanguivorous leeches are specialized for blood sucking ectoparasitic mode of life having sucking jaws equipped with teeth. They have modified gut for the storage of large quantity of blood as the frequent feeding is difficult for want of suitable prey. The unusual sized gut has resulted in the reduction of coelom. The carnivorous leeches have long eversible proboscis.

Leeches are known to cause considerable damage to young fishes as parasitism due to them cause potential mortality in both natural and hatchery fish populations. The repeated bite by the leech at one place can cause open sores attached by bacteria and fungi and which lead to the complete destruction of the fish tissue.

Leeches are also known to act as transmitters of pathogens in vertebrates. Piscicola geometra Linnaeus, is the common fish leech which has been found to transmit,

Trypanosoma phaleri and other parasitic protozoa in fishes (Jones & Woo ., 1991).

The leeches have been reported to cause temporary or permanent blindness in their prey as they attack the eyes of their victims. Leeches can also enter into the body of their prey through any aperture. For instance they have been found to enter the anus of elephant and mouth of crocodile. The Placobdella multilineata is known to be a potent parasitic leech of crocodile (Yang, 1985).

Leeches are important for human beings in more than one way. Hirudo medicinalis and Haemopsis sanguisuga Blanchard, both have been commonly used in the laboratories for experimental puposes. The use of Hirudo medicinalis Ray had been a home remedy for abscesses boils, black eyes and other local inflammations available from time immemorial. As some of the other uses of leeches are: leeches are eaten by many aquatic vertebrates including fish hence can be used as fish bait, leeches had also been used in the hospitals during surgery because of anticoagulant property of hirudin. Recent studies (Aggarwal, 1994) have reported that leeches provide the best possible solution for plastic and vascular surgeons as these help in tidying up the wounds after plastic surgery and decongesting the flaps of skin from wounds where tumours have been removed. They also help patient's with peripheral vascular disease. It has been further reported that apart from

being an anticoagulant, leech saliva contains very potent anti-inflammatory agents, vasodilators, some enzymes and anti-enzymes all of which if splits into the bite, these different compounds holds in the promise of new, powerful and effective drugs. The leeches have a deleterious effect on the agriculturists directly as they attack them and the domestic animals of the farmers.

Visualising the significance of leeches as enemies of many vertebrates assaulting man and causing serious economic loss to him yet awaiting exploration in this part of the world, the taxonomic studies of the leeches of northern Indian States were undertaken. This study will generate knowledge about the leeches inhabiting our ecosystems.

Chapter II

REVIEW OF LITERATURE

Work done in India

Our knowledge of Indian fresh water leeches is still in its infancy. Kaburaki (1921) analysed the leech specimens lying in the Indian Museum, Calcutta. Moore (1924) write notes on some Asiatic leeches principally from China, Kashmir and British India. Harding and Moore (1927) have reported 38 species and 6 subspecies of leeches from the present geographical limits of India (excluding Pakistan, Sri Lanka, Bangladesh and Burma) in the Fauna of British India on Hirudinea.

Bhatia made significant contribution to the Indian leeches by publishing a series of papers spread over a span of over forty years (1930-1976). In 1930, he published the anatomical details of Placobdella emdae Harding (1920), a leech parasitic on Indian turtles and in the same year he described a new species Glossiphonia cruciata from Achabal, Kashmir. In 1934, he again described a new species, Glossiphonia lobata from Achabal, Kashmir. Chelladurai (1934) described a new species, Hemiclepsis viridis from Travancore, Kerala. In 1938, Bhatia described the structural variation in the Indian leech, Hirudinaria granulosa (Savigny, 1820). In the same year, Bhatia published work on the structure of

nephridia and funnels of the Indian leech Hirudinaria with remarks on these organs in Hirudo. In subsequent years Bhatia published more work on the different aspects of leeches. In 1939, he studied leeches inhabiting Dal lake, Kashmir. In 1939a, he published work on the prostomial glands of Indian leech Hirudinaria granulosa Savigny, 1820. He described carnivorous leech Haemopsis indicus which was a new species of Arhynchobdellid from Kashmir (1940). In 1941 Bhatia published detailed account on the Indian cattle leech, Hirudinaria. He also published the nephridial system of the Indian carnivorous leech, Haemopsis indicus in 1945.

Raj (1951) described Ozobranchus polybranchus a new species belonging to family Ichthyobdellidae from Porto-Novo (Tamil Nadu). This was followed by a report on the synopsis of the Ozobranchus polybranchus. This was reported to be a marine form and was parasitized on turtles (1954).

Bough (1960) published work on some Indian rhynchobdellid leeches describing four glossiphonid leeches, of which three were new, while the fourth one, Glossiphonia heteroclita Lin., 1761 was of zoogeographical importance. The new species were Placobdella horai, Hemiclepsis bhatiai and Batracobdella harding.

Mann's (1962) book embraced detailed information of the structure, physiology, ecology and embryology of leeches. This important work was followed by publication of a report on the segmentation of the gnathobdellid leeches with special

reference to the Indian leech Hirudinaria and the medicinal leech- Hirudo Bhatia (1970).

In 1973, Bhatia and Bora published work on the bionomics and distribution of the land leeches of Kumaon hills, Uttar Pradesh. Their studies were primarily based on the two common leech species namely Haemadipsa zeylanica agilis Moore, 1927 and Haemadipsa montana Moore, 1927.

Chandra (1976a) collected leeches from temporary rain water ponds and tanks of Maharashtra state. He described eight species, Glossiphonia reticulata Kaburaki, 1921, Glossiphonia annandalei Oka, 1922, Hemiclepsis marginata marginata (Muller, 1774), Paraclepsis praedatrix Harding, 1924, Paraclepsis vulnifera Harding, 1924, Herpobdelloidea indica (Kaburaki), 1921, Herpobdelloidea lateroculata Kaburaki, 1921 and Hirudo biramica (Blanchard, 1894).

Chandra and Mahajan (1976b) redescribed ten leech species including one new species from Simla hills, Himachal Pradesh. Ten species reported by Chandra and Mahajan were Glossiphonia reticulata Kaburaki, 1921, Glossiphonia weberi Blanchard, 1897, Hemiclepsis marginata asiatica Moore, 1924, Helobdella stagnalis (Linnaeus, 1758) Paraclepsis praedatrix Harding, 1924, Paraclepsis vulnifera Harding, 1924, Barbronia weberi (Blanchard), 1897, Herpobdelloidea indica (Kaburaki), 1921, Hirudinaria granulosa Savigny, 1820 and Haemadipsa zeylanica (Moquin-Tondon) 1826.

Mahajan and Chandra (1976) published work on the material collected from various localities in Rajasthan by different tour parties of Zoological Survey of India, during 1944-1964. These authors described ten species of leeches namely Glossiphonia heteroclita (Lin., 1761) Glossiphonia weberi Blanchard, 1897, Glossiphonia annandalei Oka, 1922, Placobdella undulata Harding, 1924, Hemiclepsis marginata marginata (Muller, 1774), Paraclepsis praedatrix Harding, 1924, Paraclepsis vulnifera Harding, 1924, Herpobdelloidea indica (Kaburaki 1921), Herpobdelloidea leteroculata Kaburaki 1921 and Hirudo biramnica (Blanchard, 1894).

Chandra (1983) reviewed work on Indian leeches. His paper deals with 52 species and 8 subspecies so far known from the Indian region. The species were arranged in the systematic order. The original and latest reference along with important synonyms have been mentioned under each species. The type locality and type depository has also been given. The distribution of each species in India has also been discussed. His paper embraced the keys which are quite useful for the identification of leeches.

Singhal et al. (1985) published a short report on the taxonomy and morphology of parasitic leeches from Beas river. In the same year they published work on the taxonomy and ecology of three leech species, Placobdella trionyxa, P.

kuliana, Hemiclepsis marginata Muller, 1778 also from river Beas. .

In 1987 Singhal et al. published another paper on the morphology, anatomy and systematics of leeches; Barbonia weberi (Blanchard, 1897) of Erpobdellid and Asiaticobdella biramica (Blanchard, 1894), Hirudinea sp. and Placobdella fulva (Harding, 1924).

Work done abroad

The earliest reference on the leeches is of Linnaeus; In 1758, he described a new genus and two species namely Glossiphonia complanata, Glossiphonia stagnalis. After this Lankester (1880) described the connective and vasifactive tissue of the medicinal leech. Four years later, Haycraft (1884) described the action of secretion obtained from the medicinal leech on coagulation of blood. The same year (1884) Bourne published a detailed study on the anatomy of Hirudinaria. In 1910, Harding published the work on the British leeches. Miller (1937) published on the leeches collected by Dr Y. Metzellaar from Michigan making the beginning of leech study in America. This publication carried the keys to orders, suborders and leech species described therein. The order Rhynchobdella embraced two species of Glossiphonia and four species of Placobdella and order Rhynchobdella seven of genus species were described. The species described by him were Glossiphonia stagnalis

(Linnaeus, 1758), G. complanata (Linnaeus) 1758, Placobdella monifera Moore, 1912, P. parasitica (Say, 1824), Epicta (Verrill, 1871), P. rugosa (Verrill, 1874), Macrobdella decora (Say, 1824); Haemopsis marmortis (Say), 1824, H. lateralis (Say, 1824), H. plumbeus Moore, 1912; H. grandis (Verrill, 1874), Herpobdella punctata (Leidy, 1870) and Dina fervida (Verrill, 1871). In addition the work on the following species of Ohio was also published for the leech species food habits Glossiphonia nepheloidea Moore, 1906, G. fusca Castle, 1900, Placobdella phalera Graf, 1899, Actinobdella inequiannulata Moore, 1901, Piscicola punctata and Dina microstoma Moore, 1912.

Ringuelet (1944) published on the synonymy and distribution of 61 leech species, based upon collections in Museum of Buenos Aires, Cardoba and Entre Rios and the author's own collection. Out of 61, 28 species were recorded from Argentina, 27 from Brazil, 20 from Chile, 123 from Paraguay, 18 from Uruguay, 8 from other South African countries and 6 from outside South Africa. There was a new and workable taxonomic key, a geographical summary in an extended table showing the occurrence of every species by provinces in the countries concerned. Mann (1954) had given a revision of British leeches of family Glossiphoniidae, with a description of Batracobdella paludosa (Carena, 1824) a leech new to British fauna. He also gave the key to genera and species of Glossiphoniidae.

Puccinelli (1968) carried out the karyological studies on Trocheta subviridis Dutrocht, 1817 and Trocheta bykowskii Gedroyc, 1913 collected in Great Britain

Sawyer (1972) reported fresh water pisciolid leeches of North America and gave a key for their identification of all the species discussed in that paper. Davies (1973) published the geographic distribution of fresh water leeches of genus Hirudinoidea from Canada and discussed these on a province basis. The host for those species recorded as temporary parasites were listed and one hundred and eight new records were listed including 28 records new to province. The 42 species were recorded from Canada. The author took pains and examined over 5000 specimens from different cities of Canada (150 from British Columbia, 1500 from Alberta, 3000 from Ontario and 200 from Quebec and published a review which is important for the workers in the field.

Meyer (1975) described a new species Macrobdella diplotertia from Missouri. The genus Macrobdella contained only three species all endemic to north America, M. decora (Say, 1804), M. restetia Whitman, 1886 and M. dietetra Moore, 1936. M. diplotertia was the fourth species added to the genus Macrobdella. Danieleles (1976) reviewed the genus Actinobdella. Specimens collected from fish host Catostomus commersoni and C. catastomus at Alogonquin provincial park, Ontario, he described three species of Actinobdella: A.

inequiannulata Moore, 1901, A. triannulata Moore, 1924 and A. annectans Moore, 1906.

Eugene (1976) described a new species Cytobranchnus meyeri (Hirudinea: Piscicolidae) from Catostomus commersoni lacepede in North America. The specimens were taken from the Mohawk river drainage of Eastern New York.

White (1977) described new distribution records of fish leeches in the Ohio river, during the course of fish collecting at 11 U.S. Army Corp of Engineers locks and dams on the Ohio river in the fall of 1976. The author recorded three species of leeches, two of the family Piscicolidae and one of family Glossiphoniidae. The names were Cyprinus carpio, Ictalurus punctatus, Aplodinatus grunniens and Lepomis sp. Illinobdella moorei Meyer, 1940 was found on the carp, channel cat fish, fresh water drum and a hybrid sun fish; Piscicolaria reducta. Meyer, 1940 was found on a logperch on Percina caprodes and the lone members of family Glossiphoniidae Placobdella parasitica (Say, 1824) was found on the eye of a carp Cyprinus carpio.

Mckee (1979) reported the incidence of Marvinmeyeria lucida (Hirudinea : Glossiphoniidae) in the finger nail clam, Sphaerium occidentale. Marvinmeyeria lucida Moore, 1954 was reported for the first time from Ontario. It was reported to feed exclusively on fresh water gastropods. This small leech was found in the pericardium of its sphaeriid host and showed marked preference for large clams.

In 1980 Oosthuizen redescribed Placobdella multistriata. Sawyer et al. (1980) gave a check list and key to marine and fresh water leeches. His paper contained species- Trochelobdella lubriia (Grube, 1840), Stiborobdella macrothela (Sachmarda), Malmiana philotherma (Sawyer), Paecilobdella blanchardii (Moore), Hellobdella stagnalis(L.) Blanchard, 1896 (L.), H. elongata (Castle, 1900), H. punctatolineata (Moore, 1939, Haementeria tuberculifera (Gube) and Oxytychus ontellarum (Moore).

Appy and ~~Dods~~well (1981) studied the Piscicolid leeches collected from marine and estuarine fishes and crustaceans of Bay of Fundy. The species reported were Calliobdella vivida (Verrill, 1872); Malmiana brunnea (Johanson, 1896); M. scorpii (Malm 1863), Oceanobdella sexoculata (Malm, 1863); Platybdella anarrhichae (Diesing, 1859); Myzobdella lugubris Leidy, 1851; Mysidobdella borealis (Johanson, 1899), Oxytonostoma typica, Malm, 1863.

Khatoon and Ali. (1981) published work on the fresh water leeches of Pakistan and discussed the taxonomy of 4 genera and 7 species Glossiphonia meyeri, Gheteroclita Moquin-Border 1846, G. complanata Linnaneus, 1758, G. castlii, Batracobdella paludosa, Carena, 1824, Hirudinaria granulosa Savigny, 1820 and Erpobdella octoculata Linnaeus, 1758 belonging to three families.

Hajduck (1984a, 1984b) contributed a lot to the study of

leeches in 1984a, He studied fauna of mid and lower current and the old beds of the Biebrza river (Poland). Material was collected from old river beds. A total of 3287 individuals were examined and assigned to the 15 species named in sequence Glossiphonia complanata Linnaeus 1758, G. heteroclita Linn, 1761, Hemiclepsis marginata Muller, 1778, Batracobdella paludosa Carena, 1824, Theromyzon tessulatum Muller, 1774, Hellobdella stagnalis Linnaeus 1758, Haimenteria costata (Pr Muller, 1846), Piscicola geometra Linnaeus, 1758. Cytobranchus fasciatus Kollar, 1842, Hirudo medicinalis Ray 1710, Haemopis sanguisuga Blanchard 1896, Erpobdella nigricollis, E. octoculata Linn. 1758, E. testacea Savigny, 1820 and Dina lineatus were reported. After this Hajduck (1984b) described the hirudinean fauna of the clay pits in stanowice near Swiebodzice (Lsfower sileia, Poland). He assigned 2038 individuals to 13 species, Glossiphonia complanata Linn. 1758, G. heteroclita Linnaeus, 1758, 1846, Hemiclepsis marginata Muller, 1718, Betracobdella palludosa, Carena, 1824, Theromyzon tessulatum, Muller, 1774, Hellobdella stagnalis Linn., 1758, Piscicola geometra Linnaeus, 1758 , Haemopies sanguisuga Blanchard, 1890, Erpobdella monostriata, E. nigricullis, E. octoculata Linn., 1758; E. testacea Savigny, 1820 and Dina lineata.

Baagoe et al. (1985) recorded Hirudo medicinalis Ray, 1710 from Denmark. Matsiak et al. (1985) studied the leeches occurring in low land streams of Norewka basin

(Poland). Erpobdella monostriata was found on piece of wood. Glossiphonia complanata Linn. 1758 was found on stones. E. nigricalis was found on water plants.. In summer no leech was found in peat bog, whereas in other seasons only Haemopsis sanguisuga Blanchard, 1896 and E. octoculata Linn. 1758 occurred.

Davis et al. (1985) described a new species Erpobdella montezuma from North America. Kutschera (1985) described a new species Hellobdella striata Ringuelet, 1943, a small flat leech, found from the running streams rich in aquatic plants. The hosts of H. striata included Oligocheta, aquatic snails and Asellus aquaticus.

Sket in 1985 and 1986 described Piscicola e hadzii a new species (Piscicolidae: Hirudinea) probably endemic species of leeches from Herzegovina yugoslavi and and in 1986, he recorded Piscicola hadzii new species from the Buna Spring near Mostar which was anatomically similar to the pontoaspian Casiobdella caspiea (Selensky). Yang (1985a, 1985b) described a new species, Placobdella multilineata from Crocodiles in China. In all 34 specimens were collected from Beijing. It was recorded for the first time from Asia.

Agapow et al. (1986) published the leeches from the planned Drawieski National Park (Poland). The material was collected from terrestrial habitats between 1976-1985 during the different seasons of all these years. Total of 6930

specimens from 31 localities were collected and examined and assigned to out of 23, species 18 were identified. Hajduck (1986) studied the hirudinean fauna of lake Jeziaro Lubiatowski (Poland). The material was collected from seven dunes of the lake yielded 1283 individuals of 13 species. Out of 13 species, 1 were Erpobdella octoculata Linn. 1758, Helobdella stagnalis Linn. 1758, Haementeria costata, Muller, 1846, Hirudo medicinalis Ray, 1710. Hartwich (1986) revised the types of Hirudinea in the Zoological Museum, Berlin, which include 51 species including one sub species preserved and arranged in alphabetical order.

Zhatkanbaeva and Ten (1987) described leeches of lake Markakal, U. S.S.R.. Eight species found were Protoclepsis tessulata, P. maculosa, Hemiclepsis marginata Muller 1728, Barreobdella verrucata Pr Muller, Glossiphonia complanata Linn. 1758, G. heteroclita Linnaeus, 1758, Helobdella stagnalis (Linn. 1758), H. octoculata. Delmastro et al. (1988) reported Piscicola geometra Linnaeus, 1758 from Italy. Kutschera et al. (1988) described a new species Hellobdella californica (Hirudinea: Glossiphoniidae) collected from slow lake, San Fransisco, California.

Madill (1988) studied the parasitic leeches of fish and reported these for the first time from Canada. The species found were Beringbdella retangula, Malmiana virida, Oceanobdella bollida and Ostriobdella papillata.

Okland (1988) found Bareobdella verrucata (Muller) and

Batracobdella poludosa (Carena 1824). Oosthuizen (1988) described and figured a new species Alboglossiphonia polypomphalyx from Egypt. In (1989), he reported Batracobdelloides tricarinata (Blanchard, 1897) from Africa.

Batra and Sawyer (1990) redescribed the genus of glossiphid leech, Clepsine picta Verrill 1872. Bielecki et al. (1990) reported new records of Copiobdella fadejewi (Epstein, 1961) from Leuciscus indus, Esox lucius, L. abramis, Rutilus surtilus collected from Biebrza river in Poland. In 1990, Jones and Woo redescribed the leech Desserobdella phalera, new combination (Graf, 1899) (Rhyncobdellida: Glossiphoniidae).

Nesemann (1990) reported five species from central Europe giving their ecology, zoogeography and taxonomy. The species were D. lineata, D. apathyi, D. punctata, Trocheta bykowskii Gedroyc, 1913 and T. pseudodina. Sapkarev (1990) described three new species from Balkan, Lake Ohrid. All the three species were found to belong to genus Dina namely D. kuzmani, D. lupnida, D. profund. Moser et al. (1991) listed sixteen sites for ten leech species in Nebraska, 3 of the 10 were new records. They were Alboglossiphonia heteroclita, Dina dubia Harding and Moore, 1951 and Theromyzon biquulatum.

Elshimy et al. (1991) gave the description of subspecies of Solifa perspicax Blanchard 1897, from Egypt. Ricciardi and David (1991) added seven new species from Island of Montreal to the list of Quebec fauna. Species described by him were

Cyotbranchus meyeri, Mooreobdella tetragon (reported for the first time in Canada), Myzobdella lugubris, Piscicola reducta Meyer, 1940, Actinobdella inequannulata Moore, 1961, Placobdella parasitica Say, 1824 and Cyotbranchus . Kahl et al. (1991) studied ten species of leech from Swietokrzyskii mountains. Out of ten, seven species studied were Glossiphonia complanata Linn. 1758, G. heteroclita Linn. 1761, Helobdella stagnalis Linn. 1758, Piscicola geometra Linnaeus, 1758, Haemopsis sanguisuga Blanchard 1896, Erpobdella monostricita, E. octoculata Linn. 1758 and Erpobdella species.

Oosthuizen et al. (1991) gave an annotated check list of leeches of Kruger national park (South Africa) along with a key to the species.

Finogenova et al. (1992) studied leech of lake Baikal Codobdella truneata and also proposed a new taxonomical status for Dagaroubdella zelensky.

Shankland et al. (1992) described a new species of Californian leech Helobdella robusta. Hussein et al. (1993) reported American fresh water leech, Hellobdella punctata lineata (Moore, 1939) in Drainage irrigation system of Egypt where it was introduced by man himself.

MATERIAL AND METHODS

Leeches were collected from different habitats of variable dimensions such as tanks, ponds, stagnant waters, seasonal ponds, paddy fields and vegetation of forest area of Punjab, Himachal Pradesh, Haryana Prant and Assam. In Punjab, various habitats were located at Dasuya, Jahura, Hazipur, Ladiari, Gaira, Saldarpur, Kizarpur, Matiana, Singriwala, Mai Dia Kanga (Hoshiarpur district), Rajpura (Patiala), Jhand Bali (Ferozepur), Murmandi, Prem Nagar, Dukhari, Model Town, Ambala City, Ambala Cantt were the places in Haryana Prant and Nadaun in Himachal Pradesh; material was also collected from quite a few ponds at Duliajan (Assam.).

Method of Collection

The leeches were hand picked, removed from cattles, gathered with a bottom dredge (Ekmanidredge). The bottom mud of the ponds was collected with the help of a dredge and thereafter leeches separated. Soon after collection the colour of leeches was observed and recorded. The leeches so collected were kept alive in glass jars half full of water and transported to the laboratory from various habitats.

Preservation

The leeches possess great power of contraction and can look short and stumpy if killed directly. Therefore, these were first relaxed in ethanol by keeping them in 10 % ethanol

for 30 minutes. Since leeches secrete mucus and blood often oozes through their mouth, the ethanol had to be changed three or four times. It was seen that After 30 minutes of keeping in the ethanol body contractions of animals became feeble and finally stopped making them to relax and mucus secretion and blood ooze also stopped. Then the leeches were properly dried on a filter paper so as to remove the mucous from their bodies. Thereafter, the specimens were preserved in 10% formalin solution in extended form. In some cases the specimens were pressed between two slides tied with thread and placed in glass jars having 10 per cent formaline solution. The leeches were preserved in specimen tubes in the formaline solution and stored for further study. For each tube, information about the localities of collection, date and time of collection was recorded.

Method of Study

As far as possible live specimens were studied. Diagnostic taxonomic characters such as number of segments, number of annuli in each somite, pair of eyes, their location, jaw structure, shape and size of anterior and posterior suckers, location of genital pores, structure of reproductive organs and gastric caecae were observed.

Staining and Dissection

For whole mount preparation specimens were stained with borax carmine after dehydration in alcohol series and mounted in DPX. Teeth cushions of leeches were also stained by the

same method. Live leech specimens were dissected after narcotization in 10% ethanol. The leech was stretched and pinned down in the dissecting dish through the mouth and posterior sucker. A mid-dorsal incision was given through the integument extending from anterior to the posterior end. The flaps of the body wall were separated from the underlying botryoidal tissue with a pair of forceps and sharp needles and pinned down in the dissecting dish. A small quantity of rectified spirit was poured on the dissected leech so as to give the internal viscera the necessary hardness required for dissection.

Measurements

Measurements were carried out with divider and scale. Measurement of teeth cushions reproductive organs, gonopores were carried out by using ooculometer.

Identification

The different leeches were identified up to the species level by using standard keys of Moore and Harding (1927), Ward and Whipple (1966) and Chandra (1983). The figures of specimens were drawn and in some cases photographs were also taken.

Repository

The specimens have been deposited in the Museum, Department of Zoology, Punjab Agricultural University, Ludhiana.

SYSTEMATICS

Genus Herpobdelloidea Kaburaki, 1921

Herpobdelloidea Kaburaki, 1921, Rec. Indian Mus. 18: 705.

Nematobdella Kaburaki, 1921, Rec. Indian Mus., 18: 706.

Small, slender, eyes a single dorsal pair on head and several small submarginal pairs on somites IV to IX or some of them, pharynx spiral twisted, atrium spheroid.

Colour

Variable pale buff, live reddish brown and preserved grey, body opaque or translucent.

Remarks

The variation in the number of accessory eyes in the H. lateroculata and H. indica indicates their derivation from a type having more numerous pairs, like Nematobdella. This genus embraces species showing diversity in the number of accessory eyes.

Type species: Herpobdelloidea lateroculata Kaburaki, 1921.

Herpobdelloidea indica (Kaburaki, 1921) .
(Figs. 1-5)

Nematobdella indica Kaburaki, 1921, Rec. Indian Mus., 18: 707, text fig., 7.

Herpobdelloidea indica Moore, 1927, Fauna of British India
Hirudinea, 144-148, Pl. III. Fig.3, VI, Figs.15,16;
Chandra, 1976a, Rec. Zool. Surv. India, 69: 327;
Chandra and Mahajan, 1976b, Rec. Zool. Surv. India,
69: 258; Mahajan and Chandra, 1976c, Rec. Zool. Surv.
India, 71: 146.

Slender, slightly wide at middle, pointed cephalic end,
Head small, six pairs of eyes present, first pair of eyes on
head region dorso-anterior, other four pairs of eyes lie
dorso-laterally on somites III, V, VI, VII, VIII, IX, a small
eye on somite IV also present; Clitellum well developed
glandular zone, darker, extending over eighteen annuli Xb5-
XIIIa2; Male gonopore ventro-median (Length and width-0.148 x
0.148 mm), large, rounded at the furrow of somites XIIb1/b2,
female gonopore ventro-median slit like (length and width, 0.81
x 1.11 mm), lying five annuli behind the male gonopore at
XII/XIII; Annuli wrinkled, body divided into somites having
variable annuli, I and II uniannulate, III uniannulate, IV and V
biannulate, VI quadrannulate, VII quinquannulate, VIII
sexannulate, IX-XXIII sexannuli, XXIV quinquannulate, XXV-
XXVII comprised of few or six annuli, Alimentary canal
complete from mouth to anus; pharynx long slender, spiral near
anterior end extending from VI-XII somites; Stomach thin
walled, translucent, six chambered extending from XIII-XIX
somites; intestine walls thicker opaque with pair of pockets;
anus opens at somite XXVII, Testes eight pairs on somites
XXIII-XVII; epididymis much folded on somites XVII-XV; atrium

glovoid, ovisacs small globoid, Nerve cord present mid ventrally.

Colour

Live specimens reddish brown, preserved specimens grey and white having black pigmentation on dorsal sides, dorsal side darker than the ventral side, clitterer region even more darker.

Locality

Gaira (Hoshiarpur) from a village pond.

Number of specimens

6(Preserved), measurements of 6 specimen taken.

Measurements

Mean length of leech	=	3.6 cm
Mean width of leech	=	0.4 cm
Mean length width of posterior sucker	=	0.2 cm
Mean length width of anterior sucker	=	0.1 cm

Remarks

This species has been reported from aquatic bodies of diverse forms from number of places as Simla (Himachal Pradesh), Patiala (Punjab), Madhya Pradesh, Maharashtra and Rajasthan (Chandra, (1983).The material at hand, however, was collected from a village pond at Gaira (Hoshiarpur). The present material agrees with the description given by earlier authors (Harding and Moore, 1927), the sole exception being the presence of pigments on the body

Genus Foraminobdella Kaburaki, 1921

Foraminobdella Kaburaki, 1921, Rec. Indian Mus., 18: 707.

Robust, eyes single dorsal pair on III, except first four somites and last three are complete somites consisting of seven annuli, dorsal opening into stomach at XIV/XV.

Colour

Grey, slaty having yellowish tinge,

Type species: Foraminobdella heptomerata Kaburaki, 1921.

Formaniobdella heptomerata Kaburaki, 1921
(Fig.6 -8; Plate I, Fig.a)

Foraminobdella heptomerata Kaburaki, 1921, Rec. Indian Mus., 18: 707-709, Fig.6 (Type Locality: Madras (India)).

Robust, uniform width, slightly tapers at ends, wrinkled lip short, mouth large, eyes one pair on somite III, clitellum thick zone, extending over twenty one annuli, Xb5-XIIIa2, male gonopore lie mid ventrally (length and width, 1.11 x 1.11 mm) on somites XI/XIII, female gonopore lie mid-ventrally (length and width, 0.259 x 0.259 mm) behind male gonopore on somites, XII/XIII, gut pore present dorsally on somite XIV/XV, body somites having variable annuli, I, II, III uniannulate, VI biannulate, V triannulate, VI quadrannulate, VII-XXIV

having seven annuli each, XXV quadrannulate, XXVI-XVII biannulate, internal anatomy not clear.

Colour

Colour grey, slight yellowish tinge, having black pigments on the dorsal side.

Locality

Safdarpur (Hoshiarpur), rice fields.

No. of specimens:

2 specimens. Measured 2.

Measurements

Length of leech	=	3.9 cm
Width of leech	=	0.6 cm
Length and width of posterior sucker	=	0.3 cm
Length and width of anterior sucker	=	0.2 cm

Remarks

The earliest record of this species is from Madras. The leech was collected from a stream and described by Harding and Moore (1927). The present specimens were collected from the rice fields of Safdarpur (Hoshiarpur). The specimens vary only from Kaburaki's description in the presence of black pigments on dorsal side of the body.

Genus-Hirudinaria, Whitman, 1886

Hirudinaria Whitman, 1886, Quart. Journ. Micr. Sci. 25:373.

Poecilobdella Blanchard, 1893, Boll. Mus. Zool. ed. Anat. Comp. 145.:28.

Limnatis (subgenus of Poecilobdella) Blanchard, 1897, Zool. Ergeb. Reise in Niederländisch Ost-Indien, 4: 337, 338.

Medium to large Sanguivorous leech, form generally robust, maximum width near middle tapering towards ends, recognisable into XXXIV somites, XXVII body segments, seven caudal sucker segments, I-VI segments forming cephalic region, VII-IX preclittellar region, X-XXIV post clittellar region, XXV-XXVII anal region XXVIII-XXXIV caudal region somites; Cephalic region mouth, jaws, on ventral side and eyes on dorsal side first pair of eyes on second somite; I, II, III somites uniannulate, IV, V somite biannulate, VI somite triannulate dorsally but biannulate ventrally, VII triannulate, somite VIII quadrannulate, IX-XXIII quinqannulate, XXXIV quadrannulate, XXV triannulate, XXVI biannulate, XXVII uniannulate, apertures median-ventral, separated by five to seven annuli, male gonopore on somite XI b5/b6, female gonopore on somite XII b3/b6 or XIII b5/b6 male aperture surrounded by narrow tumid area marked with furrow, a filamentous penis sometimes protrude through aperture, female generative aperture smaller, less conspicuous; integument rough, areolated especially at ends; sensellae large, linear, elevated or elliptical, transverse or oblique to body axis, salivary papillae, teeth monostichodont about hundred in number gastric caecae two pair per somite, unequal, spacious much lobulated, atrium pyriform differing in length and

proportion, ejaculatory bulb present, vagina distinctive, caecum opening through a duct into female bursa or vaginal stalk ;seventeen pairs of nephridia arranged metamerically; eleven pairs of testis sac; nerve cord present , median ventrally.

Colour

Dorsally green, brown or reddish with a very precise pattern of black stripes, median black or brown-stripe continuous or broken, four black supramarginal stripes on one side of median line and four on the other total of eight stripes arranged in different pattern around median line, marginal spots present, orange margins, yellowish orange ventral side, broad-black paramarginal stripes orange on ventral side.

Remarks

This is one of the commonest genera of leeches in India and neighbouring countries.

Type species: Sanguisuga javanica Wahlberg, 1856.

Hirudinaria javanica (Wahlberg, 1856) (Figs. 9 - 11; Plate 1, Fig. b)

Sanguisuga javanica Wahlberg, 1856, Ofversigt
Kangl. Vet. Akad., Forth: 233-234 (Type locality: Java
(Type-Deposited: Not known).

Hirudinaria javanica Whitman, 1886, Q. Journ. Microsc. Sci.,
26: 373-376, Pl.20, fig.56 (Caudal annulation, 21, 60
(jaw); Brandes, 1901, in Leukart Die Parasites des
Menschen, 2nd ed.1: 880-881, pL.2, Appendix Leipzig;
Moore, 1924, Proc. Acad. Nat. Sci. Philad. Ixxxii:

377, Pl. 19, Figs. 1, 10 (Exterior) (Type Locality- Assam); Moore, 1927, Fauna Brit., India, Hirudinea, 210-218.

Limnatis (Poecilobdella) javanica, Blanchard, 1897, Zool. Ergeb. Reise in Neiderlandisch Ost Indian, 4:349-351.

Limnatis javanica Kaburaki, 1921, Rec. Indian Mus. 711, 712.

Poecilobdella javanica Soos, 1970, Opus . Zool. Bpest, 10(2): 313-324; (Wahlberg) Chandra, 1983, Rec. Zool. Surv. India, 80: 284.

Robust, body tapers very little near both ends almost uniform in width, margins sharp when empty, rounded when filled with blood, head projecting as triangular point, five pair of eyes present antero-dorsally on annuli 2,3,4,6,9 of somites II, III, IV, V, VI, ^{separately} seventeen pair of nephridiopores present latero-ventrally VIII to XXIII; Male gonopore ventro-median (length and width, 0.37 x 0.74 mm) lies on furrow of somite XI b5/b6, female gonopore ventro-median (length and width, 0.37 x 1.11 mm) seven annuli posterior to male gonopore on somite XIII b2/b3, body divided into XXXIV somites having variable annuli, I, II, III uniannulate IV, V biannulate, VI triannulate dorsally, but biannulate ventrally, VII triannulate, VIII quadrannulate, IX-XXIII quinquannulate, XXIV quadrannulate, XXV triannulate, XXVI biannulate, XXVII uniannulate, XXVIII-XXXIV somites form circular caudal sucker, digestive tract extends from mouth to anus, jaws three large, median jaw prominent, pharynx ellipsoidal VIII to IX, crop thin walled with nine pairs of gastric caeca extends

from IX to XIX, intestine straight tube with lateral pouches; vas deference smooth and become slender when approaches epididymis, epididymis consists of few coils of the tubes, atrium small, atrium divided into penis sac and prostate, prostate further divided into short stalk and bursa, ovisacs lies on each side of nerve cord but close to median line, vagina consists of a short wide duct directed forward, seventeen pairs of nephridia, nerve cord ventro median.

Colour

Olive green dorsally, ventral side brown ventrally, flap orange, median discontinuous black stripe present on dorsal side, paramedian black dots present with supramarginal irregular stripes, paramarginal, black dots also present on dorsal side, broad-black paramarginal stripe present on ventral side.

Locality:

Duliajan (Assam)

Number of Specimens:

Fifteen

Measurements

Length of leech	:	5.6 cm
Width of leech	:	0.8 cm
Length and width of posterior sucker	:	0.8 cm
Length and width of anterior sucker	:	0.4 cm

Remarks

This species is very common in east Indian states West Bengal, Assam and Manipur. Outside India, there are reports of its occurrence from Sri Lanka, Burma, Java, Sumatra, Malaysia and Phillipines. For the present study, specimens were collected from paddy fields, tanks and pools etc. The leech is known to attack cattle and human beings in eastern Indian states (Chandra, 1983). The present specimens also collected from Assam. The specimens were compared with the details given by Harding and Moore (1927). The length of the present specimen is less than the specimens described first.

Hirudinaria manillensis (Lesson, 1824) (Plate 1, Fig. c)

- Hirudo manillensis Lesson, 1824, Revue Zoologique Societe Curierieme, 8 (Type Locality: Luzoa, Phillipines Islands; (Type Depoted: Not known).
- Limnatis (Poecilobdella) manillensis Moore, 1924, Proc. Acad. nat. Sci. Philad. Ixxxix: 376 (Type-Locality-Philippines, Java, Sri Lanka, Siam and South India).
- Hirudinaria manillensis, Moore, 1927, Fauna Brit. India, Hirudinea, 218, 226.
- Poecilobdella manillensis Soos, 1970, Opusc. Zool. Bpest, 10(2): 313-324; (Lesson) Chandra, 1983, Rec. Zool. Surv. India, 80: 284.
- Hirudo multistriata Schmarda, 1861, Neue Turbellarien, Rotatorien Und Anneliden, Leipzig, 2 te Halfte, Leeches, 2-7.
- Hirudo luzonia Kinberg, 1866, Ofver Kongl. Vet. Akad. Forh. 1865, 9, Hirudinacea; 256 (Type Locality: Manila).

- Hirudo maculosa Grube, 1868, Novara Reise. Zool. Bd.ii, Abth.3. Anneliden. Wien. Lechner, 30, 40, Taf.4, fig. 6 (Exterior and colour pattern) (Type Locality: Singapore)
- Limnatis maculosa (Grube) et granulosa (Savigny), 1901, Brandes, In Leukart. Die Parasiten des Menschen, 2nd ed, 1: 878-879, Pl.2, Appendix Leipzig.
- Limnatis maculosa (Grube) De Qual, 1917, Boll. Mus. Zool. ed. Anat. Comp., 32, 724:9 (Type Locality; Siam). Singapore).
- Hirudo maculota. Baird, 1869, Proc. Zool. Soc. London, 315 (Type-Locality: Siam).
- Limnatis (Poecilobdella) granulosa Blanchard, 1893, Boll. Musei. Zool. Anat. Comp. Univ. Torin, 7(145): 32; (Savigny) Blanchard, 1897, Zool. Ergeb. Reise in Neiderlandisch Ost-Indian, 4: 338-349, text figs. 3-6; (Savigny) Kaburaki, 1921, Mem. Indian Mus., 673-675.
- Limnatis granulosa (Savigny) Robertson, 1909, Quart. Journ. Micr. Sci. Iiii: 676-679; (Savigny) Kaburaki, 1921, Rec. Indian Mus., 711.
- Hirudo boyntoni Wharton, 1913, Philip. Journ. Sci., 8: 369-371 (Type Locality-Phillippine Islands).

Robust, sides rounded, elliptical in section, width equal throughout the body else at middle third of body, head broad, lip rounded and broad, cephalic sucker extends from I-IV somite, eyes five pair present antero dorsally on annuli 2, 3, 4, 6, 9 of somites II, III, IV, V, VI nephridiopores seventeen pairs on somite, male gonopore present mid ventrally (length and width, 0.37 x 0.37 mm) in furrow of somite XI b5/b6, female gonopore present mid-ventrally (lenmgth and width, 0.185 x 0.185 mm) five annuli posterior to male gonopore on somite XII b5/b6, body divided into XXXIV

somites having variable annuli, I,II, III uniannulate, IV, V biannulate, VI triannulate dorsally but biannulate ventrally, VII triannulate, VIII quadrannulate, IX-XXIII quinquannulate quadrannulate, XXXV triannulate, XXVI biannulate, XXVII uniannulate, XXVIII-XXXIV seven somites form circular caudal sucker; digestive tract extends from mouth to anus, three jaws large prominent, papillae and teeth present on jaws, pharynx fusiform present on somites XIII to IX, crop thin walled sac with lateral lobes, lateral caecae nine pairs extending from somite IX to XIX, intestine without lateral pouches; anus present dorsally on somite VIII, twelve pair of testis sacs present on somites XXVII; vas deference continuous to epididymus, epididymis small knot of few coils, atrium (Length and width, 1 mm) lies right to nerve cord, small, calvate, penis sac and prostrate present, vagina small (length 6 mm), ovi-sacs open by oviducts into female bursa, vagina with wider sac (2 mm wide) and narrow duct (1 mm wide) also opens into the bursa, nephridia seventeen pair present, six pairs of pre-testicular nephridia and eleven pairs of testicular nephridia, nerve cord mid-ventral extends from anterior to posterior end.

Colour

Dorsal surface olive green, ventral surface orangish-yellow, black median stripe on dorsal side, supra marginal irregular wavy narrow stripes present, para-marginal black

dots also present, flanks orange, broad black para marginal stripe present on ventral side.

Locality

Prem Nagar (Ambala) in Haryana Prant.

Number of Specimens

Fifteen

Measurements

Specimens measured	:	5
Mean length of leech	:	7.5 cm
Mean width of leech	:	0.82 cm
Mean length of anterior sucker	:	0.62 cm
Mean width of anterior sucker	:	0.63 cm
Mean length of posterior sucker	:	0.36 cm
Mean width of posterior sucker	:	0.59 cm

Remarks

This species is very common in south-east India. It has been reported from Uttar Pradesh, West Bengal, Assam, Kerala (India); Pakistan, Sri Lanka, Burma, Borneo, Malaysia, Phillipines and China. It was found in paddy fields, tank, pools and rivers (Chandra, 1983). It attacks cattle and human beings, the present specimens were collected from stagnant water bodies at Prem Nagar, Ambala. This was used for medicinal purpose.

Hirudinaria granulosa (Savigny, 1820)
(Figs. 12-15)

Sanguisuga granulosa Savigny, 1820, Systeme des Annelids, Paris
(Type locality: Pondicherry: Type-Deposited: Not known)

Hirudo granulosa Moquin-Tandon, 1846, Monographie de la famille des Hirudinees, 2nd ed., Paris.

Limnatis (Poecilobdella) granulosa (Savigny) Blanchard, 1893, Boll. Musci. Zool. Anat. Comp. R., Univ. Torino, 8: 26; (Savigny) Blanchard, 1897, Zool. Ergeb. Reise in Neiderlandisch Ost. Indien, 4: 338-349 test figs. 3-6 (Type locality: Hindustan and Burma); (Savigny) Mathal, 1920, Jour. & Proc. Asiatic Soc. Bengal, 8: 344-346, text. 1 and Pl. xviii (Cocoon formation); Kaburaki, 1921, Mem. Indian Mus., 5: 673-675; Kaburaki, 1921, Rec. Indian Mus., 38: 711; Moore, 1924, Proc. Acad. Nat. Sci. Philad. IXXXIII: 375-377 (Type Locality: Punjab).

Limnatis granulosa (Savigny) Khan, 1912, Rec. Indian Mus., 206-207 (Culture).

Hirudinaria (Poecilobdella) granulosa Moore, 1927, Fauna Brit. India, Hirudinea, 226-238.

Poecilobdella granulosa Soos, 1970, Opus. Zool., Bpest. 10(2): 313-324; (Savigny) Chandra, 1983, Rec. Zool. Surv. India., 80: 285.

Hirudinaria granulosa Chandra, 1977, Rec. Zool. Surv. India, 73(1-4): 189-195.

Large, robust body, dorso-ventrally flattened when extended, elliptical in transverse section, body wall more thicker dorsally than ventrally; mouth having three jaws bearing teeth, measurements of specimens vary, length of jaw from 1.3 mm to 2.9 mm, width of jaw from 0.74 mm to .85 mm, length of teeth from 0.03 mm to -0.06 mm, width of teeth ^{from} 0.015 mm to 0.03 mm; head broad bearing five pairs of eyes antero-dorsally on annuli 2,3,4,6,9 of somites II, III, IV, V, VI;

nephropores seventeen pairs present ventro-laterally at somites VIII to XXIV; male gonopore circular, present mid-ventrally (length and width, 1.11 x 1.11 mm) in furrow of somite XI b5/b6; female gonopore transverse slit, present mid-ventrally (length and width, 0.74 x 1.48 mm) five annuli posterior to male gonopore in furrow of somite XII b5/b6; anus dorsal opening on somite XXVII; sensillae present throughout body; body somites XXXIV having variable annuli, somites I, II, III uniannulate, IV, V biannulate, VI triannulate dorsally but biannulate ventrally forming buccal ring, VII triannulate, VIII quadrannulate, IX-XXIII quinquannulate, XXIV quadrannulate, XXV triannulate, XXVI biannulate, XXVII uniannulate; XXVIII-XXXIV form circular caudal sucker, comprised of seven irregular concentric circles; alimentary canal straight extended from mouth to anus, divisible into pre-oral chamber, oesophagus crop, stomach, intestine and rectum, mouth bordered by three unequal jaws, median jaw more prominent, jaws having numerous papillae and short teeth with blunt cones; pharynx short, fusiform extending through somite XIII and part of X; crop extending from somite IX to XXIII, thin walled with nine pairs of gastric caecae; stomach heart shaped in somite XIX, intestine straight narrow tube extending from somite XX to XXIII; testes-sac eleven pairs in somites XIV to XXIV, epididymis well developed, atrium (length and width, 4.44 mm and 4.07 mm) pyriform, equal in size to epididymis (length and width, 3.77 mm and 3.81 mm) but smaller

than vagina; vagina divided into two parts: stalk (1.85 mm wide) and caecum(4.44 mm wide), ovisacs ovoid, oviduct join vagina at middle of its length, nephridia seventeen pairs, six pre-testicular and eleven testicular nephridia; nerve cord run mid-ventrally with ganglia from anterior to posterior end.

Colour.

Olive, green at dorsal side and orangish yellow ventrally, margins sharply defined, stripes of orange bounded ventrally by a broad, black paramarginal stripe and dorsally by a series of metameric black spots on b2 and b5, median continuous black stripe on dorsal side with supra-marginal black stripes.

Locality

Ponds of different dimensions at Hoshiarpur, Patiala, Ferozepur (Punjab), Ambala (Haryana Prant), Nadon (Himachal Pradesh)..

Number of specimens

Total 56, measured 25.

Measurements

Mean body length = 11.452 cm

Mean cephalic sucker size= 0.256 cm

Mean caudal sucker size = 0.576 cm

Remarks

H. granulosa is the commonest species of leeches in India, Sri Lanka, Nepal and Burma (Harding and Moore, 1927).

The earliest Indian records of this species were from Himachal Pradesh (Chandra, 1976b), Uttar Pradesh, Gujarat, Maharashtra (Chandra, 1976a), Madhya Pradesh, Tamil Nadu States. In Punjab, this species was reported only from Patiala (Chandra, 1983). But in the present work, these are reported from three districts of Punjab. It is also being reported from Himachal Pradesh and Haryana. The leech occurs in rivers, marshes, swamps, tank pools and attacks cattle visiting these water bodies. This leech species has been recorded from 3,000 m in Kumaon hills. The occurrence of this species in the paddy fields is of concern because rice planters can be inflicted by them. The farmers should be made aware of the occurrence of leech in the paddy fields. This species can be easily recognized by colour, presence of five pairs of eyes on first nine annuli, five annuli different in male and female genital pore and three jaws. the paddy fields. This species can be easily recognized by colour, presence of five pairs of eyes on first nine annuli, five annuli different in male and female genital pore and three jaws.

Hirudinaria (Poecilobdella) viridis Moore, 1927
(Figs. 16 - 17; Plate II, Fig. a and b)

Hirudinaria (Poecilobdella) viridis Moore, 1927, Fauna Brit. India, Hirudinea, 239-243 (Type Locality: Travancore, Kerala; Type-deposited: Z.S.I.).

Hirudinaria viridis Chandra, 1966(1970) Rec. Zool. Surv. India,
64(1-4): 107-110.

Poecilobdella viridis Soos, 1970, Opus. Zool. Bpest. 10(2):
313-324; (Moore) Chandra, 1983, Rec. Zool. Surv.
India, 80: 285.

Large, robust body, equal width except at posterior half, tapering towards ends, elliptical in section, sides rounded, head broad, oral chamber spacious, five pairs of eyes present antero-dorsally on annuli 2,3,4,6,9 of somites II, III, IV, V, VI, ^{respectively} seventeen pairs of nephridiopores present ventro-laterally on somites VIII- XXIII male gonopore present mid ventrally (Length and width, 0.19 x 2.59 mm) in furrow of somite XI b5/b6; female gonopore present mid-ventrally (length and width, 0.74 x 1.11 mm) five annuli posterior to male gonopore in furrow of somite XII b5/b6; body divided into XXXIV somites having variable annuli, somite I, II, III uniannulate, IV, V biannulate, VI triannulate dorsally but biannulate ventrally, VII triannulate, VIII quadrannulate, IX- XXIII quinquannulate, XXIV quadrannulate, XXV triannulate, XXVI biannulate, XXVII uniannulate, XXVIII-XXXIV form the circular caudal sucker seven somites represented by seven concentric circles; digestive tract straight extends from mouth to anus, three jaws prominent, pharynx fusiform present from VIII to IX; crop with nine pairs of lateral caecae extending from X to XIX somite; stomach small, anus present dorsally on somite XXVII, penis protrudes as coarse filament, having length, 3.7 mm and width, 0.72 mm, from male gonopore; testis sac eleven pairs on

somite; no distinctive vas deference present, epididymus giving rise to ductus ejaculatoris (Length and width 5.mm and 2.5 mm), atrium large (length, 5 mm and width 3 mm), penis sac present, Vagina large, 15 mm long, extends up to two somites; ovisacs and oviducts very small not distinctive, vagina long with vaginal caecum (3 mm wide) and stalk(2 mm wide), nephridia seventeen pairs present on somite VIII to XXIII, nerve cord run mid ventrally from anterior to posterior end.

Colour

Dorsal surface olive green, ventral surface brown flanks orange, on dorsal side, median black stripe, irregular black supramarginal stripes present, submarginal black discontinuous stripe, broad black submarginal stripe on ventral side.

Locality

Seasonal pond at Chandigarh.

Measurements

Length of leech	:	17 cm
Width of leech	:	1.5 cm
Length and Width of posterior sucker	:	1.3 cm
Length and width of anterior sucker	:	0.8 cm

Remarks

Hirudinaria viridis was described by Moore from Kerala (India) in 1927. Though not very common, this species has been

reported from Himachal Pradesh, Uttar Pradesh, Tamil Nadu, Kerala from Paddy fields and ponds, attacks cattles. The present author was successful in collecting a single large specimen of H. viridis from seasonal pond at Chandigarh in Sector 24D.

Hirudinaria sp.indt.
(Figs. 18-19; Plate II, Fig.c)

Robust, elliptical, width equal throughout the body else at middle third of body, head broad, cephalic sucker circular extends from I-IV somite, eyes five pairs present antero-dorsally on annuli 2,3,4,6,9 of somites II, III, IV, V, VI, seventeen pairs of nephridiopores present on somites VIII-XXIII, male gonopore lie mid ventrally (length and width, 1.11 x 1.11 mm) in furrow of somite XI b5/b6, two female gonopores present first gonopore lie mid-ventrally (length and width, 0.69 x 1.32 mm) five annuli posterior to male gonopore on somite XII b5/b6, second female gonopore (length and width, 0.62 x 1.22 mm) lie five annuli posterior to first female gonopore on somite XIII b5/b6, body divided into total XXXIV somites having variable annuli, I, II, III, uniannulate, IV, V biannulate, VI triannulate dorsally but biannulate ventrally, VII triannulate, VIII quadrannulate, IX-XXIII quinquannulate, XXIV quadrannulate, XXV triannulate, XXVI biannulate, XXVII uniannulate, XXVIII-XXXIV seven somites form

circular caudal sucker, seven circular rings and seventy two rays present on caudal sucker, length of caudal sucker more than width; digestive tract complete extends from mouth to anus, three jaws large, median jaw large convex, teeth and salivary papillae present on jaws, pharynx ellipsoidal present on somite VIII to IX, crop thin walled saccate, nine pairs of gastric caecae on somite IX to XIX, intestine straight, rectum small, anus present dorsally on somite XXVII, vas deference continuous to epididymus, atrium small first female vagina sac like having small ovary on left side, second female vagina also sac like small ovary on left side second female genital organs lying over the first female genital organs; seventeen pair of nephridia present ventrally; nerve cord run mid ventrally run from anterior to posterior region.

Colour

Dorsal side olive green, ventral side orangish-yellow, flanks orange, black median stripe present on dorsal side with supramarginal stripes and paramarginal black spots, broad black paramarginal stripe present on ventral side.

Locality

Dasuya (Hoshiarpur).

Number of specimens:

One specimen

Measurements

Length of leech : 6.7 cm

Width of leech : 0.7 cm
Length and width of posterior sucker : 0.7 & 0.6 cm
Length and width of anterior sucker : 0.45 & 0.4cm

Remarks

The literature scan reveals that this species has not been described so far, hence appears new to science. The leech was collected on Hoshiarpur-Dasuya road from a seasonal pond. A total of fifteen leech specimens were collected from the habitat of which 14 were found to be conspecific with Hirudinaria granulosa Savigny, 1820 (described on page 36). The 15th specimen could not be assigned to any known species of leech. Detailed investigation of external morphology and anatomy reveals that this species belongs to genus Hirudinaria Whitman, 1886 for its possession of five pair of eyes on head region on first nine annuli specially one annuli difference in 3rd and 4th pair of eyes, five annuli difference in the genital pores, seventeen pair of nephridia etc. This species comes close to the species of Hirudinaria due to possession of above characters.

Pseudohirudinaria assamensis gen. et sp. nov.
(Figs. 22-24; Plate III, Fig. a)

Diagnostic characters

Two pair of eyes present dorsally on head region on

somites II and IV, six annuli different in male and female gonopores.

Robust, large, sides rounded, width equal, throughout the body else at middle third of the body, head broad eyes two pair present antero-dorsally on annuli 2, 5 of somites II, IV; nephridiopore seventeen pairs, male gonopore present mid ventrally (length and width 0.92 x 1.11 mm) at somites X1b2/a2, female gonopore (length and width, 0.37 x 1.11 mm) present at somite X11b5, body divided into XXXIV somites having variable annuli, I, II, III uniannulate, IV biannulate, V biannulate dorsally but uniannulate ventrally, VI, VII triannulate, VIII quadrannulate, IX-XXIII quinquannulate, XXIV-XXVI somite division is not distinguishable, XXVIII-XXXIV seven somites form caudal sucker, digestive tract complete extends from mouth to anus, three jaws large, pharynx fusiform, stomach thin walled nine pairs of gastric caecae extending from X to XIX somite, testis sac eleven pairs continuing from somite XIV, vasdeference continuous to epididymus; epididymus of few coils having length, 1.55 mm and width, 1.11 mm, atrium small having length, 1.92 mm lies left to nerve cord, vagina small with very small ovisacs, length and width of vagina, 3.33 mm and 3.70 mm, seventeen pairs of nephridia present, nerve cord present mid-ventrally runs from anterior to posterior end.

Colour

Dorsal surface, olive green, ventral orangish yellow in five specimens turned grey in preserved specimens, discontinuous median line is present on dorsal side, para median spots and supra marginal stripes are also present on dorsal side, flaps are orange, para marginal black spots present of shape, broad-black paramarginal stripe is present on the ventral side.

Type Locality

Duliajan (Assam) from a pond. The temperature, depth and dimensions of pond were 19.5°C, 15 feet, 10 x 20 feet respectively at the time of collection.

Itemology

The generic name has been given as a different form from genus Hirudinaria yet close to it in external morphology, colour pattern and anatomy, new species is named after Assam, an eastern Indian state from where the taxon was collected.

Repository

The holotype has been deposited in the museum of Deptt. of Zoology, P.A.U., Ludhiana. This will, however, be shifted to the Z.S.I. Museum, Calcutta as on as the paper appears in print.

Measurement

1 Specimen

Length of leech : 7.5 cm

Width of leech : 1.2 cm

Length and width of anterior sucker : 3 and 7 cm

Length and width of posterior sucker : 0.7 cm

Remarks

The sale specimen of the taxa at hand was collected from a temporary pond in Duliajan (Assam). Specimen resemble in external morphology colour pattern; internal anatomy-nephridia, genital organs, nervous system and digestive system with the genus Hirudinaria yet differ in the presence of two pairs of eyes, six annuli difference in male and female gonopores, annuli of somites, XXIV-XXVII are not very clear. The annuli of Hirudinaria VI is triannulate dorsally and biannulate ventrally but in case of present specimen V somite is biannulate dorsally and uniannulate ventrally. The present author considers that the present taxa though close to genus Hirudinaria described by Harding and Moore (1927) yet differs from it in the characters mentioned above which are taxonomically important to accommodate this new genus Pseudohirudinaria is erected with the description of new species, P. assamensis, its type species. It is hoped that in due course of time some new species will be described and accommodation under this new genus.

Genus Haemadipsa (Tennent, 1859)

Haemadipsa Tennent, 1859, An account of the Islands, etc. 2 vols. London, 4th ed., 1860. Leeches, 302.

Haemadipsa, Whitman, 1886, Quart. Journ. Micr. Sci.
26: 322.

Haemadipsa Blanchard, 1917, Bull. de la Soc. Pathologie
Exotique, 10: 656, 657,

Size small, form slender, subcylindrical, tapering to head from near caudad end, tip triangular, eyes large, first four pairs usually contiguous annuli, third and fourth pair separated by partial or complete annulus, gonopores separated by five annuli (X1b5/b6 and X11b5/b6), integument tessellated areas prominent on head and caudal sucker, caudal sucker with radiating ribs, nephridiopores marginal, jaws three prominent, teeth acute, conical slightly curved, pharynx with three or six longitudinal folds; stomach bearing simple unbranched caecae, one pair in each somite, the last pair elongated, atrium small, pyriform, ejaculatory bulb little developed, epididymus an open convoluted loop, vagina divided into a narrow tubular duct and cylindrical caecal sac.

Colour

Colour varied black or brown with yellow regions and yellow margins, longitudinally striped or mottled, without or with yellow spots.

Remarks

Land leeches of Indian region are extremely variable at least externally. They fall into different geographical races distinguished by size, colour, pattern arrangement of head



plates and number of sucker rays. This genus is very common in damp, drippy forests of south east India and neighbouring countries like Sri Lanka, Nepal, Burma, Java, and Sumatra. In the present work, this genus is represented by one species.

Type Species: Sanguisuga zeylanica Moquin-Tandon, 1826.

Haemadipsa zeylanica Moquin-Tandon, 1826

Sanguisuga zeylanica, Moquin-Tandon, 1826, Monographs de la famille des Hirudinees, Moutpellier, 126.

Hirudo zeylanica Moquin-Tandon, 1846 Monographs de la famille des Hirudinees Moutpelleir, 2nsd ed. Paris: 346.

Haemadipsa zeylanica (Moquin-Tandon) Blanchard, 1894a, Abhandll u Ber. d. k. Mus. Zool. Anthr. Eth du Dresclen, 1892-3, 4:5, figs.3-7; 1894c, Ann. Mus. Civico. di sterio Naturelle, Genova, (2): 113. (Moquin-Tandon) Blanchard, 1917, Bull. de la Soc. Pathologie Exotique, 10: 657-661, text figs. 2-6, Pl.7. (MoquinTandon) Kaburaki 1921, Rec.Indian Mus., 18: 715-716. (Moquin-Tandon) Moore, 1924, Proc. Acad. Nat. Sci. Philad., 131: 363, 384. Chandra, 1970, Rec. Zool. Surv. India, 64(1-4): 107-109 (1966). Chandra, 1976, Rec. Zool. Surv. India, 69: 259.

Hirudo (Haemopsis?) ceylanica Schmarda, 1861, New Turbellarien, Rotatorien und Anneliden. Leipzig Zte Halfte, Leeches: 3, Taf, 16, fig.143.

Haemadipsa ceylanica Tennent, 1859, An account of the Island, etc. 2 vols. London. 4th ed., Leches: 301-304. (text figures of movements, head and teeth) (Type Locality: Ceylon); Whitman, 1886, Quart. Jour. Micr.Sci. 26: 319-349. (in account of H. japonica, pl. 18, figs.8 and 9 (Colour)); Blanchard, 1887, Dictionnaire encylcopedique sci med. Art. Hirudinees. Paris: 156. Haemadipsa ceylanica Brandes, 1901 in Leukart. Die Parasiten des Menschen, 2nd ed., 1: 886-889.

Haemadipsa zeylanica cochiniensis Moore, 1927
(Figs.22-26; Plate III, Fig.b and c)

Haemadipsa zeylanica cochiniensis Moore, 1927, Fauna
Brit.India, Hirudinea, 265-266 (Type Locality:
Cochin, Kerala: Type Deposited: Z.S.I.); (Moore)
Soos, 1967, Acta Zool. Hung., 13(3-4): 417-432;
(Moore) Chandra, 1983, Rec. Zool. Surv. India, 80:
286.

Small slender, tapering more towards cephalic end, head expanded triangular rough with prominent tessellae, eyes five pairs on annuli 2,3,4,5,8 of somites II,III, IV, V, VI, nephridiopores seventeen pairs marginal on somites VIII-XXIV. Gonopores lie midventrally, male gonopore small(length and width, 0.185 x 0.185 mm), round at somite X1b5/b6, female gonopore small round(length and width, 0.185 x 0.185 mm) lie five annuli posterior to male gonopore at somite X11b5/6, anus small on somite XXVII, body divided into XXXIV somites having variable annuli I, II, III, IV not defined due to areoli, somite I, three assymetrical subcircular areas, II, III, IV having irregular areas on annuli,V biannulate, VI, VII, triannulate, VIII quadrannulate,IX-XXIII quinquannulate, XXIV triannulate, XXV-XXVII uniannulate, XXXVIII-XXXIV seven somites form caudal sucker with 70 rays, digestive system complete from mouth to anus, jaws three, Pharynx, fusiform extending from somite VIII-IX, stomach with ten pair of caecae

present on somites X-XIX nine pair of caecae simple unbranched but last pair branched, testis sac ten pairs, spheroidal on somite XII-XIII, vas deferens folded, epididymus loosely folded, atrium pyriform present above nerve cord, penis sac short, vaginal sac small with ovisacs on each side of nerve cord, vaginal duct narrow and straight, nerve cord run midventrally.

Colour

Colour is reddish-brown both dorsally and ventrally black narrow median dorsal stripe is present with two dark black supra marginal stripes on the dorsal side. No other markings present on the body except eyes on the head region.

Locality: Duliajan (Assam).

Number of specimens : 24 specimens, 15 measured.

Measurement

Mean length of the body	: 1.34 cm
Mean width of the body	: 0.3 cm
Mean length and width of posterior sucker:	0.51 cm
Mean length and width of anterior sucker:	.08 cm

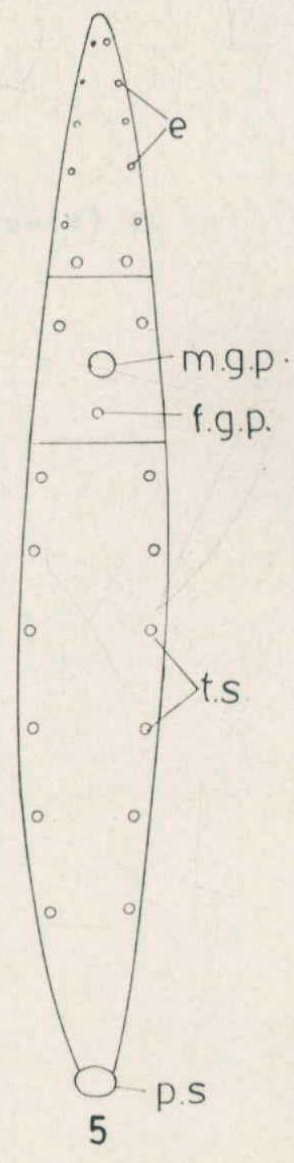
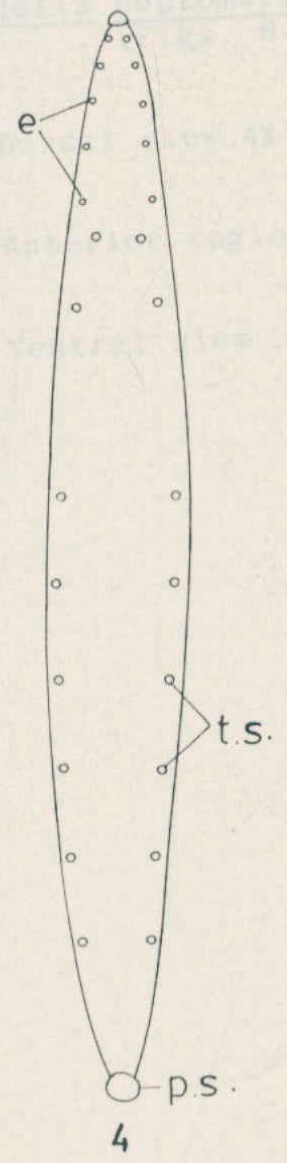
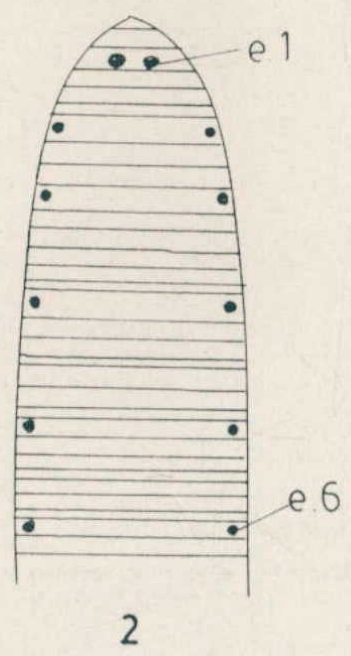
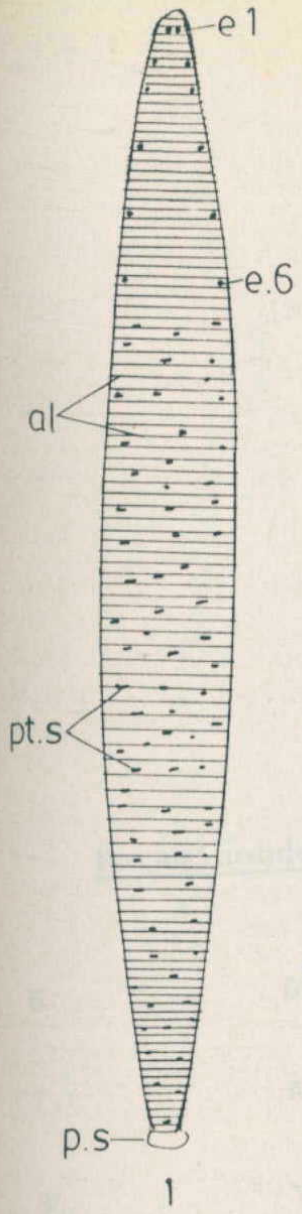
Remarks:

Till now four subspecies of H. zeylanica are known. This was recorded in India from Cochin, Nilgris Hills, Madras, M.Kanara and Bombay. The present specimens were collected from Duliajan (Assam). Though can be assigned to H. zeylanica

cochiniana, yet minor variations in colour and presence of dorsal stripes exist. Harding and Moore (1927) described only one dorsal stripe on the species examined by them but the material at hand has three dorsal stripes.

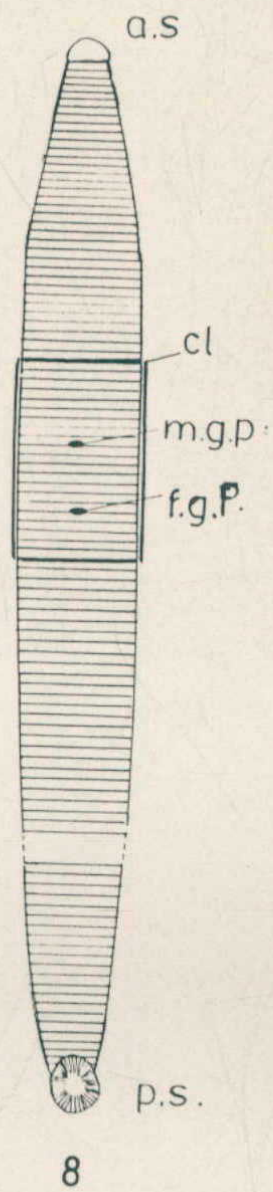
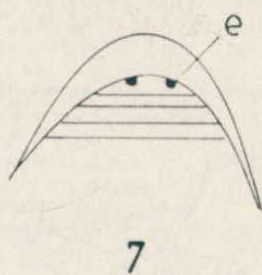
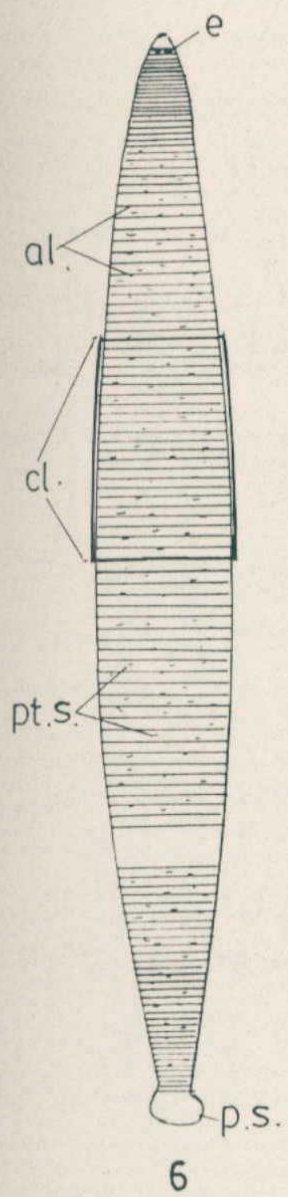
Herpobdelloidea indica (Kaburaki, 1921)
(Figs. 1-5)

1. Dorsal view .4X
2. Anterior region bearing six pairs of eyes (e.1-e.6), 6X
3. Ventral view .4X
4. Dorsal view .4X
5. Ventral view .4X



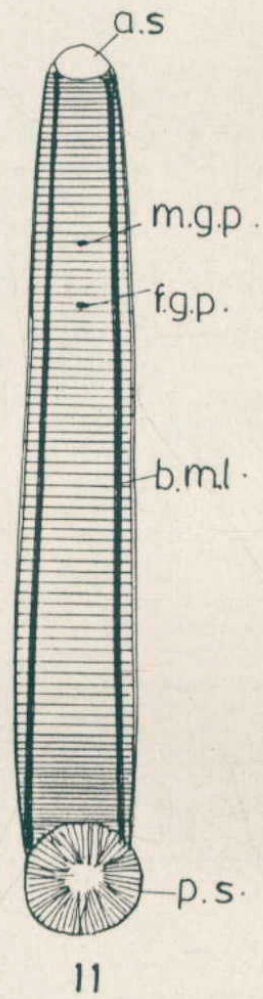
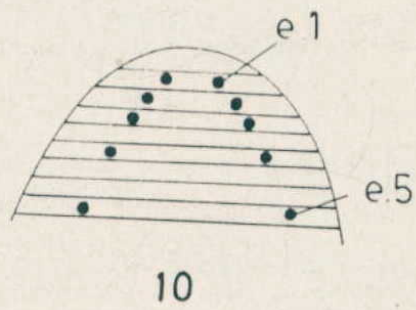
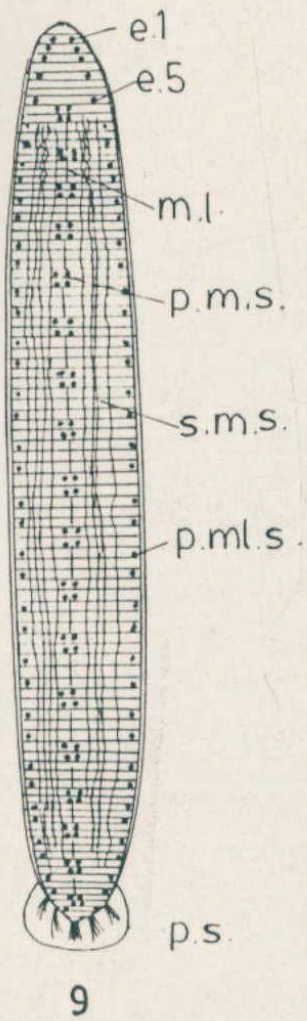
Foraminobdella heptomerata Kaburaki, 1921
(Figs. 6-8)

6. Dorsal view.4X
7. Anterior region bearing eyes(e).4X
8. Ventral view .4X



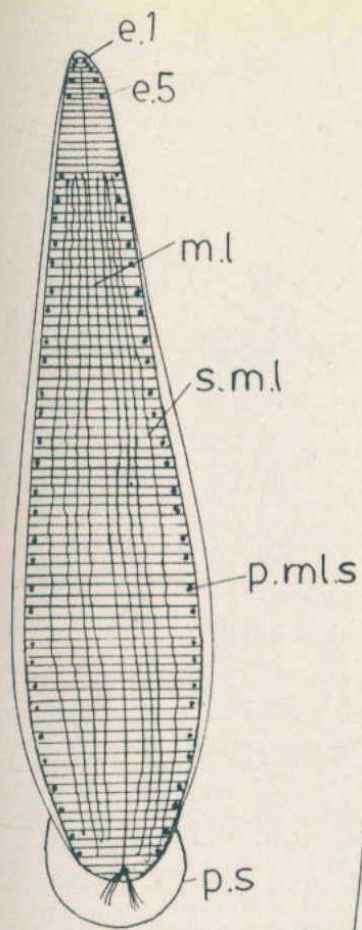
Hirudinaria javanica (Wahlberg, 1856)
(Figs. 9-11)

9. Dorsal view .4X
10. Anterior region showing eyes (e. 1-
e. 5). 4X
11. Ventral view. 4X

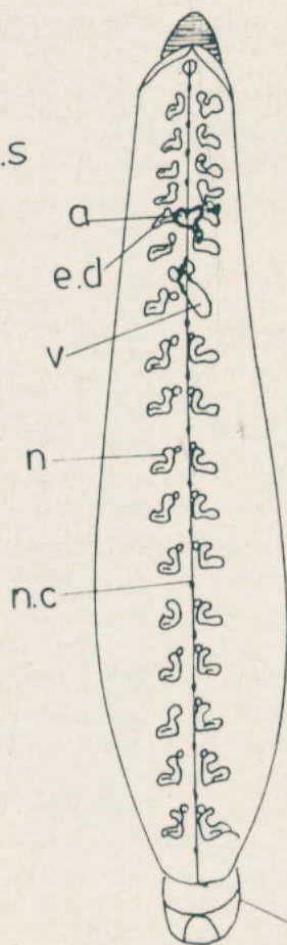


Hirudinaria granulosa Savigny, 1820
(Figs. 12-15)

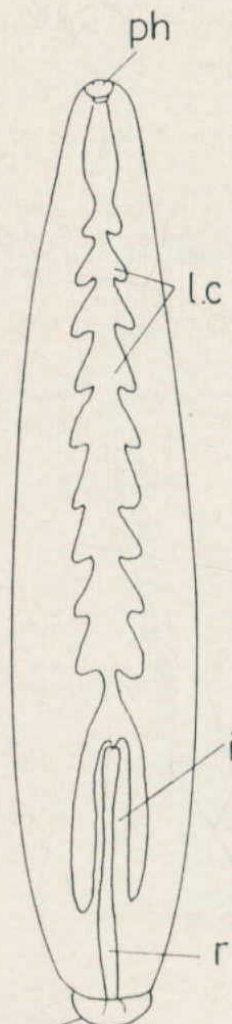
- 12. Dorsal view
- 13. Ventral view
- 14. Dissected specimen
- 15. Dissected specimen



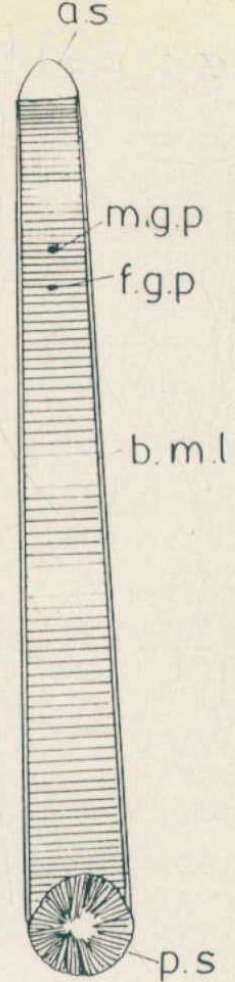
12



14



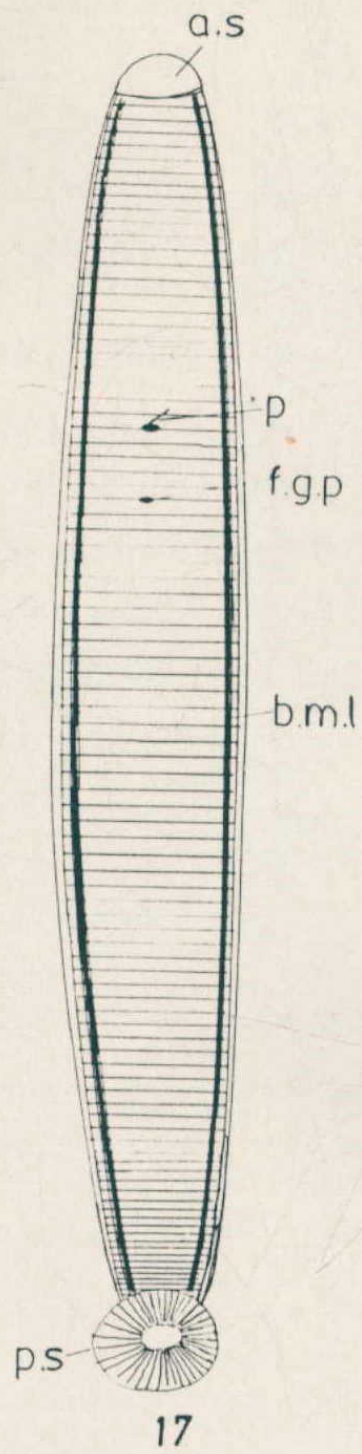
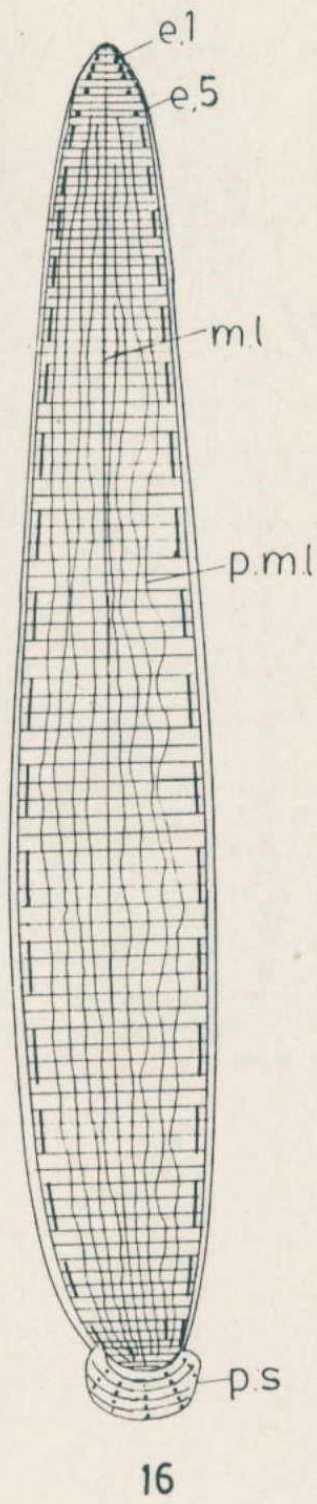
15



13

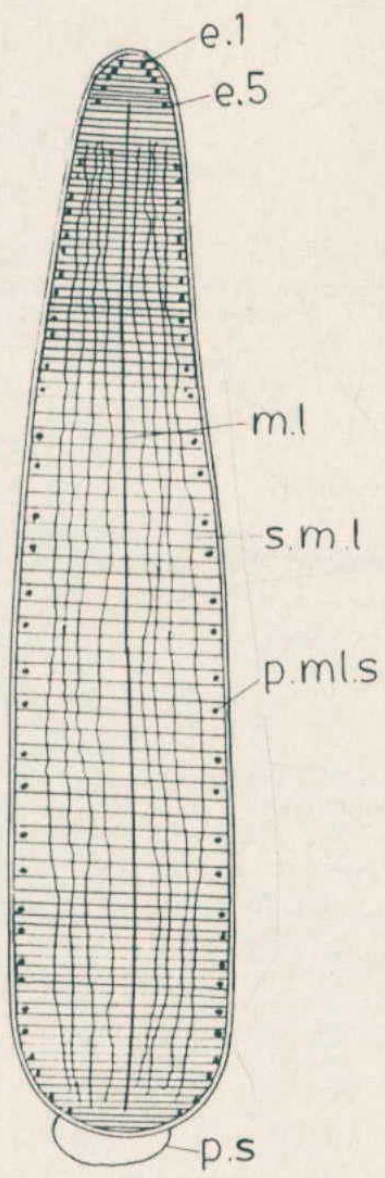
Hirudinaria viridis Moore, 1927
(Figs. 16-17)

16. Dorsal view
17. Ventral view

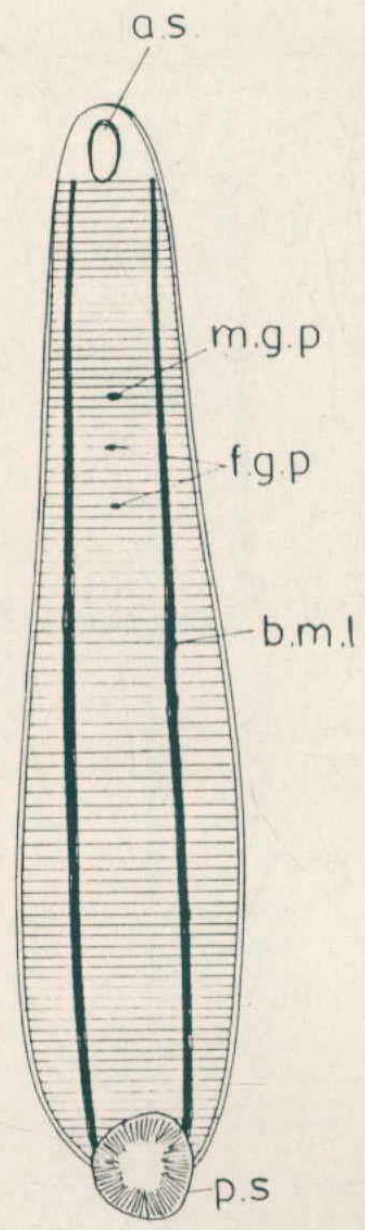


Hirudinaria sp. indt.
(Fig. 18-19)

18. Dorsal view .2X
19. Ventral view .2X



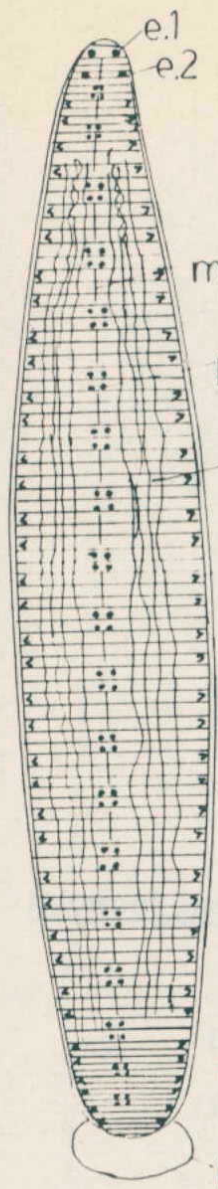
18



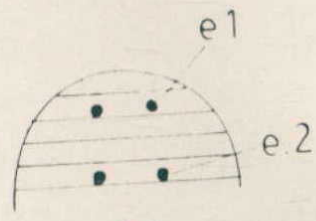
19

Pseudohirudinaria assamensis gen. et. sp.nov.
(Figs.20-24)

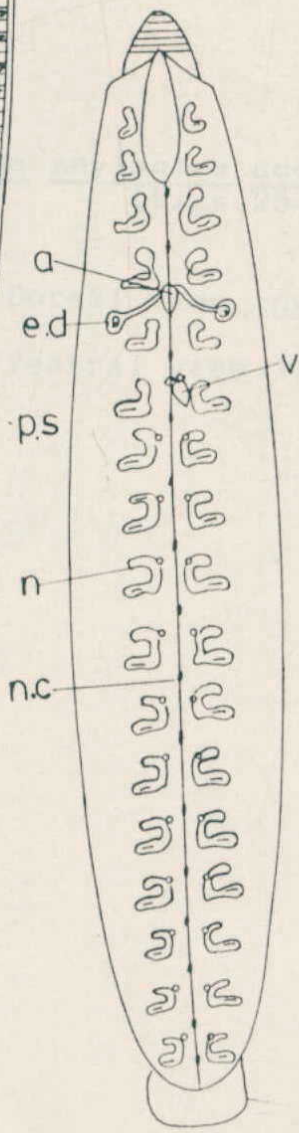
- 20 Dorsal view.2X
- 21 Anterior region bearing eyes (e.1-2.2).2X
- 22 Ventral view. 2X
- 23 Dissected specimen.2X
- 24 Dissected specimen.2X



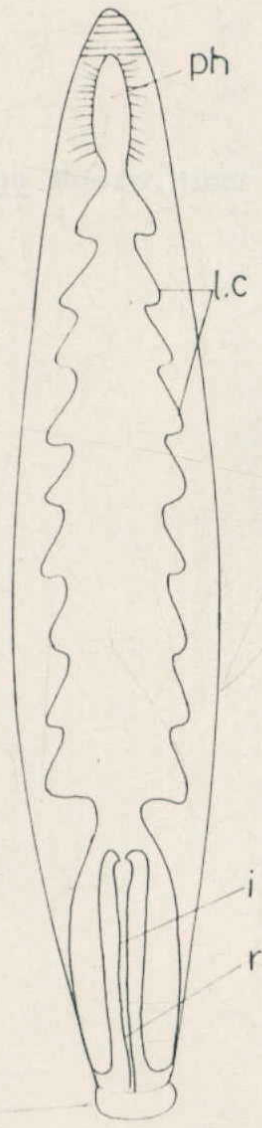
20



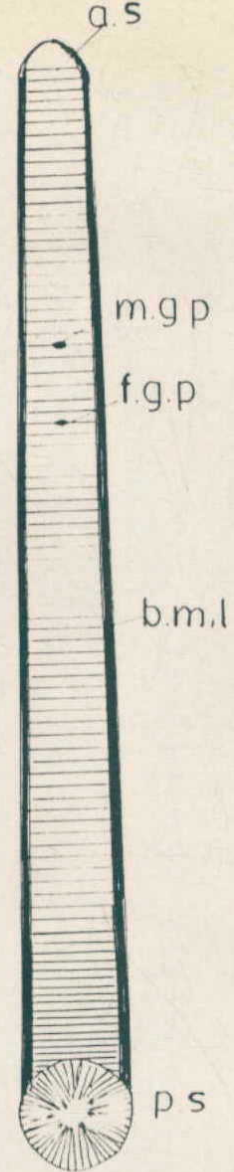
21



23



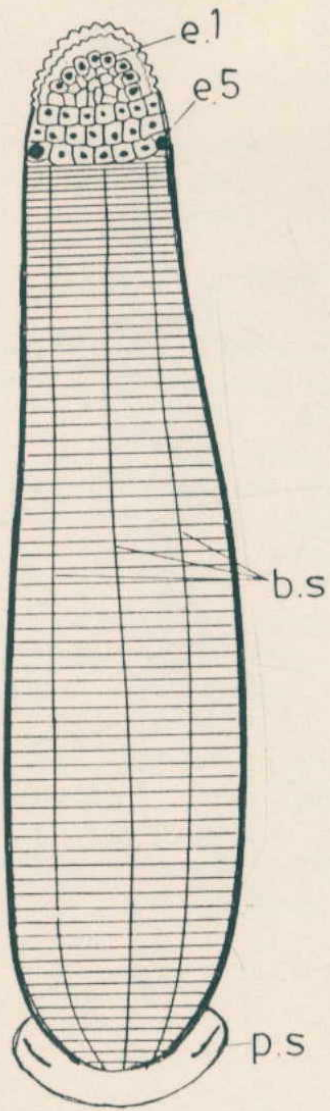
24



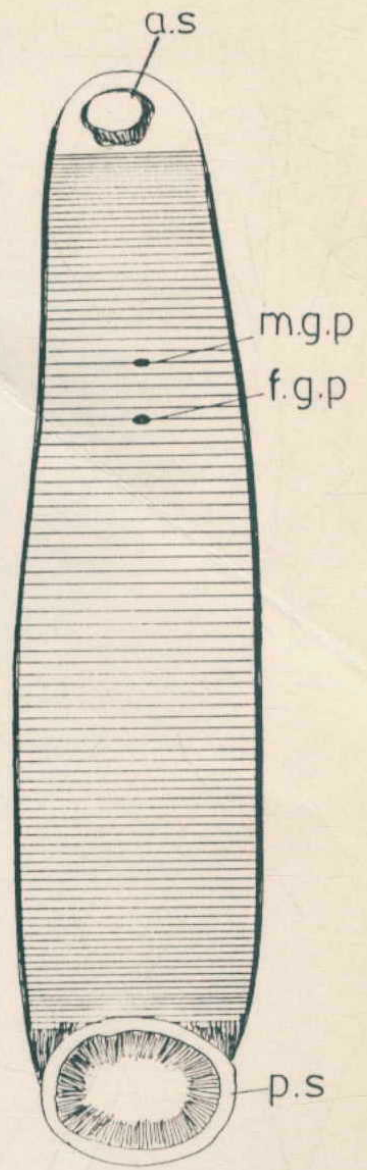
22

Ilaemodipsa zeylanica cochiniiana Moore, 1927
(Figs. 25-26)

- 25 Dorsal view .10X
26 Ventral view .10X



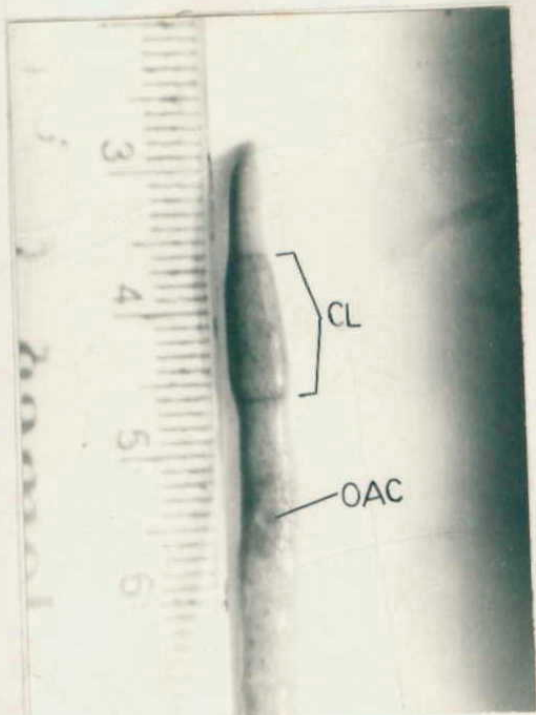
25



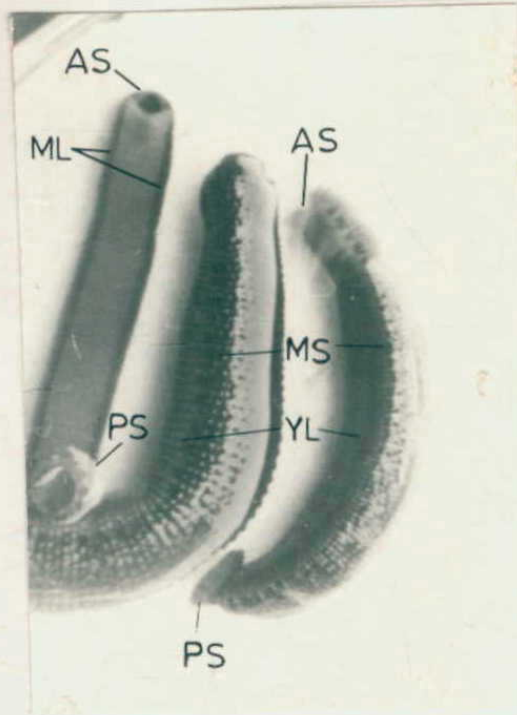
26

PLATE I

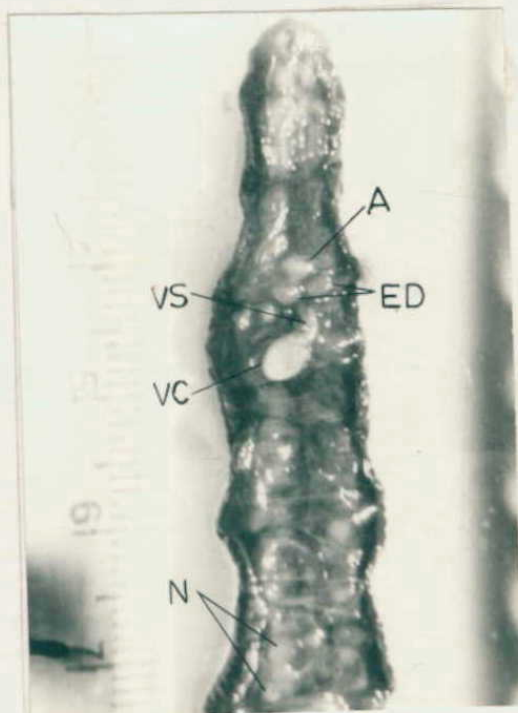
- Fig.(a) Foraminobdella heptomerata Kaburaki, 1921.
Dorsal view of adult leech showing the clitellum (CL) and opening of the alimentary canal (OAC) .144X
- Fig.(b) Hirudinaria javanica Wahlberg, 1856.
(i) Ventral view showing anterior sucker (AS), posterior sucker(PS) and black marginallines (ML) .144X
(ii) Dorsolateral view showing yellow (lightly) coloured line(YL) and dark marginal spots(MS) .144x
(iii)Lateral view showing anterior (AS) and posterior sucker(PS), yellow line(YL) and marginal spots(MS) .144X
- Fig.(c) Hirudinaria manillensis Lesson, 1842.
Dissected specimen showing reproductive organs i.e. atrium (A), ejaculatory ducts (ED), vaginal stalk (VS) and vaginal caecum (C) and nephridia (N) .144X



(a)



(b)



(c)

PLATE I

PLATE II

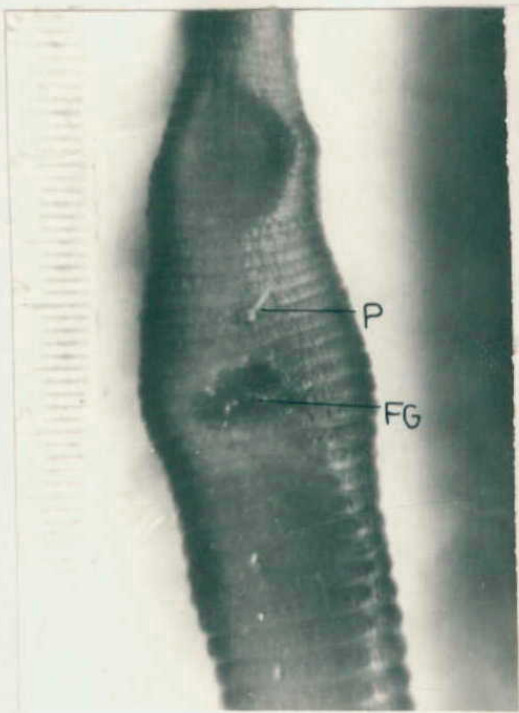
- Fig.(a) Hirudinaria viridis Moore, 1927.
Ventral view showing penis (P) and
female gonopore (FG). 144X
- (b) Hirudinaria viridis Moore, 1927.
Dissected specimen showing male
reproductive organs i.e. atrium (A),
ejaculatory ducts (ED) and Female
reproductive organs i.e. vaginal
stalk (VS) and vaginal caecum (VC). 144X
- (c) Hirudinaria sp. indt.
Dissected specimen showing pharynx
(PH) male reproductive organs i.e.
atrium (A), ejaculatory duct (ED) and
two female reproductive organs i.e.
vaginal stalk (VS) and vaginal caecum
(VC); and nephridia (N). 144X

PLATE III

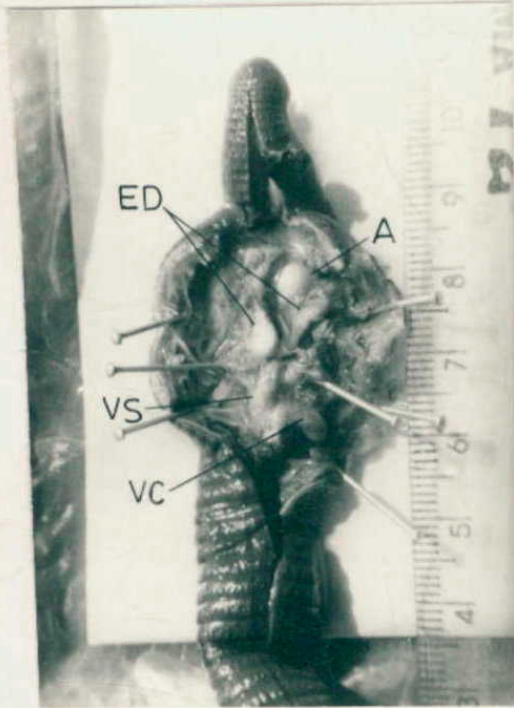
- Fig.(a) Pseudohirudinaria assamensis gen.et.
sp. nov.
Dissected view showing pharynx (PH);
male reproductive organs i.e. atrium
(A), ejaculatory ducts (ED); female
reproductive organs i.e. vaginal; and
nephridia(N). 144X
- (b) Haemodipsa zeylanica cochini
Moore, 1927.
Dorsal view showing five pairs of
eyes (E), dorsal stripes (DS) and
posterior sucker(PS). 144X
- (c) Haemodipsa zeylonica cochini
Moore, 1927.
(i) Ventral and lateral view showing
anterior (AS) and posterior suckers
(PS). 144X

(ii) Lateral view posterior sucker
(PS). 144x

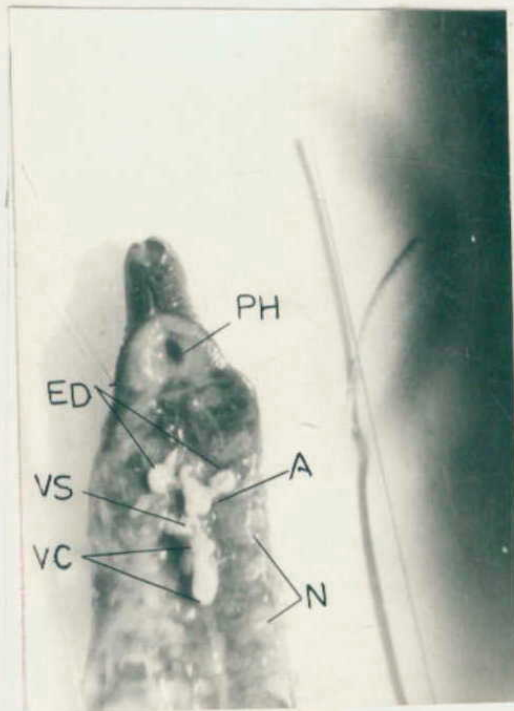
(iii) Dorsal view showing three
dorsal stripes (DS) and posterior
sucker (PS). 144X



(a)

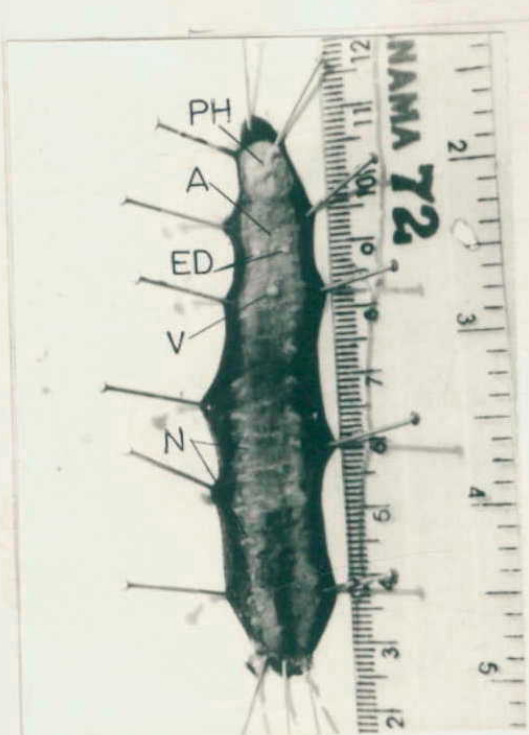


(b)

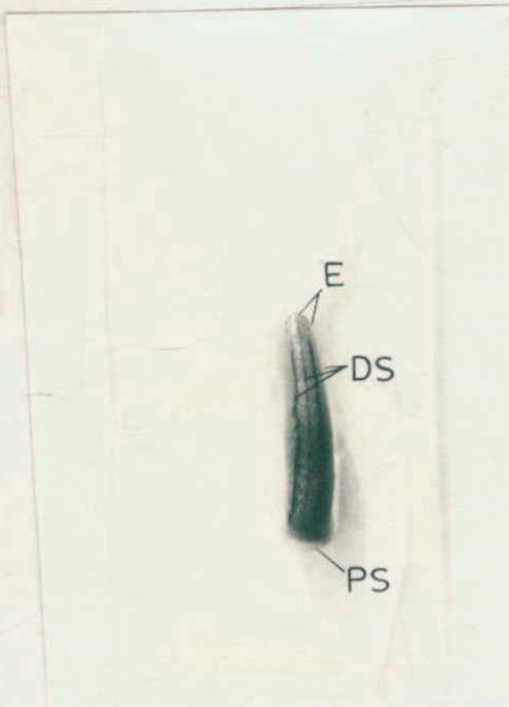


(c)

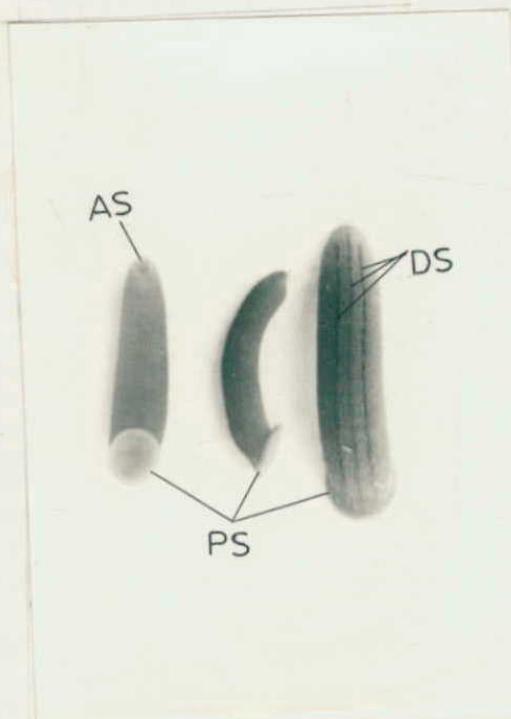
PLATE II



(a)



(b)



(c)

PLATE III

INTRODUCTION

The study of ecology is concerned with the interactions between organisms and their environment. It is a branch of biology that deals with the distribution and abundance of organisms, and the factors that influence these patterns. Ecology is a broad field that encompasses a wide range of topics, from the behavior of individual organisms to the structure and function of entire ecosystems. The study of ecology is essential for understanding the natural world and for addressing the challenges of environmental conservation and resource management.

ECOLOGY

Ecology is the study of the interactions between organisms and their environment. It is a branch of biology that deals with the distribution and abundance of organisms, and the factors that influence these patterns. Ecology is a broad field that encompasses a wide range of topics, from the behavior of individual organisms to the structure and function of entire ecosystems. The study of ecology is essential for understanding the natural world and for addressing the challenges of environmental conservation and resource management. Ecology is the study of the interactions between organisms and their environment. It is a branch of biology that deals with the distribution and abundance of organisms, and the factors that influence these patterns. Ecology is a broad field that encompasses a wide range of topics, from the behavior of individual organisms to the structure and function of entire ecosystems. The study of ecology is essential for understanding the natural world and for addressing the challenges of environmental conservation and resource management.

INTRODUCTION

Like any other animal the presence and abundance of leeches is governed by environmental factors. The majority of the leeches though known to inhabit aquatic environment both fresh water as well as marine yet some inhabit humid land also. The leech, Haemadipsa is one example of terrestrial leech living in soils of tropical jungles. It feeds from time to time on terrestrial animals. The amphibious leeches which leave water seasonally to live in the soil preferring places under stones or logs etc. These leeches take worms or slugs and prefer to swallow them as whole. The aquatic leeches however show a pattern of distribution which can be correlated with the physical and chemical characterisation of water in which they live. Temperature, potential hydrogenic and dissolved oxygen are among the parameters important affecting them. Even eutropic and oligotropic waters indicate the presence of different species of leeches (Mann, 1955). Leeches prefer moderate temperature i.e. near 20°C (Wrona *et al* 1987) and potential hydrogenii more than 5.5 (Gates, 1987).

be called as a tank. It was surrounded by stress and small weeds. The tank dried in summer. Only Chlamydomonas and Chara were the abundance. The banks of the tank have vegetation including trees as well as shrubs.

Kizarpur(P3)

The village Kizarpur is situated on the Dasuya Hazipur road about sixteen km from Dasuya. The tank in question is situated in the middle of the village adjacent to the road. The water of the pond was spread in an area of about one acre. The walls of the tank are made from hard stones on all sides. The tank is temporary, being fed by rain water only. It was dried in the summer of year 1993. It contained muddy water throughout the period of investigation. A mango tree was present. No submerged vegetation was seen in the pond.

Gaira(P4)

The village Gaira is situated on Hazipur - Talwara road, four and half km from Hazipur. The pond is situated at the beginning of the village. It had a water expanse of one and a half acre at the time of collection. The pond is surrounded by vegetation including trees of Mango, Acacia and Euclyptus.

REVIEW OF LITERATURE

Ecology

Work dealing with the ecology of leeches is not available in India. Nevertheless, quite a few references are available from other parts of the world giving ecology of leeches in some form. Mann has done a great deal of work on the ecology of leeches in abroad. Poirier (1942) reported two cases of nasopharyngeal hematysis caused to the soldiers in Morocco by Limnatis nilotica Savigny, 1820. The author also quoted Montel's report of vaginal blood of some women from Indochina because of the leech attack. Chin & Hsing (1949) studied the attack of Dinobdella ferox on the nasopharynx of cattle, horse and other mammals including man. This leech has also been found in India, Burma and China. Mann in several publications (1951, 1955, 1957, 1961, 1962) reports his findings on the ecology of leeches. The distribution and bionomics of leech Theromyzon tessulattum Muller, 1774, was described by Mann in 1951. The author also published work on the life history of the Erpobdella octoculata Linn., 1758 by analysing 100 samples of leech at intervals of one month in 1954 (continuing his work on ecology). Work on the ecology of the British fresh water leeches was published by Mann in 1955. The ecological data were collected alongwith collection of

leeches from 58 localities, 29 in Berkshire and 99 in the Lake district. In all, six physico-chemical factors of environment were estimated and evaluated in relation to leeches. Total alkalinity, dissolved organic matter, pH (of mud and water) and colour of water and area of surface. The leech, Erpobdella octoculata was reported to be abundant in soft water and Helobdella stagnalis abundant in hard water. The other leeches studied for ecology were Erpobdella testacea Savigny, 1820, Glossiphonia complanata Linn. 1758, Theromyzon sp., Dina lineata (Muller, 1774),, Hirudo medicinalis Ray, 1710, Betracobdella paludosa Carena, 1824, Haemopsis sanguisuga Blanchard, 1896, Glossiphonia heteroclita Linn. 1761, Hemiclepsis sp. and Piscicola sp. Again in 1957, Mann published on the breeding, growth and age structure of a population of leech Helobdella stagnalis Linn. 1758 and in 1961 he studied the requirements of leeches considered in relation to their habitat. Mann (1962) in his book which dealt with the structure, physiology, ecology and embryology of leeches has dealt with leeches. The above said book also contained a revised version of earlier work published by the author. The leeches were shown to suck blood from a host of animals belonging to almost all the vertebrate phyla namely bony fishes, amphibians, birds and mammals. In the list of victims even the invertebrate animals like worms, molluscs, insects and crustaceans were also given by the author (Mann, 1962).

Wrona (1979) analysed the trophic niche of Glossiphonia

complanata Linn., 1758 using serological techniques.

Wilkialis^{& Davies} (1980) published on the population ecology of the leech Theromyzon tessulatum (Muller, 1774). The observations were taken on the leeches of northern Poland from 1974-1977.

Work on the population ecology of Theromyzon tessulatum (Muller, 1774) from Canada was also published by Davies and Wilkialis (1980).

Bielecki (1986) studied the effect of salinity on the leeches of Jammo lake (Poland). Information on the 66 individuals (2 adults and 64 young) of Boreobdella verrucata was analysed in July and September, 1979.

Wrona^{et al} (1987) published work on the reproductive success and growth of two species of Erobdelellidae and the effect of water temperature on it. The optimum temperature promoting maximum growth was found to be 20°C.

Gates (1987) published work on the influence of temperature on the distribution of Sympatric Erobdelellidae. Nepheleopsis obscura Verrill and Erobdelella punctata Leidy in the water column. Starved small leech, N. obscura Verrill and started large non-reproductive E. punctata Leidy preferred colder water. The results were obtained by using aerated artificial littoral zone and maintaining temperature range of 5 to 20°C.

MATERIAL AND METHODS

Ecological observations were carried out from September, 1993 to March, 1994 in some selected habitats. Ponds at Ladiari(P1), Dasuya(P2), Kazarpur(P3) and Gaira(P4) were selected for the purpose. The ecological parameters known to influence leeches such as temperature, dissolved oxygen (DO), free carbon dioxide (FCO_2), conductivity, pH, transparency, and depth were estimated using digital portable Kit Model KK 704. Besides the value of FCO_2 and penetration of light was recorded as explained below.. The investigations in these habitat were carried out at fortnightly intervals between 9 to 10 a.m. Physico-chemical parameters were measured by taking samples in two BOD bottles each of 500 ml capacity.

Free carbon dioxide (FCO_2)

Free carbon dioxide was determined by Titrimetric method in which sample of 100 ml was titrated against standard Alkali (0.0229 N NaOH) using phenolphthalein as indicator.

Transparency

Transparency of water was taken with the help of sacchi disc. The average depth at which the sacchi disc just disappeared and reappeared in water was taken as the value of light penetration

Water depth

The depth of the pond water was recorded with the help of graduated iron rod. The rod was lowered in the water at five selected spots at each habitat. Thus maximum depth and minimum depth were recorded.

OBSERVATIONS

The fortnightly observations of physico-chemical parameters of following leech infested ponds were taken. Ladiari(P1), Dasuya (P2), Kizarpur (P3), Gaira(P4). The values of the parameters, temperature i.e. pH, conductivity, DO,FCO₂, transparency and depth are given in Tables 1 to 6 and Figs. 1-16.

Temperature

Tables 1 to 4 and Figs.1, 5, 9, 13 depict the temperature changes in the four ponds observed. The water temperature fluctuated during different months following the changes in the atmosphere. The maximum temperature was recorded during the month of September, 1993 in all the ponds when the actual values were 32.2, 30.5, 33.3 and 29.9^oC respectively while the minimum temperature was observed during the month of January, 1993 in the P1, P2, and P4 with the actual value of 6.8, 6.5 and 7.3^oC. But in case of P3 temperature was minimum i.e.,7.6^oC in December, 1993. The temperature was not significantly different ($F=0.29$; $P < 0.05$) (Table 6) in all the four ponds.

Depth

The fortnightly observations of depth in ponds P1, P2,

Transparency

P3, P4 are shown in Tables 1 to 4 and Figs. 4,8,12,16. The water depth in all the ponds varied from month to month. The depth in P1 increased and reached maximum depth 70 cm in October, 1993 and minimum 60 cm in December, 1993. The depth of P2 was maximum i.e., 48 cm in December, 1993 and minimum 30 cm in November, 1993 and January, 1994. The depth in P3 was maximum, i.e. 52 cm in September 1993 and minimum 30 cm in February and March, 1994. The maximum value of depth in P4 was recorded to be 50 cm in January, 1994 and minimum of 40 cm in November, 1993 and March, 1994. The depth was significantly different ($P = 73.582$: $P < 0.05$) (Table 6) in all the four ponds which were observed during the period of investigation. The pond P1 had the maximum depth and P2 minimum. The depth of P3 and P4 was almost the same and ranged between P1 and P2.

Water colours

The observations on water colour are given in Tables 1-4. The colour of water in the four ponds was found to be different. In the P1 water colour was nearly transparent during the period of observations but became slightly muddy during October and November, 1993. The water colour of P2 remained mostly green due to presence of algae. The colour was, however, muddy green in September, 1993. The water colour in P3 and P4 remained muddy most of the time during observation.

Transparency

Wide fluctuation in the transparency are given in Table 1 to 4 and Figs.4,8,12,16. The transparency of P1 was maximum 35 cm in March, 1994 and minimum 13.5 cm in January, 1994. The transparency of P2 was 18.5 cm, the maximum in March, 1994 and minimum i.e. 3.3 cm in January, 1994. The transparency P3 was maximum i.e. 28.75 cm in P3 during September, 1993 and 11.40 cm the minimum in December, 1993. In P4, the maximum values of transparency was 21.1 cm in March, 1994 and minimum i.e. 7.8 cm in November, 1993. The statistical analysis reveal that transparency values differed significantly different ($F=14.489$; $P < 0.05$) in all the four ponds (Table 6). In all transparency in P1 was, however, maximum followed by P3, P4 and P2.

Chemical parameters

pH: Of the four ponds investigated ecologically were found to be in alkaline range throughout the period of investigation (Tables 1 to 4, Figs.2,6,10,14). Only during one collection, pH was found to be acidic in P1, P2 and P4 using a value of 6.7, 6.97, 6.7.. The pH of P1 was maximum at 8.68 and minimum 6.7 in January, 1994. The pH of P2 was maximum with a value 8.7 in January, 1994 and minimum 6.97 in December, 1993 while in P3 and P4 the pH fluctuated between 8.17-7.10, 8.49-6.7 respectively being maximum in December, 1993 and minimum in January, 1994. The pH was significantly different ($F=.864$; $P < 0.05$) in all the four ponds (Table 6). The pH was maximum

in P3 and minimum in P4, P1 and P 2 having almost same pll both related with P3 and P4.

DO: The DO fluctuated in four ponds between (Tables 1 to 4, Figs.3,7,11,15). The DO of P1 was maximum 16.2 ppm in December, 1993 and minimum 3.1 ppm in September, 1993. In P2 DO was maximum 15.7 ppm in October, 1993 and minimum 3.4 ppm in March, 1994. In P3, DO was maximum at 13.10 ppm in December, 1993 and minimum 6.8 ppm in October, 1993. The P4 DO was maximum i.e.16.3 ppm in December, 1993 and minimum having value of 3.5 ppm in March, 1994. The DO was not, however, significantly different ($F=0.088$; $P < 0.05$) in all the four ponds (Table 6).

FCO₂: The CO₂ changed in four ponds as shown in Tables 1 to 4 and Fig. 3,7,11,15. The CO₂ in P1 was maximum with a value of 36 ppm in September, 1993 and minimum i.e.6.8 ppm in January, 1994. The FCO₂ in P2 was maximum at 30.3 ppm. in September, 1993 and minimum at 2.7 ppm. in February, 1994. The P3 had FCO₂ was maximum 20.4 ppm (maximum value) in October, 1993 and 6.2 ppm in November, 1993(minimum) The FCO₂ in P4 was maximum i.e. 24.2 ppm in February, 1994 and minimum 2.5 ppm in February, 1994. The FCO₂ was significantly different ($F=.966$; $P < 0.05$) in all the four ponds (Table 6). The FCO₂ of P2 was maximum and P4 was minimum while FCO₂ of P1 and P3 was same and inbetween P1 and P4.

Conductivity: The conductivity of four ponds is shown in

Tables 1-4, Figs. 2,6,10 and 14. The conductivity in P1 was maximum 0.289 mmhos in March, 1994 and minimum 0.115 mmhos in September, 1994. The conductivity of P2 was maximum with value 0.479 mmhos in January, 1994 and minimum having 0.199 mmhos in December, 1993. The conductivity of P 3 was maximum 0.758 mmhos in December, 1993 and minimum 0.479 mmhos in January, 1994. The conductivity of P4 was maximum 0.482 mmhos in Dec., 1993 and minimum 0.177 mmhos in January, 1994. The conductivity was significantly different ($F=67.087$ $P<0.05$) in all the four ponds (Table 6). The conductivity of P2 and P4 is same. The P3 had maximum conductivity and P1 has minimum conductivity.

Table 1. Records of physico-chemical parameters of water at Ladiari pond (Collection fortnightly between 9 to 10 a.m.) (September 1993-March, 1994)

S.No.	Month	Temp H ₂ O (°C)	pH	Conduc (mmhos)	D.O. (ppm)	ECO ₂ (ppm)	Trans. (cm)	Depth. (cm)	Colour of water
1.	Sep. I	32.2	7.31	0.115	3.1	36.0	32.5	65	Transparent
2.	Sep. II	26.5	7.35	0.157	12.9	8.3	30.0	63	
3.	Oct. I	23.8	7.38	0.229	9.0	12.5	28.5	60.	Light muddy
4.	Oct. II	20.4	8.05	0.219	9.2	10.3	20.0	70	"
5.	Nov. I	15.5	7.39	0.138	8.5	14.2	17.0	61	"
6.	Nov. II	14.7	7.69	0.159	10.2	16.4	27.0	63	"
7.	Dec. I	8.7	7.69	0.223	9.0	18.9	25.5	60	Transparent
8.	Dec. II	7.5	7.77	0.167	16.2	14.5	15.0	60	"
9.	Jan. I	6.8	6.70	0.279	13.7	24.7	13.5	68	Clear
10.	Jan. II	10.5	8.68	0.192	8.4	6.8	20.5	67	"
11.	Feb. I	12.6	7.70	0.163	7.3	10.0	26.0	65	"
12.	Feb. II	14.5	7.83	0.232	12.5	7.0	30.0	65	"
13.	Mar. I	16.3	7.45	0.169	5.7	7.3	34.0	62	"
14.	Mar. II	17.2	7.68	0.289	9.9	15.4	35.0	63	"

Table 2. Records of physico-chemical parameters of water at Pond No. 2 Dasuya pond (collection fortnightly between 9 to 10 a.m.) (September 1993 to March, 1994)

Sr No.	Month	Tem H_2O_2 (°C)	pH	Conduc. (mmhos)	DO (ppm)	FCO ₂ (ppm)	Trans. (cm)	Depth (cm)	Colour of water
1.	Sep. I	30.5	7.69	0.358	13.3	30.3	17.3	35	Muddy green
2.	Sep. II	26.7	7.80	10.239	10.1	10.2	15.4	42	"
3.	Oct. I	23.8	8.30	0.259	8.9	8.4	14.5	44	"
4.	Oct. II	20.9	7.39	0.218	15.7	14.3	13.3	46	Green, Aglae
5.	Nov. I	17.3	7.49	0.357	14.9	18.8	12.2	30	"
6.	Nov. II	16.4	7.65	0.429	8.2	18.7	10.7	33	Green
7.	Dec. I	15.3	7.50	0.359	13.8	28.1	5.8	36	"
8.	Dec. II	9.8	6.97	0.199	11.3	10.5	6.5	48	Light green
9.	Jan. I	6.5	7.30	0.227	7.5	15.4	3.3	30	Muddy green
10.	Jan. II	7.7	8.70	0.479	6.7	5.2	8.9	31	"
11.	Feb. I	10.4	7.92	0.347	8.3	2.7	11.1	36	Daphnia, Algae green
12.	Feb. II	12.5	7.79	0.328	7.8	24.2	16.6	32	"
13.	Mar. I	14.6	7.54	0.378	11.8	16.7	14.7	39	Muddy green
14.	Mar. II	17.8	7.63	0.413	3.4	8.9	18.5	38	"

Table 3. Records of physico-chemical parameters of water Pond No.3 at Kizarpur pond
(Collection fortnightly between 9 to 10 a.m.) (September 1993 to March, 1994)

S.No.	Month	Temp. H ₂ O (°C)	pH	Condc. (mmhos)	DO (ppm)	FCO ₂ (ppm)	Trans. (cm)	Depth (cm)	Colour of water
1.	Sep. I	33.3	7.84	0.648	9.2	14.4	28.75	50	Muddy
2.	Sep. II	26.45	7.63	0.556	8.01	20.1	25.35	52	Light Muddy
3.	Oct. I	24.2	7.92	0.638	6.8	18.3	16.75	45	"
4.	Oct. II	21.5	7.92	0.629	10.0	20.4	15.8	50	"
5.	Nov. I	16.7	7.9	0.728	9.70	6.2	14.5	45	"
6.	Nov. II	15.5	7.8	0.679	12.3	12.35	13.0	45	"
7.	Dec. I	10.3	7.87	0.758	13.10	10.40	12.55	42	Muddy
8.	Dec. II	7.6	8.17	0.659	9.0	16.00	11.40	43	"
9.	Jan. I	10.4	7.10	0.479	10.29	15.50	15.95	49	"
10.	Jan. II	11.8	7.60	0.537	8.00	6.87	16.80	46	"
11.	Feb. I	12.7	7.57	0.549	7.69	7.60	19.35	30	"
12.	Feb. II	14.9	7.40	0.492	9.00	8.5	22.15	35	"
13.	Mar. I	15.2	7.80	0.630	10.00	11.15	24.25	40	"
14.	Mar. II	16.8	7.69	0.553	11.35	13.00	27.65	30	"

Table 4. Records of physico-chemical parameters of water(Pond No.4) at Gaira pond (Collection fortnightly between 9 and 10 a.m.) (September, 1993 to March, 1994)

S.No.	Month	Temp. H ₂ O (°C)	pH	Conduc. (mmhos)	DO (ppm)	FCO ₂ (ppm)	Trans. (cm)	Depth (cm)	Colour of water
1.	Sep. I	29.9	7.22	0.326	6.8	10.5	15.0	45	Light muddy
2.	Sep. II	27.6	7.21	0.322	12.9	12.3	14.8	42	"
3.	Oct. I	22.7	7.2	0.389	5.7	4.4	13.3	43	"
4.	Oct. II	21.5	7.68	0.438	8.9	10.7	10.7	43	"
5.	Nov. I	16.7	7.08	0.218	9.2	18.9	7.8	43	"
6.	Nov. II	15.6	7.75	0.309	8.5	16.6	12.0	40	"
7.	Dec. I	9.6	7.39	0.228	11.2	12.8	14.6	42	"
8.	Dec. II	8.5	8.49	0.482	16.3	14.5	15.3	44	"
9.	Jan. I	7.3	6.7	0.177	13.7	10.7	20.5	50	"
10.	Jan. II	11.2	7.65	0.299	12.6	3.0	20.8	47	"
11.	Feb. I	13.5	7.7	0.325	11.9	2.5	18.5	45	"
12.	Feb. II	15.3	7.56	0.378	4.3	24.2	17.4	42	"
13.	Mar. I	17.5	7.8	0.459	8.7	7.8	20.1	40	"
14.	Mar. II	17.7	7.65	0.312	3.5	5.6	21.1	40	"

Table 5. Physico-chemical parameters of water of four ponds (collection fortnightly between 9 to 10 a.m.) (September, 1993-March, 1994)

	P ₁	P ₂	P ₃	P ₄
Temp. (°C)	32.2-6.8	30.5-6.5	33.3-7.6	29.9-7.3
pH	8.68-6.70	8.70-6.97	8.17-7.10	8.49-6.70
Conduc. (mmhos)	0.289-0.115	0.479-0.199	0.758-0.479	0.482-0.177
DO (ppm)	16.2-3.1	15.7-3.4	13.10-6.80	16.3-3.5
FCO ₂ (ppm)	36-6.8	30.3-2.7	20.4-6.2	24.2-2.5
Trans (cm)	35-13.5	18.5-3.3	28.75-11.40	21.1-7.8
depth (cm)	70-60	48-30	52-30	47-40

Table 6 : Showing variation in the temp, pH, conductivity, DO, FCO₂ transparency and depth of four ponds P₁, P₂, P₃ and P₄.

Ponds	Temp. (°C)	pH	Conductivity (mmhos)	DO (ppm)	FCO ₂ (ppm)	Transparency (cm)	Transparency Depth (cm)
1	16.23 ^a +1.97	7.62 ^{ab} +0.12	0.19 ^a +0.01	9.68 ^a +0.90	14.45 ^{ab} +2.14	25.32 ^d +1.88	63.71 ^c +0.83
2	16.44 ^a +1.89	7.69 ^{ab} +0.11	0.32 ^b +0.02	10.12 ^a +0.93	15.17 ^b +2.21	12.05 ^a +1.22	37.14 ^a +1.59
3	16.96 ^a +1.90	7.72 ^b +0.07	0.60 ^c +0.02	9.60 ^a +0.47	12.91 ^{ab} +1.27	18.87 ^c +1.54	43.00 ^b +1.88
4	16.75 ^a +1.82	7.50 ^a +0.11	0.33 ^b +0.02	9.58 ^a +0.99	11.03 ^a +1.66	15.89 ^b +1.10	43.28 ^b +0.75

P 0.05 with the same subscripts in a row (vertically) do not differ.

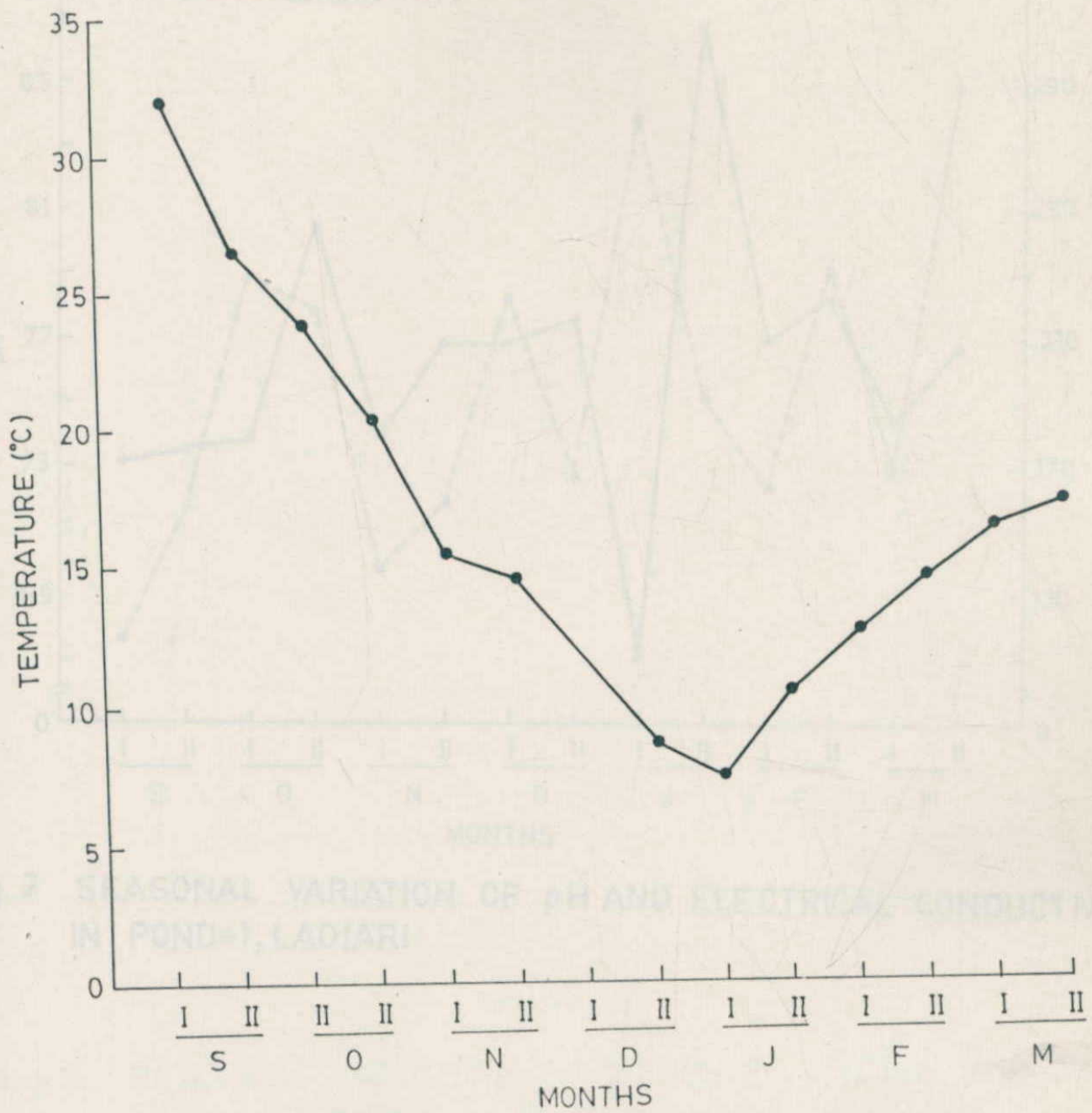


Fig.1 SEASONAL VARIATION OF WATER TEMPERATURE IN POND-1, LADIARI

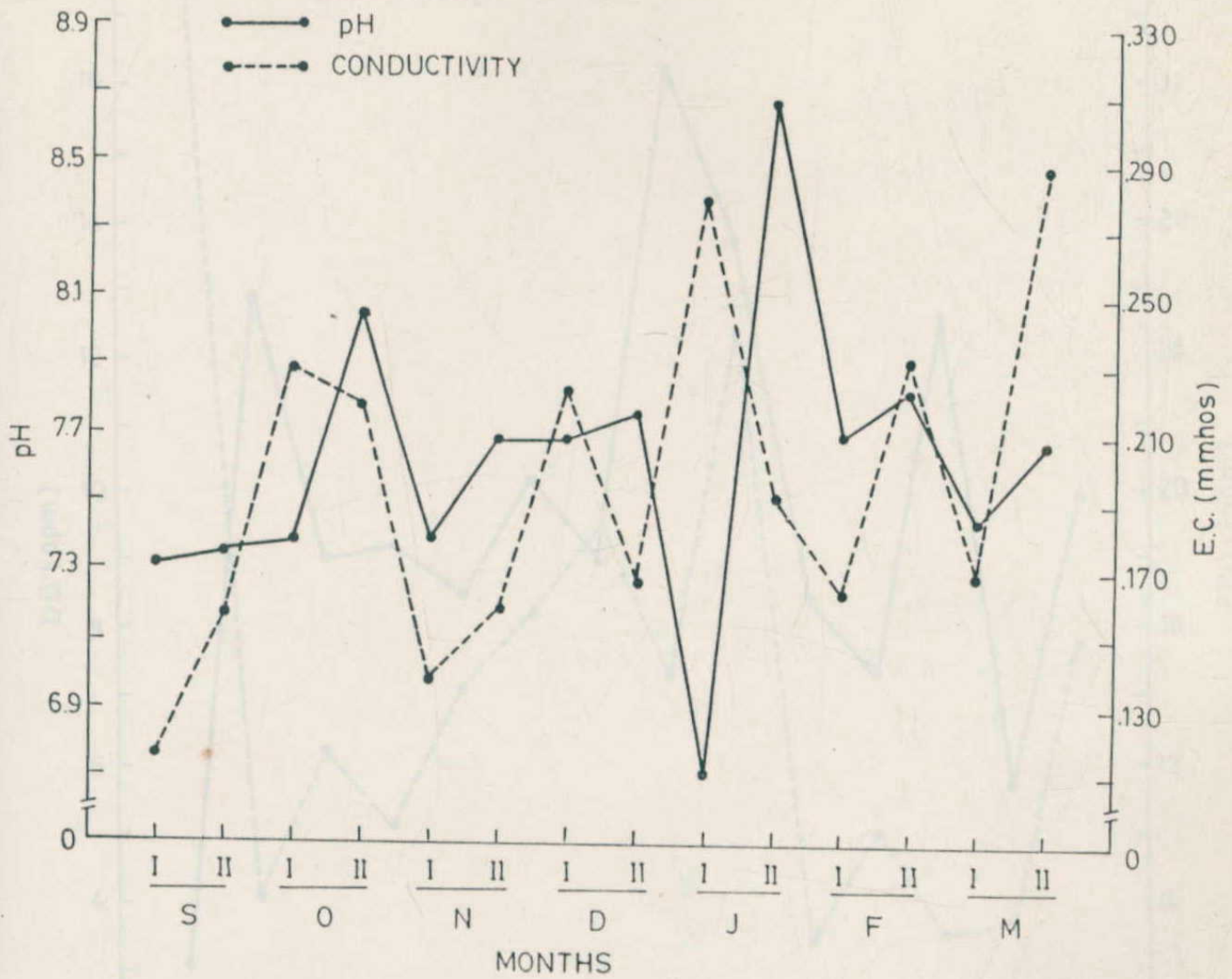


Fig. 2 SEASONAL VARIATION OF pH AND ELECTRICAL CONDUCTIVITY IN POND-1, LADJARI

Fig. 3 SEASONAL VARIATION OF DISSOLVED OXYGEN AND FREE CARBON DIOXIDE IN POND-1, LADJARI

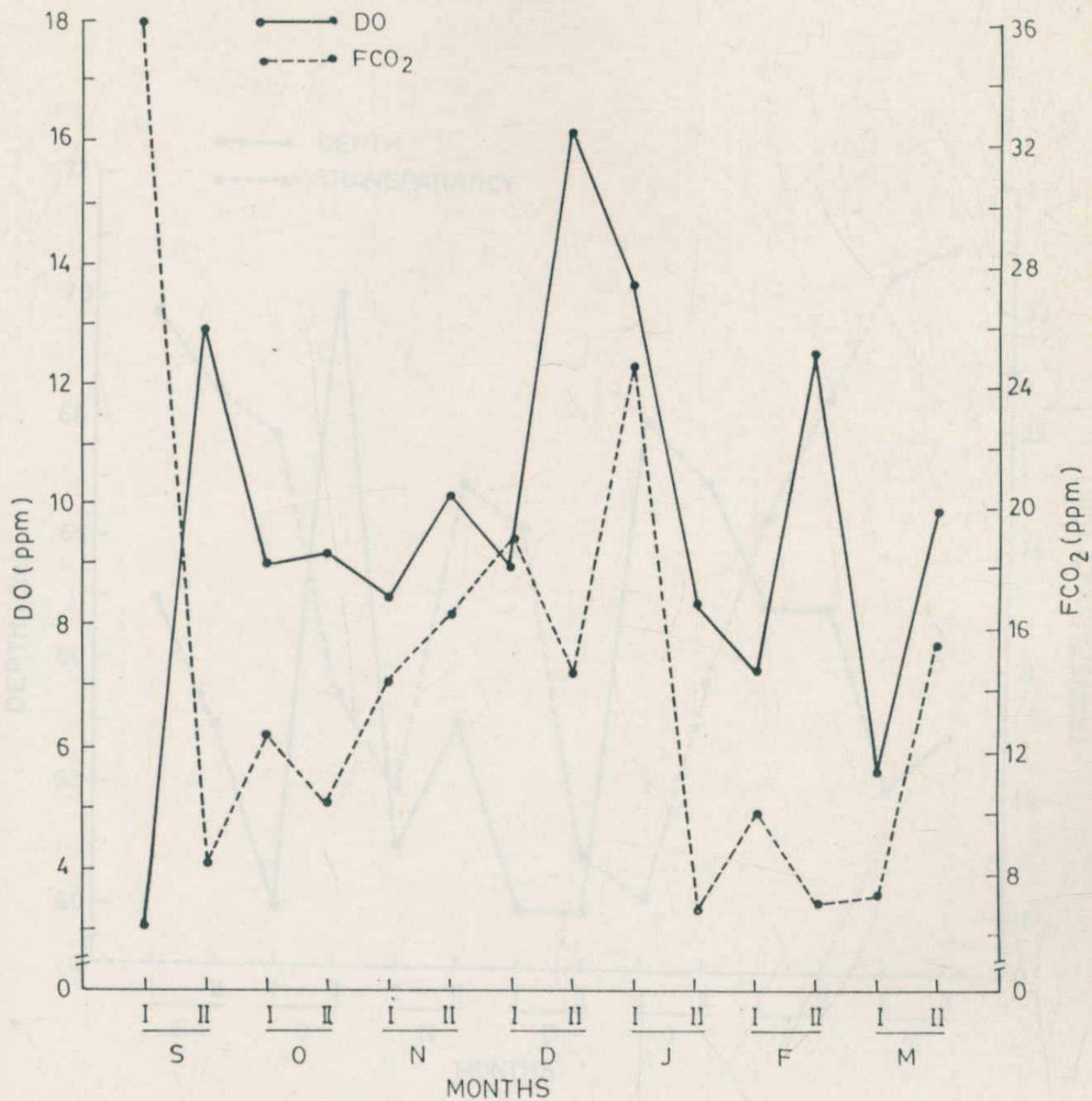


Fig. 3 SEASONAL VARIATION OF DISSOLVED OXYGEN AND FREE CARBON DIOXIDE IN POND-1, LADIARI

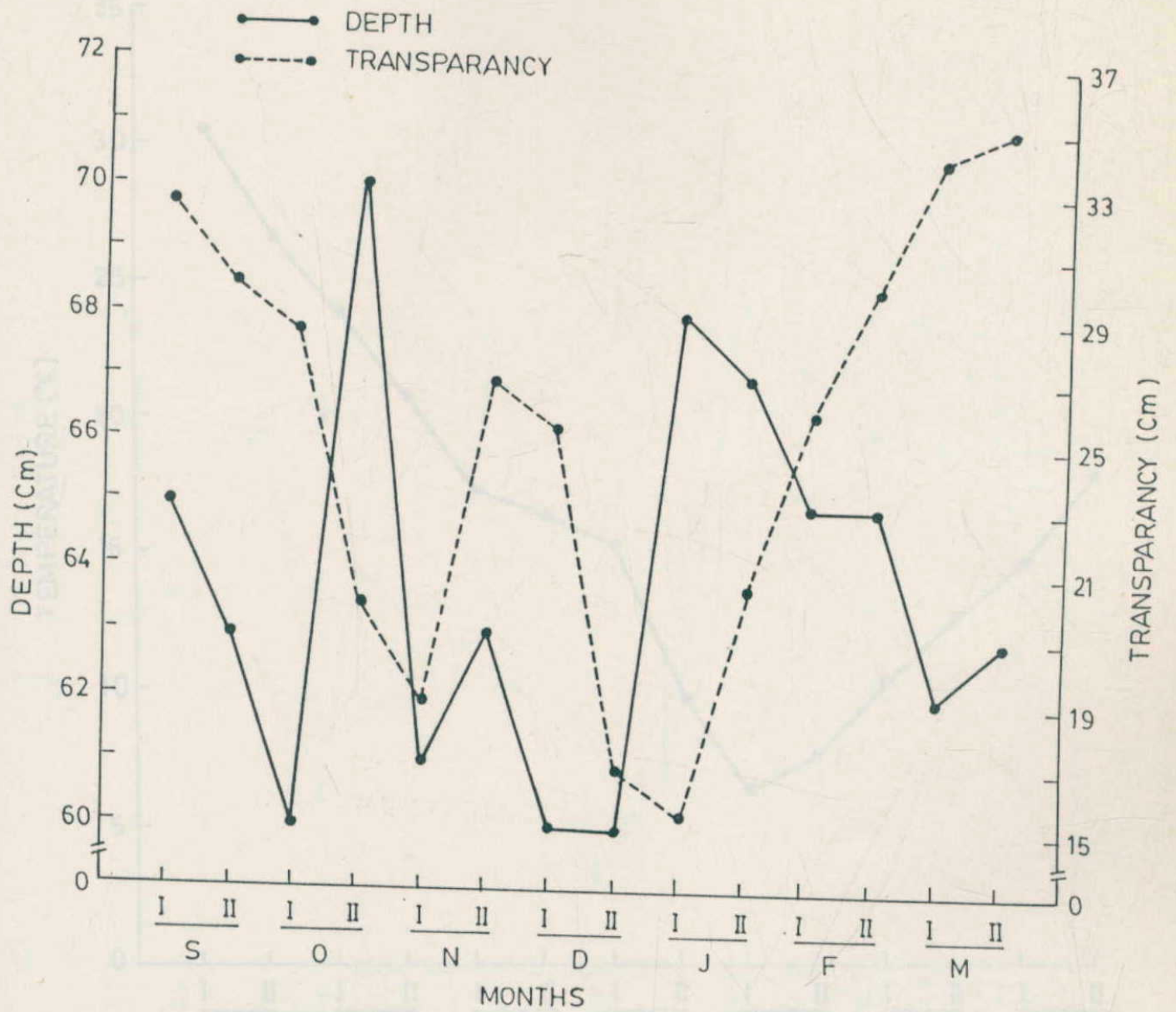


Fig. 4 SEASONAL VARIATION OF DEPTH AND TRANSPARANCY IN POND-1, LADIARI

Fig. 5 SEASONAL VARIATION IN WATER TEMPERATURE IN POND-2, DASUYA

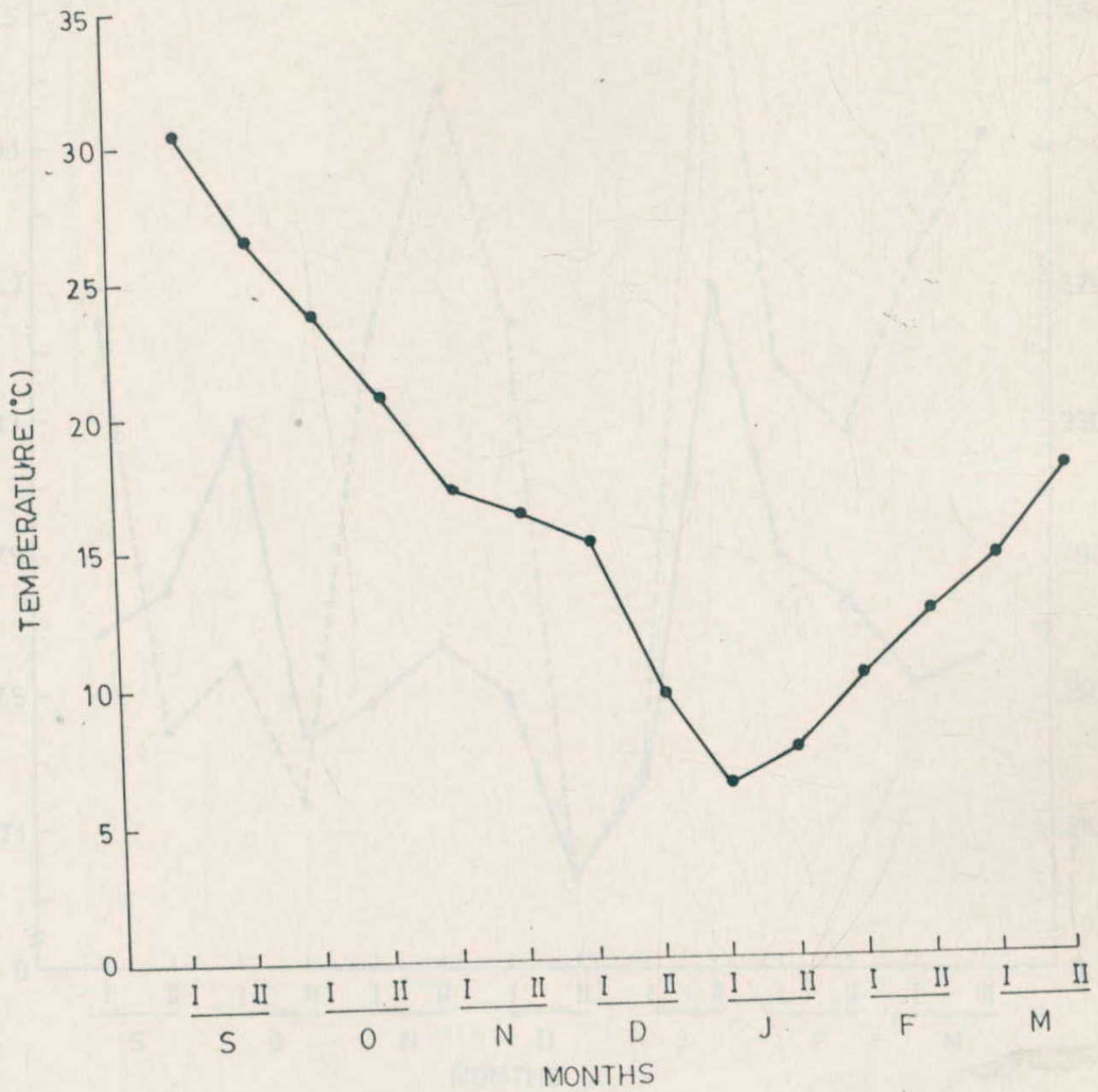


Fig. 5 SEASONAL VARIATION IN WATER TEMPERATURE IN POND-2, DASUYA

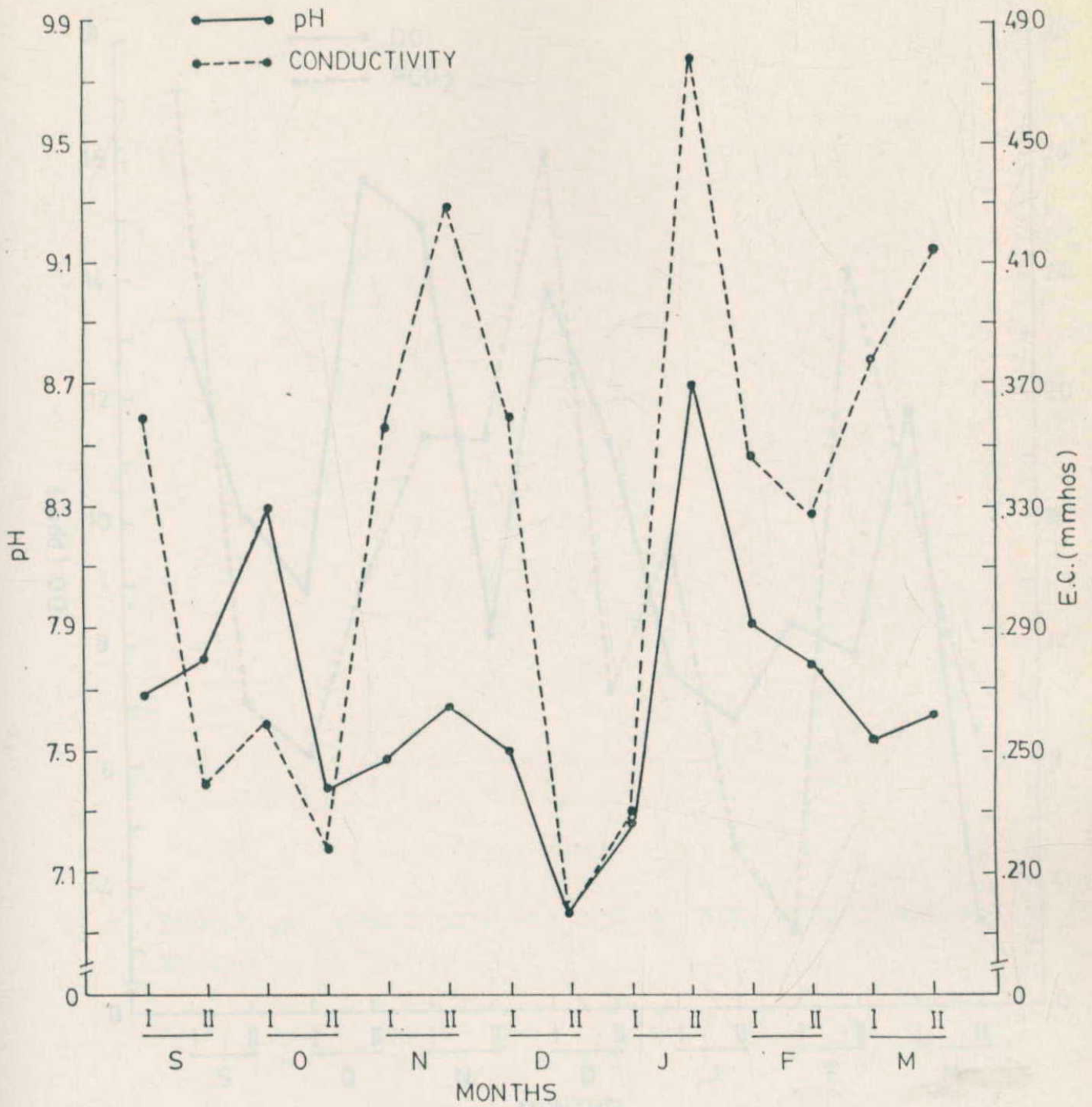


Fig. 6 SEASONAL VARIATION OF pH AND ELECTRICAL CONDUCTIVITY IN POND-2, DASUYA

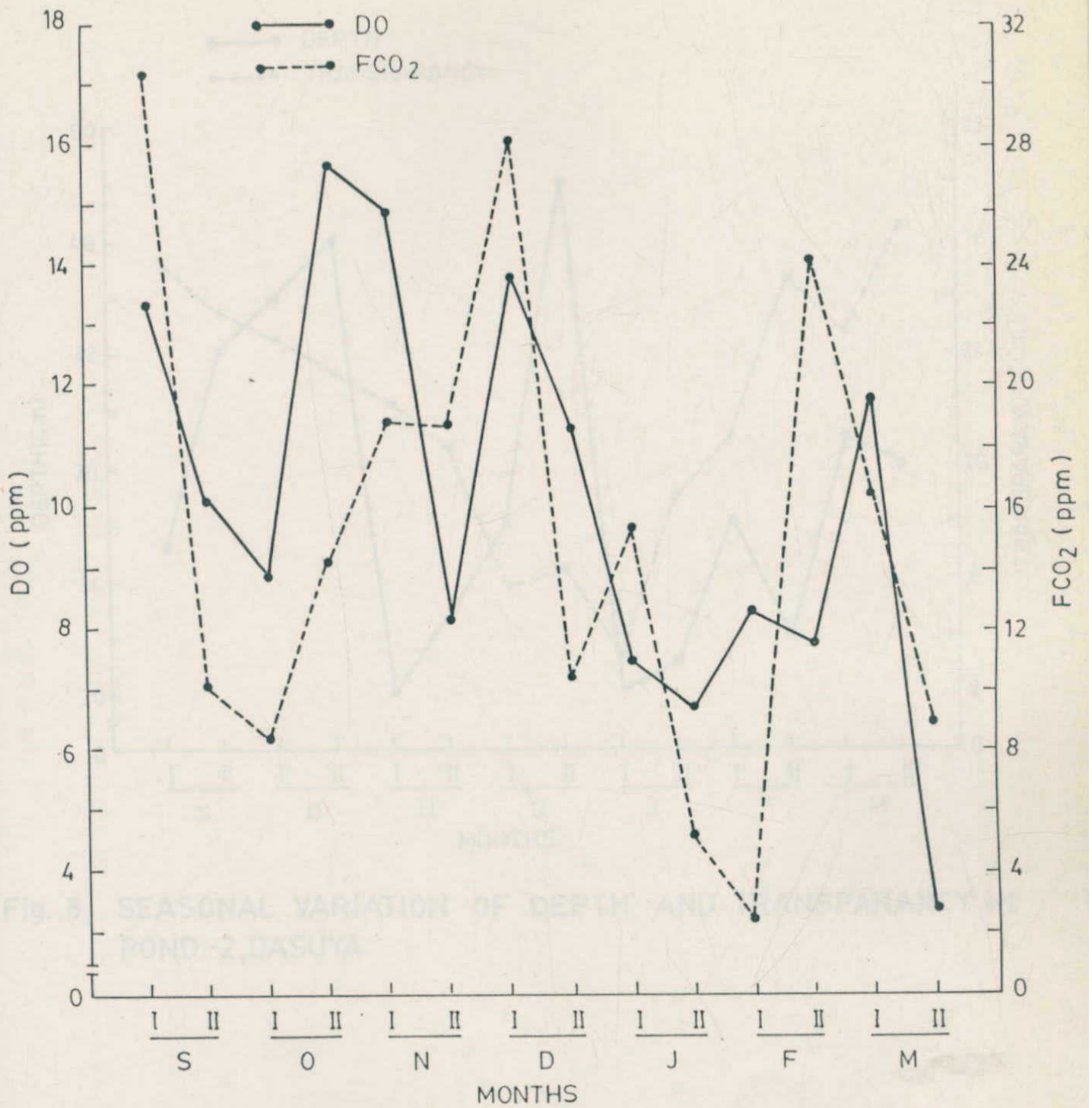


Fig.7 SEASONAL VARIATION OF DISSOLVED OXYGEN AND FREE CARBON DIOXIDE IN POND-2, DASUYA

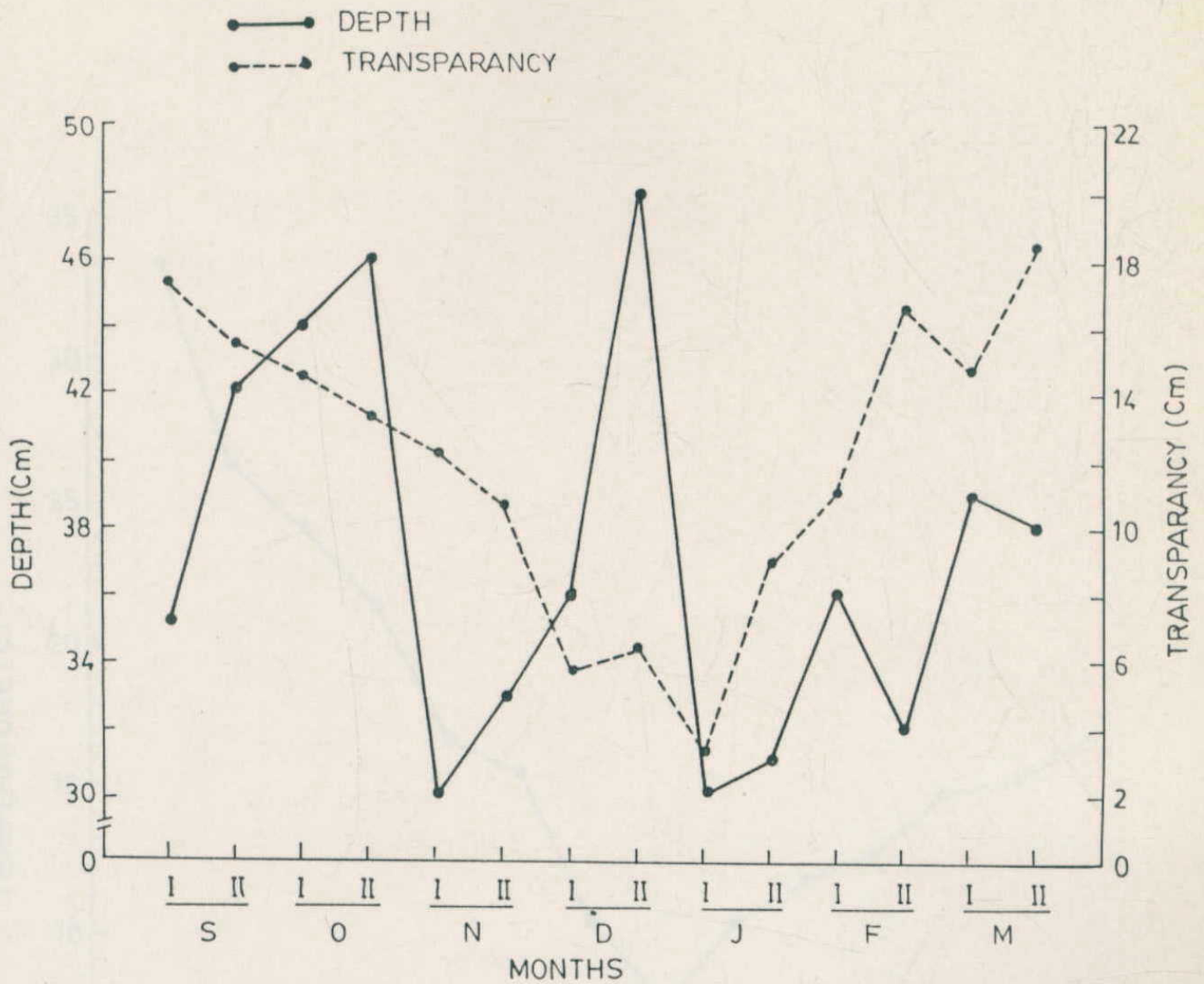


Fig. 8 SEASONAL VARIATION OF DEPTH AND TRANSPARANCY IN POND-2, DASUYA

Fig. 9 SEASONAL VARIATION OF WATER TEMPERATURE IN POND-2, DASUYA

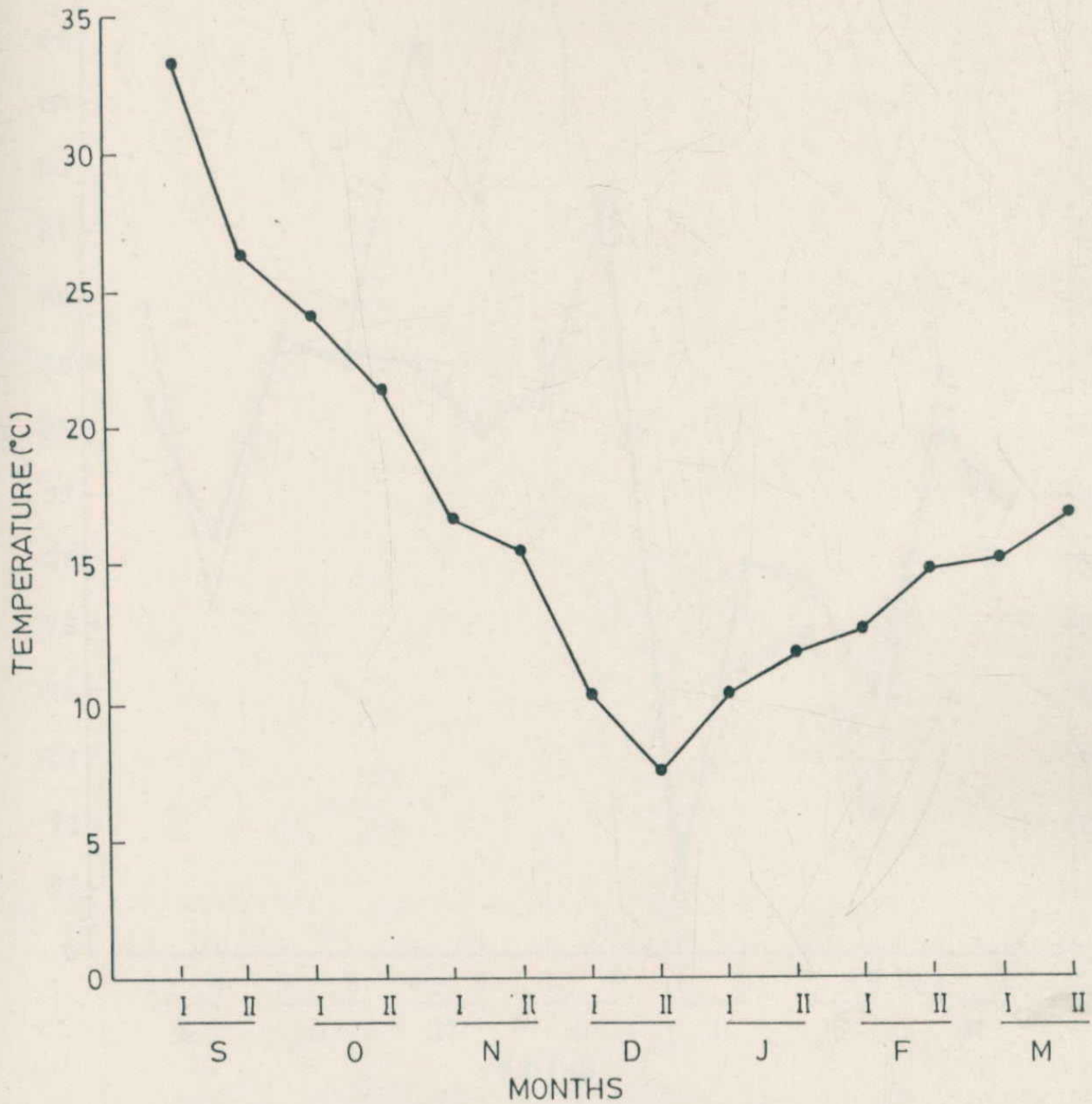


Fig.9 SEASONAL VARIATION OF WATER TEMPERATURE IN POND-3, KIZARPUR

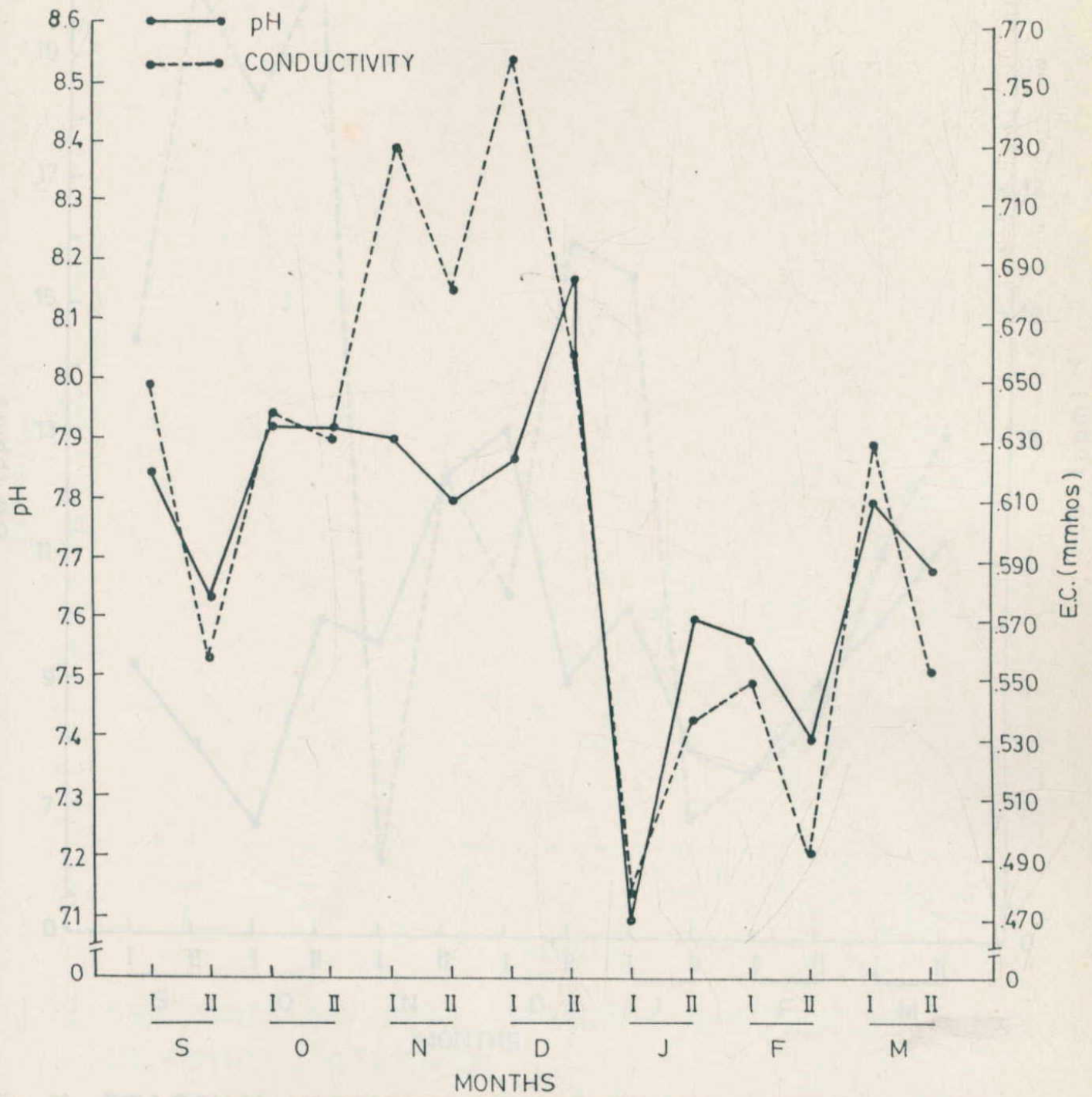


Fig. 10 SEASONAL VARIATION OF pH AND ELECTRICAL CONDUCTIVITY IN POND-3, KIZARPUR

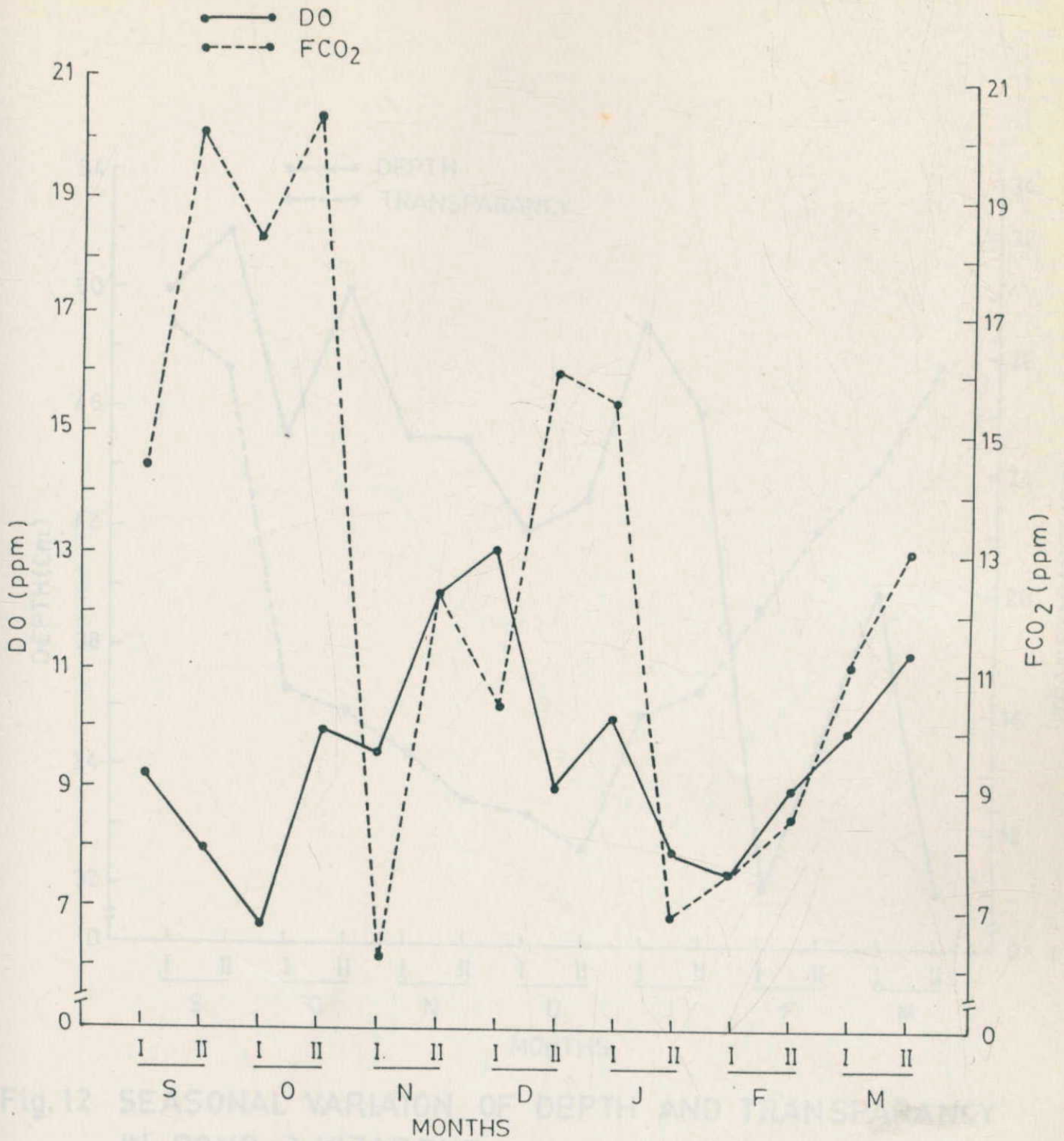


Fig.11 SEASONAL VARIATION OF DISSOLVED OXYGEN AND FREE CARBON DIOXIDE IN POND-3, KIZARPUR

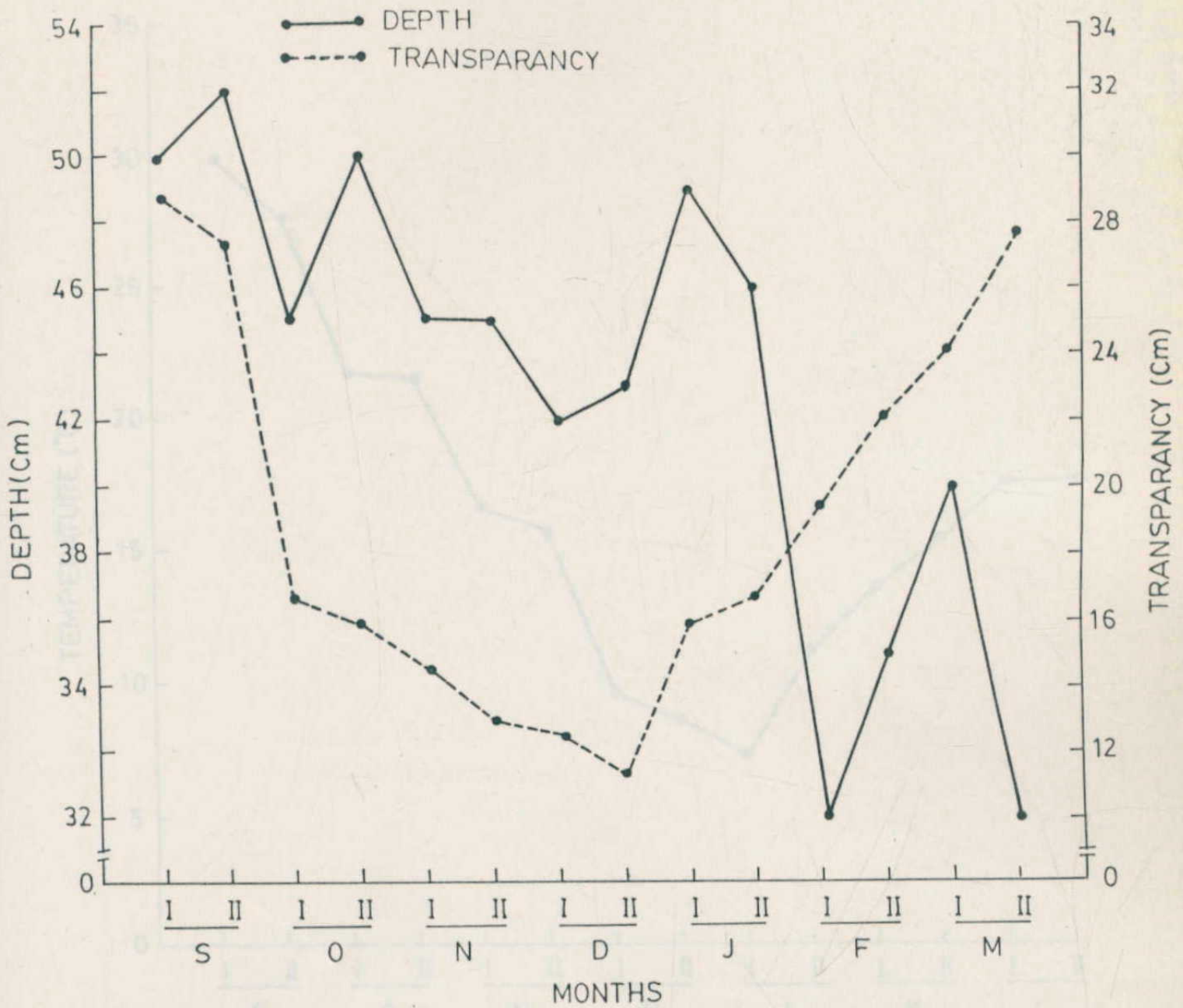


Fig.12 SEASONAL VARIATION OF DEPTH AND TRANSPARANCY IN POND-3, KIZARPUR

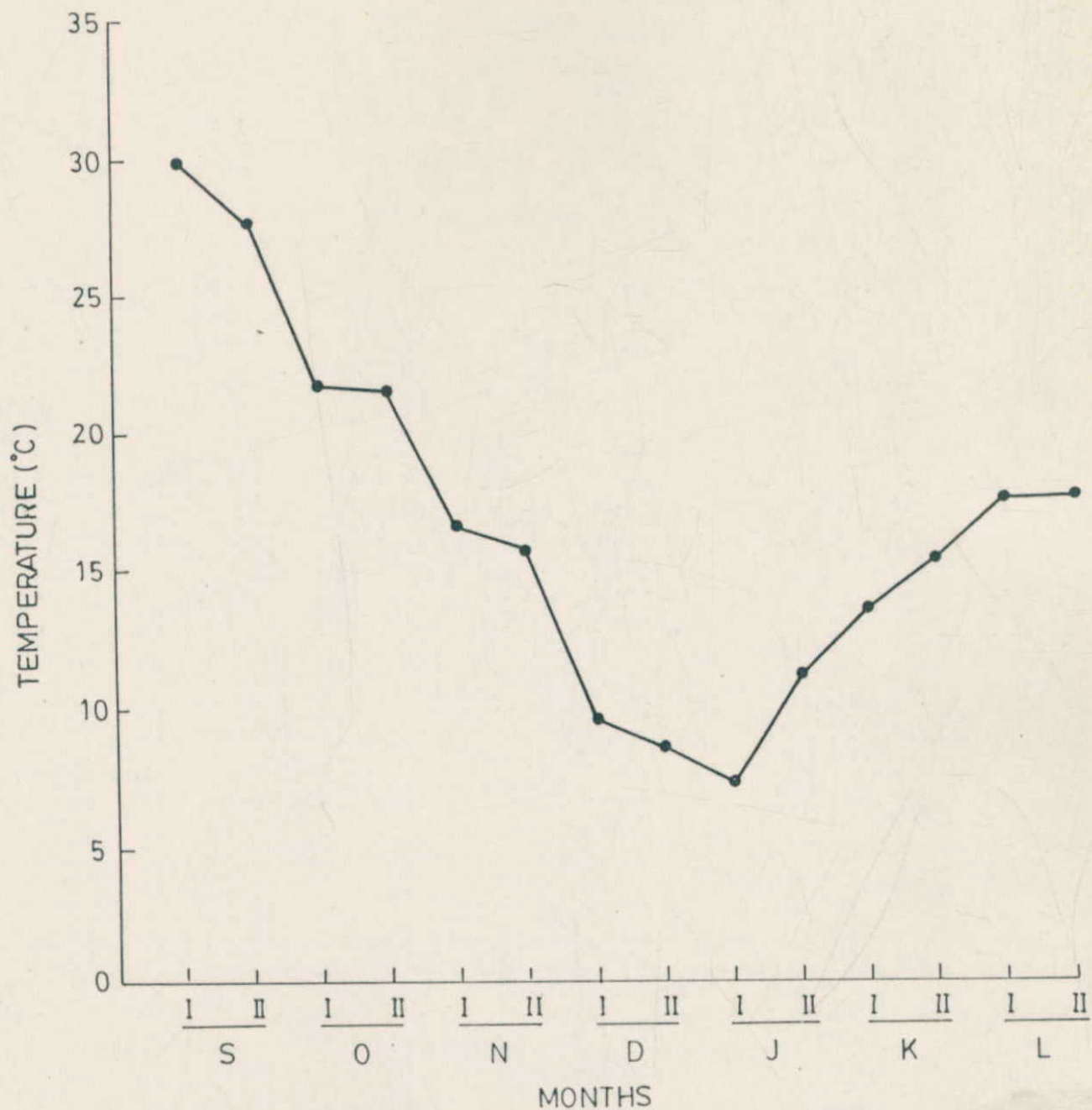


Fig. 13 SEASONAL VARIATION OF WATER TEMPERATURE IN POND-4, GAIRA

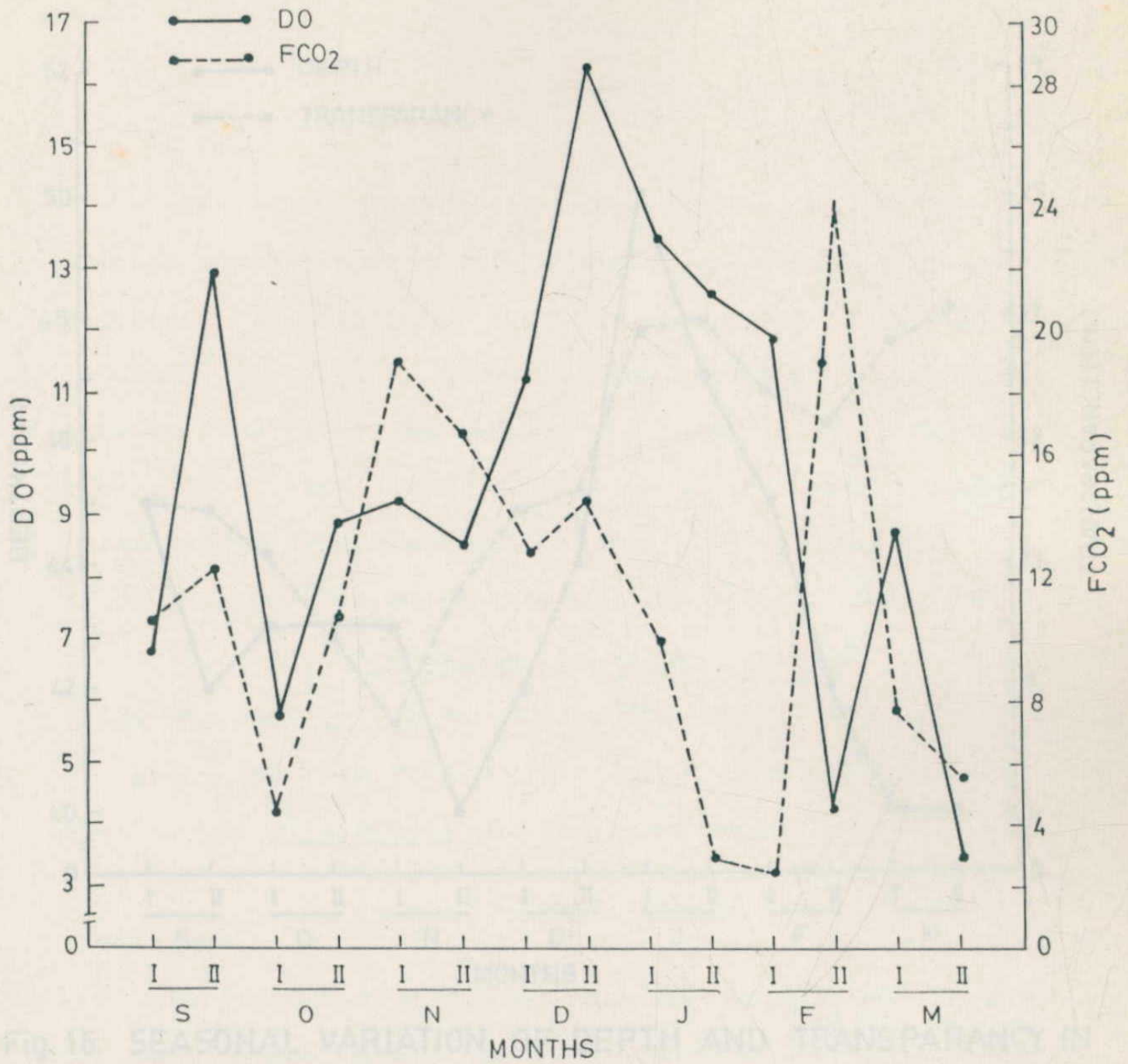


Fig. 15 SEASONAL VARIATION OF DISSOLVED OXYGEN AND FREE CARBON DIOXIDE IN POND-4, GAIRA

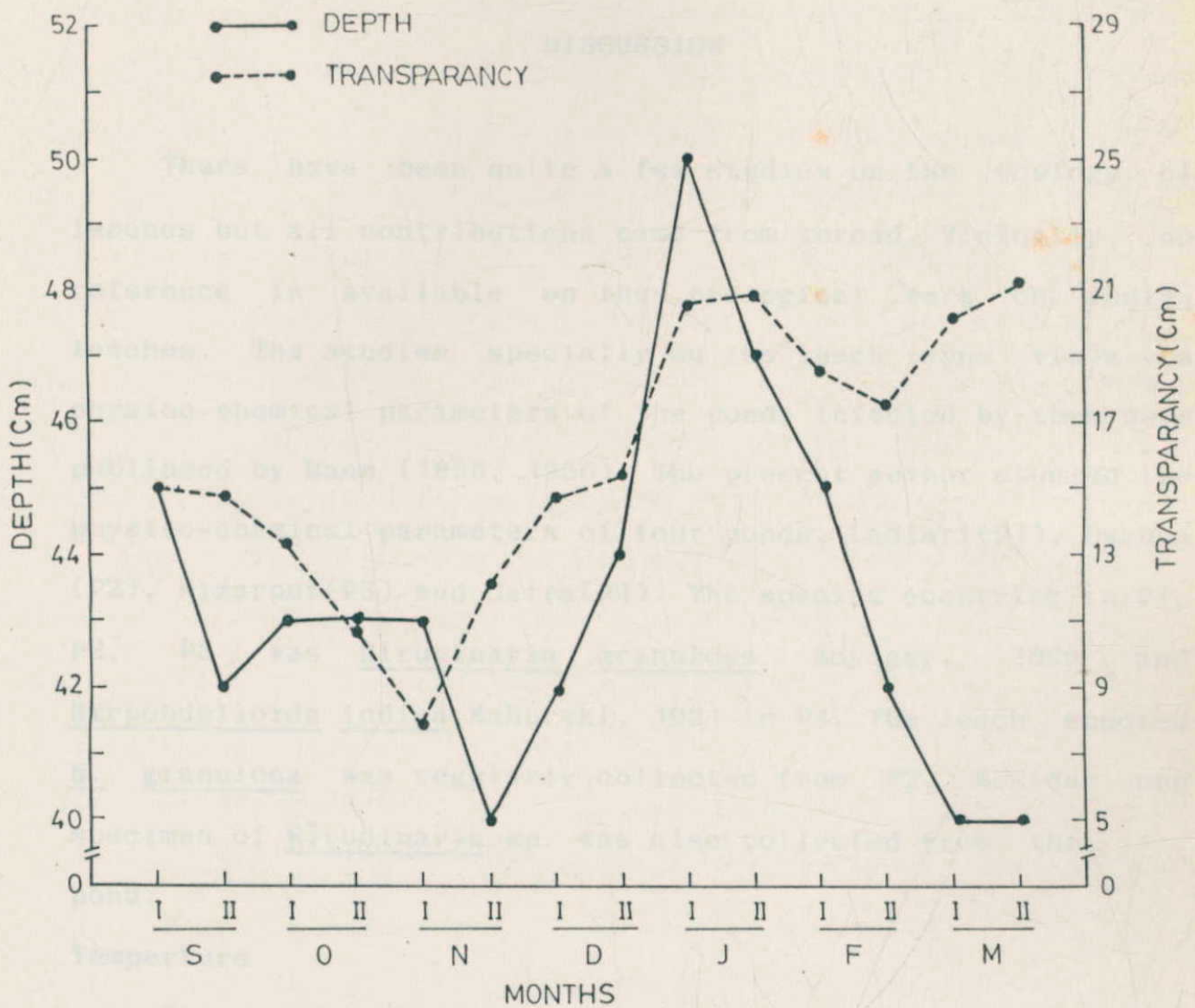


Fig. 16 SEASONAL VARIATION OF DEPTH AND TRANSPARANCY IN POND-4, GAIRA

Chapter V

DISCUSSION

There have been quite a few studies on the ecology of leeches but all contributions came from abroad. Virtually, no reference is available on the ecological work on Indian leeches. The studies specially on the leech fauna vis-a-vis physico-chemical parameters of the ponds infected by them were published by Mann (1955, 1956). The present author studied the physico-chemical parameters of four ponds, Ladiari(P1), Dasuya (P2), Kizarpur(P3) and Gaira(P4). The species occurring in P1, P2, P3 was Hirudinaria granulosa Savigny, 1820 and Hirpobdelloida indica Kaburaki, 1921 in P4. The leech species H. granulosa was regularly collected from P2. Besides one specimen of Hirudinaria sp. was also collected from the pond.

Temperture

The present studies observed the temperature fluctuations in all four ponds between 32.3°C-6.5°C. The minimum temperature of 6.5°C being in September, 1993 and maximum of 32.3°C in March, 1994. The leeches were available from March-September only during the morning hours, in the noon and evening they enter their hiding places at the pond. Ward and Whipple (1966) observed that leeches spend winter in a bottom

dormant stage buried in the upper parts of the substrate may be true as temperature reaches a minimum 2-4°C but the present observations reveal that the creatures were active within temperature range of 19-20°C. Mann (1962) in his book discussed the effect of temperature on Hirudo sp. and Theromyzon sp. as both leeches attach themselves to their hosts object warmed to at a temperature of 33-35°C. Kaiser (1954) concluded that Hirudo sp. is capable of distinguishing temperature differing by 1.5°C. Wrona (1987) reported that Nephelopsis obscura Verrill and Erpobdella punctata Leidy produce cocoons at a temperature range of 5-20°C and the rate of cocoon production was maximum at 20°C. Gates (1987) also stated that 29°C was the preferred temperature of Nephelopsis obscura Verrill and Erpobdella punctata Leidy.

Transparency, depth and colour

The transparency in all the ponds was found to be different due to their differences of water colour. The ponds had a variable depths of 70-60, 48-30, 52-30, 50-40 cms and transparency 35-13.5, 17.3-3.5, 28.75-11.40, 21.7-7.8 cms. The transparency in P1 pond due to its transparent water had a transparency values. In pond P2 water was green but muddy in ponds P3 and P4. Leeches prefer different depths of water in different seasons because their light and temperature preference. Even diurnal migration of leeches were seen (Ward and Whipple, 1953). They hide under stones, vegetation and debris during the hours of more day light, leeches burrow

into mud-bottom and can aestivate for more than four weeks at a time.

Denzer-Melbrandt (1935) studied that Glossiphonia heteroclita Linnaeus 1761 is photo negative in nature. Mann (1955) stated that leeches are photo negative in behaviour. Gates (1987) studied the effect of temperature on depth distribution of leeches, N. obscura Verrill and E. punctata Leidy move to shallow water in spring and in deeper water in autumn.

pH

The ponds were found to be in alkaline range throughout the period of investigation. Only P1, P2 and P4 were found to be acidic ones during the period of investigation. pH of P1, P2, P4 ranges from 8.49-6.7. Only P3 remained alkaline. pH of P3 ranges between 8.17-7.10. This was due to the pollutants like detergents added by the villagers to the pond. Mann (1955) also mentioned almost a similar situation for Hellobdella sp., Erpobdella octoculata Linn. 1758, Glossiphonia camplanata Linnaeus, 1758, Theromyzon sp. preferred not only alkaline water but also alkaline mud. Bendell (1991) concluded that leeches preferred pH 5.5. The author nevertheless could collect only one species, P. marmaratis in a lake having pH of 4.9. So with little fear of contradiction, a general statement can be made that leeches prefer alkaline range of water.

Do

The DO in the four ponds was found to vary from 16.2 to 3.1, 15.7 to 2.5, 25.10 to 6.8 and 16.3 to 3.5. So, leeches can survive in different DO ranges varying from very less to very high. Mann (1956) studied the effect of oxygen concentration in water on five leech species namely Glossiphina complanata Linn. 1758, Hellobdella stagnalis Linn. 1758, Piscicola geometra Linn. 1957, Erpobdella testacea Savigny, 1820 and Erpobdella octoculata Linn. 1758. The leeches were reported to adjust their oxygen uptake according to the dissolved oxygen concentration in water by adjusting their body metabolism. Lindeman (1932, 1935) studied oxygen uptake by Hirudo sp. and suggested that Hirudo can maintain oxygen uptake and thus more or less independent of oxygen concentration in the water. Brand (1946) reported that many leeches have a considerable ability to withstand anaerobic condition. Hirudo medicinalis Ray, 1710, Haemopsis sanguisuga, Blanchard, 1896, Hellobdella stagnalis Linn. 1758 and Erpobdella octoculata Linn., 1758 are survived for 5 days at room temperature while Glossiphonia complanata Linn., 1758 survived for 16 days at a temperature of 14-16°C without oxygen

FCO₂

The FCO₂ in the ponds were observed to fluctuate between 36 ppm to 2.7 ppm showing a wide tolerance to FCO₂ high concentration as well as low concentration. Mann (1958) studied the effect of CO on the rate of respiration of leech, Erpobdella testacea Savigny, 1820. Effect of CO₂ on leeches

was not studied.

Conductivity

The conductivity of the four ponds was less than 1 mmhos. The maximum conductivity was in the P3 0.758-0.479 mmhos while very less conductivity was not in P1 0.289-0.115 and pond P2 and P3 range was from 6.479-0.177 mmhos So the leeches survive in these conductivity ranges. P3 conductivity was more due to the addition of detergents and P1 was less due to the clear, transparent water without any pollutants.

Chapter VI

SUMMARY

Systematics and ecological studies of leeches from Punjab, Haryana Prant, Himachal Pradesh and Assam are the subject matter of the present thesis. The thesis carries the descriptions and illustrations of nine leech species. The leeches were collected regularly for a period of more than one year from January, 1993 to March, 1994. The leeches were collected from fresh water bodies including tanks, ponds, stagnant waters, seasonal, ponds and also from paddy fields and vegetation of forest area of Punjab, Himachal Pradesh, Haryana Prant and Assam. The various habitats were Dasuya, Matiana, Singriwala, Mai Dia Kanga (Hoshiarpur), Rajpura (Patiala), Jhand Bali (Ferozepur) in Punjab. Murmandi, Prem Nagar, Dukhari, Model Town, Ambala City, Ambala Cantt in Haryana Prant and Naudan in Himachal Pradesh. Leeches were also collected from few ponds at Duliajan (Assam).

In all 190 leech specimens belonging to 9 species of five genera and two families and two subfamilies were collected. The leeches were narcotized in 10% ethanol and preserved in 10% formalin solution. Leeches were dissected after narcotising them for 30 minutes in 10% ethanol.

Nine species described belong to five genera. Hirudinaria

is by far the best genus occurring in Punjab as it has been found to be represented by five species namely H. javanica (Wahlberg, 1856), H. manillensis (Lessen, 1824), H. granulosa (Savigny, 1820), H. viridis (Moore, 1927) and Hirudinaria sp. indt. The maximum number of specimens (119) were observed in case of H. granulosa Savigny followed by H. javanica Wahlberg (15) and H. manillensis Lessen (15). Only one specimen each of H. viridis Moore and Hirudinaria sp. indt. was found. A new genus Pseudohirudinaria has been described from the collection of Assam, its type species being Pseudohirudinaria assamensis. The remaining genera are represented by one species each. Genus Herpobdelloidea represented by H. indica (Kaburaki, 1921), Genus Foraminobdella represented by F. heptomerata Kaburaki, 1921 and genus Haemadipsa represented by subspecies H. zeylanica cochiniiana Moore, 1927.

The description of a new genus Pseudohirudinaria is the forte of this work. A taxon could be only assigned to genus when one or more characters vary from other taxon under the genus. So, of above mentioned genera, one species indt. and one genus is new to science. The species Hirudinaria indt. was collected from a seasonal pond in Dasuya. This species seemed closely related to H. granulosa Savigny, 1820, but can be easily separated from later because of the presence of three genital pores instead of two. The new genus Pseudohirudinaria

represented by a single species P. assamensis was collected from seasonal pond in Duliajan (Assam). This genus is closely related to Hirudinaria Whitman, 1886 but differed from the former in having the two pair of eyes and six annuli differences in male and female genital pores.

All the taxonomic parts of these taxa have been described, figured and measured. The measurements are based on the number of specimens available. The ecological studies have been carried out at four selected habits namely Pond-1, Ladiari; Pond-2, Dasuya; Pond-3, Kizarpur; Pond-4, Gaira. The ecological parameters, temperature, pH, conductivity, dissolved oxygen, free carbon dioxide, depth and transparency were estimated fortnightly. The occurrence of reported species in relation to above mentioned physico-chemical parameters are discussed on basis of study from September, 1993 to March, 1994. Of all the four ponds Hirudinaria granulosa was common in three ponds P1., P2 and P3 but in P4 Herpobdelloidea indica sp. indt. was present. The temperature and dissolved oxygen of four ponds was not significantly different while pH, conductivity, free carbon dioxide, depth and transparency of four ponds was significantly different.

LITERATURE CITED

- Agapow, L. 1986. Rare species of leeches (Hirudinea) in the Planned Drawienski National Park. Przeegl-Zool, 30(3): 293-298.
- Aggarwal, K.K. (ed.). 1994. Modern medicine and the leech. IJCPs' Medicines, April 199: p.26.
- Appy, R.G. and Dadswell, M.J. 1981. Marine and eutuarine Piscicolid leeches (Hirudinea) of the Bay of Fundy and adjacent waters with a key to species. Can. J. Zool., 59: 183-192.
- Baagoe, P. and Jensen, B. 1985. Recent records of Hirudo medicinalis from Denmark, Flora. Fauna, 91(1): 27-30.
- Baird, W. 1869. Description of some new suctorial Annelids in the collection of the British Museum. Proc. Zool. Soc. London, 1869, pp. 310-318.
- Barja, R. and Sawyer, R.T. 1990. Definition of a new genus of grossiphoniid leech and a redescription of the type species Clepsine picta Verrill, 1872. Can. J. Zool. 68(9): 1942-1950.
- Bendell, B.E. and Mcnical, D.K. 1991. An assessment of leeches as indicators of lake acidification. Can. J. Zool. 69: 130-133.
- Bhatia, M.L. 1930. On the Anatomical details of Placobdella emydae Harding. A leech parasitic on Indian turtles. Zoologischer Anzeiger, Leipzig, 91: 225-243.
- Bhatia, M.L. 1930. Sur une nouvelle Hirudinee, Rhynchobdelle, Glossiphonia cruciata n. sp., Provenant du vivier a truites D'Achha Bal, Kashmir. Annales de Parasitologie. Paris, 8: 344-348.
- Bhatia, M.L. 1934. Nouvelle sangsue Rhynchobdellidae, Glossiphonia lobata n. sp. De L' etablissement de pisciculture D'Achha Bal Kashmir. Annales de Parasitologie. Paris, 12: 121-129.
- Bhatia, M.L. 1938. On the structural variation in the Indian leech Hirudinaria granulosa. Current Science, 6: 439-442.

- Bhatia, M.L. 1938. On the structure of the nephridia and funnels of Indian leech Hirudinaria with remarks on these organs in Hirudo. Quart. J. Micr. Sci. **81**: 27-80.
- Bhatia, M.L. 1939. Fauna of the Dal lake Kashmir, 1 "On some leeches from the Dal lake, Kashmir". Bull. of Department of Zoology, Punjab University, Lahore, 1-20.
- Bhatia, M.L. 1939a. The prostomial glands of the Indian, leech, Hirudinaria granulosa. J. Morph., **64**: 37-46.
- Bhatia, M.L. 1940. On Haemopis indicus n. sp. A new Arhynchobdellid carnivorous leech from Kashmir. Proc. Nat. Acad. Sciences, **10**: 133-144.
- Bhatia, M.L. 1941. Hirudinaria (The Indian Cattle leech). Indian Zool. Mem., **8**: 1-107.
- Bhatia, M.L. 1945. On the nephridial system of the Indian carnivorous leech, Haemopis indicus Bhatia. Proc. Nat. Inst. Sciences, **11(1)**: 7-13.
- Bhatia, M.L. 1970. The segmentation of the Gnathobdellid leeches with special reference to the Indian leech, Hirudinaria and the medicinal leech Hirudo. J. Morph. The Wistar Institute, Philadelphia, **132**: 361-376.
- Bhatia, M.L. 1977. Memoirs of Indian animal types-Hirudinaria with appendix on Hirudo medicinalis (the leech) and Haemopis sanguisuga (The horse leech) Embay Publications, Delhi, 150 pp.
- Bhatia, M.L. and Bora, S.S. 1973. Bionomics and distribution of the land leeches of Kumaon hills, U.P. Bombay Nat. Hist. Soc. **70**: 36-56.
- Bielecki, A. 1990. New stand of Capiobdella jadejewi (Epstein, 1961) (Hirudinea, Piscicolidae) in Poland. Przegł Zool. **34(4)**: 497-500.
- Blanchard, R. 1887. Dictionnaire encyclopedique sci. med. Art. Hirudinees. Paris.
- Blanchard, R. 1893. Revision des Hirudinees du Museede Turia. Boll. Mus. Zool. ed. Anat. Comp. Univ. di Torino, viii, no. 145, 32, 13 text-figs.

- Blanchard, R. 1894. Revision des Hirudines du Museede Dresde
Abhandl. u Ber d.k. Mus. Zool. Anthr. Eth du
Dresden, 1892-3, No. 42 p. 8, Pl. i.
- Blanchard, R. 1894c. Viaggio di Leonardo Fea in Birmanica e
regioni vicine-LVII. Hirudinees. Ann. Mus. Civico di
Storia. Naturale, Genova (2) xiv, pp. 113-118.
- Blanchard, R. 1897. Hirudinees des Indes Neerlandaises. Zool.
Ergeb Reise in Neiderlandisch Ost. Indier, 4. 332-
355.
- Blanchard, R. 1917. Monographie des Hemadiopsines (Sangsues
terrestres) Bull. de la Soc. Pathologie Exetique X,
640-675.
- Bough, S.C. 1960. Studies on Indian Rhynchobdellid leeches.
Parasitology, 50(3/4): 287-301.
- Bourne, A.G. 1884. Contribution to the anatomy of the
Hirudinea. Quart. Journ. Micr. Sci., 24: 419-506.
- Brand, T. Von. 1946. Anaerobiosis in invertebrates, Missouri.
- Brandes, G. 1901. In Leuchart Die Parasiten des Menschen, 2nd
ed. Vol. VI., Leipzig.
- Chandra, M. 1970(1966). Notes on a small collection of leeches
in the Zoological Survey of India. Rec. Zool. Surv.
India, 64(1-4): 107-110.
- Chandra, M. 1976a. On a small collection of leeches from
Maharashtra State. India. Rec. Zool. Surv. India,
69(1-4): 325-328.
- Chandra, M. 1977. A check list of leeches of Himachal Pradesh.
Rec. Zool. Surv. India, 73(1-4): 189-195.
- Chandra, M. 1983. A check-list of leeches of India. Rec. Zool.
Surv. India, 80: 265-290.
- Chandra, M. and Mahajan, K.K. 1976b. Leeches of Simla Hills,
Himachal Pradesh. Rec. Zool. Surv. India. 69(1-
4): 255-259.
- Chelladurai, J.E. 1934. On a new Indian leech, Hemiclepsis
viridis sp. nov. Rec. Indian Mus., 36: 345-352.

- Chin, L. and Hsiung. 1949. Further notes on leech infestation in man. Jour. Parasitol., 35(2): 215.
- Davies, R.W. 1973. The geographic distribution of fresh water Hirudinoidea in Canada. Can. J. Zool., 51: 531-545.
- Davies, R.W. et Wilkialis, J.C. 1980. The population ecology of the leech (Hirudinoidea: Gloossiphoniidae). Theromyzon rude Can. J. Zool. 58: 913-915.
- Davies, R.W., Singhal, R.N. and Blinn, D.W. 1985. Erpobdella montezuma, a new species (Hirudinoidea: Erpobdellidae) of fresh water leech from North America. Can. J. Zool. 63(4): 965-967.
- Delmastro, G.B. 1988. Piscicola geometra New record (Linnaeus, 1758) in Western piedmont (Italy) (Hirudinea, Piscicolidae). Mus. Reg. Sci. Nat. Boll. (Torino), 6(1): 193-196.
- Deniels, B. and Freeman, R.S. 1976. A review of the genus Actinobdella Moore, 1901 (Annelida, Hirudinea). Can. J. Zool. 54: 2112-2117.
- Denzer-Melbrandt, V. 1935. Helligkeits-und Farbensinn bei deutschen Süßwasseregeln. Zool. Jb. Physiol. 55: 525-562.
- De Qual, L. 1917. Nuovi irudinei esotice del Museo Zoologico di Torino. Boll. Mus. Zool. ed. Anat. Comp., 32(724): 20.
- El-Shimy, N.A. 1991. New subspecies of Solifa perpicaux Blanchard, 1897 (Hirudinea: Salifida) from Egypt, Zool. Middle East, 5(0): 113-118.
- Eugene, G.H. and Anthony, J.G. 1976. Cytobranchnus meyeri sp.n. (Hirudinea: Piscicolidae) from Catostomus commersoni lacepede in North America. Jour. Parasitology, 62(4): 621-627.
- Finogenova, N.P. 1992. On age changes in the morphology of Baikal leech Codobdella truncata and a new taxonomic status of Dogarobdella zelenskiji (Piscicolidae). Zool. Zh., 71(1): 137-140.
- Gates, T.E., and Davies, R.W. 1987. The influence of temperature on the depth distribution of sympatric Erpobdellidae (Hirudinoidea). Can. J. Zool. 65: 1243-1246.

- Grube, E. 1868. Novara Reise-Zool. Bd. ii. Abth.3. Anneliden
Wien. Leeches, PP.37-43, Tapiv.
- Hajduck, D. and Hajduck, Z. 1986. The hirudinean fauna of
Jeziaro Lubiatoewskii (Poland). Wiad Parazytol. **32(1)**:
99-104.
- Hajduck, Danuta and Hajduck, Z. 1985a. The hirudinean fauna of
the mid and lower current and the old beds of the
Biebrza river (Poland). Wiad Parazytol. **30(2)**: 241-
248.
- Hajduck, Z. and Hajduck. 1985b. The hirudinean fauna of the
clay pits in stanowice near Swiebodziu (Lower silesia)
(Poland). Wiad. Parazytol., **30(2)**: 249-256.
- Harding, W.A. 1910. On a revision of British leeches. Jour.
Parasitology, **3**: 130-201.
- Harding, W.A. and Moore, J.P. 1927. The fauna of British India
including Ceylon and Burma. Hirudinea 302 pp.
- Hartwich, G. 1986. The types of Hirudinea in the Zoological
Museum, Berlin (East Germany). Mitt. Zool. Mus. Berl.,
62(2): 347-354.
- Haycraft, J.B. 1884. On the action of a secretion obtained
from the medicinal leech on the coagulation of the
blood. Proc. Roy Soc. **36**: 478-487.
- Hussein, M. A. and Sayed, A. and Moustafa, M. 1993. An
American fresh water leech, Hellobdella punctata
lineata (Moore, 1939) in Egypt (Hirudinea
Glossiphoniidae). Limnologia **23(1)**: 81-84.
- Jones, R.M. and Woo, T.K. 1990. Redescription of leech,
Derserobdella phalera, new combination (Graf, 1899)
(Rhynchobdellida, Glossiphoniidae). Can. J. Zool.,
68(9): 1951-1955.
- Jones, S.R.M. and Woo, P.T.K. 1991. Development and
infectivity of Trypanosoma phaleri in leech and fish
hosts. Can. J. Zool. **69**: 1522-1527.
- Kaburaki, T. 1921a. On some leeches from the Chilka Lake.
Mem. Indian Mus. **V**: 662-675. 5 text. figs.

- Kaburaki, T. 1921. Notes on some leeches in the collection of the Indian Museum. Rec. Indian Mus., 18: 689-719.
- Kahl, K. 1991. Leeches (Hirudinea) of streams of river in the Lysogary subregion. Fragm Faun (Warsaw), 35(1-8): 19-29.
- Khan, M.M. 1912. Notes on Rearing leeches in Bara Banki District, United Provinces. Red. Ind. Mus. 7: 206, 267.
- Khatoon, Sanjeeda and Ali, S. 1985. Certain fresh water leeches of Pakistan. Bull. Hydrobiolres, 0(30/31): 588-591.
- Kinberg, T. G. H. 1866. Annulate nova. Ofver. Kongl. Vet-Akad. Forh. 1865, No.9, Hirudinacea, pp.256-257.
- Kutschera, U. 1985. Description of new species, Hellobdella striata (Hirudina: Glossiphoniidae). Zool. J. Ahrb. Abt. Syst. Oekol. Georg. Tiere, 112(4): 469-476.
- Kutschera, U. 1988. A new leech species from North America, Hellobdella californica new species (Hirudinea, Glassiphoniidae). Zool. Anz. 220(3/4): 173-178.
- Lankester, E.R. 1880. On the connective and vasifactive tissue of the medicinal leech. Quart. J. micr. Sci. (N.S.) 20: 307-317.
- Lesson, J.P. 1824. Description d'une nouvelle espece de Sangsue. Revw Zoologique Societe Cuvierieme, p.8.
- Lindeman, V.F. 1932. Respiration regulation in the leech (Hirudo medicinalis). Physiol. Zool. 5: 560-565.
- Lindeman, V.F. 1935. The relation of temperature to respiratory regulation in the leech (Hirudo medicinalis). Physiol. Zool., 8: 311.
- Linnaeus, C. 1758. Systema Naturae. 10th ed.
- Madill, J. 1988. New canadian records of leeches (Hirudinea). Can. Field Nat., 2(4): 685-688.
- Mahajan, K.K. and Cahndra, M. 1976c. Report on a collection of leeches from Rajasthan, India. Rec. Zool. Surv. India, 71: 143-148.

- Mann, K.H. 1951. On the bionomics and distribution of Theromyzon tessulatum (O.F. Muller, 1774) (= Protoclepsis tessulatum). Ann. Mag. nat. Hist., 4: 956-961.
- Mann, K.H. 1954. A revision of British leeches of family Gillossiphoniidae, with a description of Batracobdella paludosa (Caarena, 1824) a leech new to British fauna. Proc. Zool. Soc. London, 123(2):377-391.
- Mann, K.H. 1954. The life history of Erpobdella octoculata (Linnaeus, 1758). Journ. Anim. Ecol., 22(2): 199-207.
- Mann, K.H. 1955. The ecology of the British fresh water leeches. Journ. Anim. Ecol., 24(1): 98-119.
- Mann, K.H. 1956. A study of the oxygen consumption of five species of leech. J. Exp. Biol., 33: 615-676.
- Mann, K.H. 1957. The breeding, growth and age structure of a population of the leech, Hellobdella stagnalis (L.). J. Anim. Ecol., 26: 171-177.
- Mann, K.H. 1961. The life history of the leech Erpobdella testacea and its adaptive significance. Oikos 12: 164-169.
- Mann, K.H. 1962. Leeches (Hirudinea), Their Structure, Physiology, Ecology and Embryology. Intern. Sci. Monographs on Pure and Appl. Sci. Zool. Div. II, Pergamon Press, Oxford, 201 pp.
- Matthal, G. 1920. Preliminary observations on cocoon-formation by the common Lahore Leech, Limnatis (Poecilobdella) granulosa (Sav.). Journal Proc. Asiatic Soc. of Bengal, n.s. xvi.No.8, pp.344-346, text-figs. and Pl.xviii.
- Matsiak, K. 1985. Various substrate and seasonal conditions on occurrence of leech species (Hirudinea) in low land streams of Narewka basin (Poland). Przeegl. Zool., 29(1): 55-68.
- Maquin-Tondon, A. 1826. Monographie de la famille des Hirudinees. Montpellier.
- Maquin-Tondon, A. 1846. Monographie de la famille des Hirudinees. Montpellier., 2nd ed. Paris.

- Mckee, P.M. and Mackee, G.L. 1979. Incidence of Marvinmeyeria lucida (Hirudinea: Glossiphoniidae) in the fingernail clam, Sphaerium occidentale. Can. J. Zool., 57: 499-503.
- Meyer, M.C. 1975. A new leech, Macrobdella diplotertia sp. n. (Hirudinea: Hirudinidae), from Missouri. Helminthological Soc. Washington. 42: 82-85.
- Miller, J.A. 1937. A study of the leeches of Michigan with key to Order, suborder and species. Ohio Jour. Sci., 37: 85-90.
- Moore, J.P. 1924. Notes on some Asiatic leeches (Hirudinea Principally from China, Kashmir and British India). Proc. Acad. nat. Sci. Philad., 76:343-388.
- Nessemann, H. 1990. Investigation on two Glossiphonia spp. (Hirudina) from running waters of Central Europe with a redescription of Glossiphonia Concolor new records (Apathy, 1888). Ann. Hist. Nat. Mus. Nat. Hung., 82(10): 65-74.
- Okland, K.A. 1988. The fresh water leeches Boreobdella verrucata (Pr. Muller) and Batracobdella paludosa (Carena) (Hirudinea: Glossiphoniidae) new to Norway Fauna (Osto), 41(2): 51-55.
- Oosthuizen, J.H. 1989. Redescription of the African fish leech, Batracobdelloides tricarinata (Blanchard, 1897) (Hirudinea: Glossiphoniidae). Hydrobiologica, 184(3): 153-164.
- Oosthuizen, J.H. 1991. An annotated check list of leeches (Annelida: Hirudinea) of Kruger National Park (South Africa) with a key to the species. Koedoe, 34(2): 25-38.
- Poirier, F.M. 1942. Hemotysies observees chez des senegalais a yant degluti des sangues. Bull. Soc. Path. Exot., 35(6/8): 213-214.
- Puccinelli, I. and Mancino. 1969. Asservazioni carilogiche sulgenese trocheta (Hirudinea, Erpobdellidae). Attiacead Naz. Uncei Rend. Cl. Scifig. Mat. Natur. Sez. III., 45(6): 597-605.
- Raj. P.J.S. 1951. On a new species of ozobranchus (Annelida: Hirudina: Family Ichthyobdellidae) from Partonova. S.India. J. Zool. Soc. India, 3: 1-5.

- Raj, P.J.S. 1959. A synopsis of the genus *Ozobranchus* (de Quatrefages, 1852) Hirudinea, Annelida, J. Bombay nat. Hist. Soc., 52: 473-480.
- Ricciardi, A. and David, L.J. 1991. New records of freshwater leeches (Annelida: Hirudinea) from Quebec. Can. Field Nat. 105(3): 368-371.
- Ringuelet, R. 1944. Sinopsis systematica y Zoogeografica de los Hirudineos de la Argentina, Brazil, Chile Paraguay y Uruguay. Rev. Mus. La Plata, Secc. Zool., 3(22): 163-232.
- Robertson, M. 1909. Studies on Ceylon Haematozoa. Quart. Jour. Mus. Sci. n.s. llll, pp.665-695.
- Sachmarda, L.F. 1961. New Turbellarien, Rotalorien und Anneliden. Leipzig. Zte Halfte. Leeches: 2-7.
- Sapkarev, J. 1990. New leeches (Hirudinea) of the ancient lake Ohrid. Fragm. Balc. Mus. Macedonici Sci. Nat. 14(17): 155-162.
- Savigny, J.C. 1820(1822). Systeme Des Annelides. Paris.
- Sawyer, R.T. 1972. North American fresh water leeches exclusive of the Piscicolidae, with a key to all species. III. Biol. Monogr. 46: 1-154.
- Sawyer, T. and Kinard, W.F. 1980. A check list and key to the marine and fresh water leeches (Annelida: Hirudinea) of Puerto Rico and other Caribbean Islands. Caribb. J. Sci., 15(3/4): 83-86.
- Shankland, N., Shirpley, B.T. and David, A.W. 1992. Description of californian leech *Hellobdella robusta*, new species and comparison with *Hellobdella triserialis* on basis of morphology, embryology and experimental breeding. Can. J. Zool. 70(6): 1258-1263.
- Sket, B. 1985. *Piscicola hadzii* new species (Piscicolidae, Hirudinea) a probably endemic species of leeches from Herzegovina Yugoslavia. Biol. Vestn., 3(2): 89-94.

- Singhal, R.N., Davies, R.W. and Shah, K.L. 1985. The taxonomy and morphology of the leeches (Hirudinoidea, Glossiphoniidae). Parasite on turtles from Beas river (India). Can. Zool. Anz., 215(3-4): 147-155.
- Singhal, R.N. and Davies, Ronald, W. 1987. The morphology anatomy and systematics of leeches from north India. Zool. Anz., 218(3/4): 177-184.
- Soos, A. 1967a. Identification key to the leech (Hirudinoidea) genera of the world, with a catalogue of the species IV. family Haemadipsidae. Acta Zool. Hung., 13(3-4): 417-43.
- Soos, A. 1970. A Zoographical sketch of the fresh water and terrestrial leeches (Hirudinoidea). Opus. Zool. Bpest., 10(2): L 303-323.
- Tennent, J. E. (1859 *1860). Ceylon. An Account of the Island, etc. 2 vols. London 4th Ed., 1869. Leeches, i, pp. 301-397.
- Wahlberg, R.F. 1856. Ofversigt Kongl. Vet. Akad. Forh. 1855: 233-34.
- Ward and Whipple. 1966. Fresh Water Biology. edited by W.T. Enmondron, N.Y. 1248 p.
- Wharton, L.D. 1913. Hirudoboyntoni, a new Philippine Leech. Philip. Journ. Sci. D.8: 369-371.
- Whitman, C.O. 1886. The leeches of Japan. Quart. Journ. Micr. Sci. 26: 317-416.
- White, G.E. 1977. New distribution records of fish leeches in the Ohio river. Jour. Parasitology, 63(6): 1138.
- Wilkialis, J., et al. R.W. Davies. 1980. The population ecology of the leech (Hirudinoidea: Glossiphoniidae). Theromyzon tessulatum. Can. J. Zool., 58: 906-912.
- Wrona, F.J., Davies, J.R.W. and Linton, L. 1979. Analysis of the feed niche of Glossiphonia complanata (Hirudinoidea: Glossiphoniidae). Can. J. Zool. 57: 2136-2142.

- Wrona, F.J., Linton, L.R. and Davies, R.W. 1987. Reproductive success and growth of two species of Erpobdellidae. The effect of water temperature. Can. J. Zool. **65**: 1253-1256.
- Yang, T. and Davies, R.W. 1985a. Parasitism by Placobdella multilineata, new record (Hirudinoidea: Glossiphiniidae) and its first record from Asia. J. Parasitol., **71**(1): 86-88.
- Yang, T. and Davis, R.W. 1985b. The morphology of P. multilineata a parasitic of crocodile. Can. J. Zool., **63**(3): 550-551.
- Zhatkanbaeva, D. and Ten, V.A. 1987. Leeches from lake Markakal (Kazakh SSR, USSR) and their role in streigeid circulation. Izvakad Nauk. Kaz. SSR. Ser. Biol., **0**(3): 37-39.

189131

