PARASITE DISTRIBUTION AND HISTOPATHOLOGICAL STUDIES ON CERTAIN COMMERCIALLY IMPORTANT FISHES OF COCHIN AREA

THESIS

SUBMITTED TO

THE COCHIN UNIVERSITY OF SCIENCE AND TECHNOLOGY

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

UNDER THE

FACULTY OF MARINE SCIENCES

BY

V. S. JALAJAKUMAR

DIVISION OF

MARINE BIOLOGY, MICROBIOLOGY & BIOCHEMISTRY

SCHOOL OF MARINE SCIENCES

Cochin University of Science and Technology

Cochin - 682 016

August 1988

To my

beloved

parents

CERTIFICATE

This is to certify that this thesis is an authentic record of the work carried out by Shri. V.S. Jalajakumar. M.Sc., under my supervision and guidance at the School of Marine Sciences, Division of Marine Biology, Microbiology and Biochemistry, Cochin University of Science and Technology, Cochin in partial fulfilment of the requirements for the degree of Doctor of Philosophy and that no part there of has been presented before for any other degree, diploma, associateship, fellowship, or other similar titles of any university.

School of Marine Sciences,
Cochin University of Science and Technology,
Fine Arts Avenue,
Cochin - 682 016.

Dr: V.J. Kuttyamma.
Reader
Supervising Teacher

Dr. V. ... A
SCH... ...ES
C... ...OF
SCIE... ...OGY,
COCHIN-682 016.

DECLARATION

I, Shri. V.S. Jalajakumar, do hereby declare that the thesis entitled "Parasite Distribution and Histopathological Studies on Certain Commercially Important Fishes of Cochin Area" is a genuine record of the research work done by me under the scientific supervision of Dr: V.J. Kuttyamma, Reader, School of Marine Sciences, Cochin University of Science and Technology in the Faculty of Marine Sciences, and has not previously formed the basis for the award of any degree, diploma, associateship, fellowship or other similar titles or recognition of any university.

V.S. Jalajakumar

Cochin - 682 016.

ACKNOWLEDGEMENTS

It is my pleasure to place on record my deep sense of gratitude to Dr: (Mrs) V.J. Kuttyamma, Reader Marine Biology, School of Marine Sciences for her deep interest and inspiring guidance throughout the course of the research work.

I have no words to express my sincere gratitude to Dr: A.Mohandas Reader, School of Environmental Studies, who wholeheartedly spent his precious time for valuable discussions, constant encouragement and constructive critisism during the various stages of my research career.

My sincere thanks are also due to Dr: N.R. Menon, Professor and Head of the Division of Marine Biology for the timely suggestions, encouragement and providing necessary laboratory facilities.

Acknowledgements are also due to Prof: G.S. Sharma, former Director of the School of Marine Sciences and Prof: Y.L. Dora, the present Director, for encouraging me throughout my research period.

I am indebted to Prof: R.C. Pillai, D.B. College, Sasthamcottah for the inspiration given to me to build up a research career.

The strenous efforts of Dr: K. Mohan Kumar, Lecturer, School of Marine Sciences for his valuable advice and help in the statistical analysis of the data and preparation of the graphs is gratefully acknowledged.

My thanks are due to my friends K.S. Gopalakrishnan, K. Sasidharan, K.N. Prabhudeva, A.V. Sasikumar, Sheeba George, Maria George and others for their help given to me during my research period.

I am also grateful to Dr: S. Radhakrishnan, of the Department of Aquatic Biology, and Mr: C.G. Rajendran of the College of Fisheries for their constant encouragements.

I wish to thank Mrs. Lalitha, School of Marine Sciences for typing the manuscript and Mr: N.G. Mani of M/s. Coastal Impex for typing the fair copy of this thesis.

The co-operation given by the teaching and non-teaching staff of the Cochin University of Science and Technology is gratefully acknowledged.

The financial assistance received from the University by means of research fellowship is also acknowledged.

......

C O N T E N T S

PREFACE

Parasites are of very great public and economic importance and have profoundly influenced human history. Inspite of the advances made in the prevention and treatment of parasite infection, diseases caused by parasites are, even today, more common than any other kind of disease, particularly in subtropical and tropical countries. Although the most common and dangerous parasites of man are associated with the terrestrial and fresh water environments, there are many marine parasites, cestodes, trematodes and nematodes which are dangerous to man (Rohde 1976, 1982). They mainly infect marine fishes which inturn become food of man and cause disease.

"Every parasite living in or on a fish exerts some degree of harmful influence on its host. This influence may result in extensive changes in individual organs or tissues or it can take the character of general effect. In either case, the parasite causing these changes is regarded as pathogenic. On the other hand, this influence can be so light that it does not cause the appearance of any external signs. Even in such cases, however, the parasite involved should not be although it commonly is, considered non-pathogenic. However small the noxious effects, every parasite is harmful to its host" (Bauer, 1958).

The great number of parasitic species of marine and brackish water animals that have been described indicates that parasites play an important part in the ecology of the ocean and brackish waters. In spite of their importance, marine and brackish water parasites are probably the least known group of organisms. Considering the large number of marine and brackish water hosts, especially in the tropics, it is no exaggeration to say that the description of marine and brackish water parasites has hardly begun (Rohde, 1982).

The role of parasites and diseases in the ecology of fishes is highly significant. They may exert profound effects on the population size of the host fish and may, sometimes, be one of the most important limitations to the biotic potential of certain species.

Epizootics in one species may have significant positive or negative effect on other species and they could cause imbalances or disruption of food relations between species by affecting population abundance at any trophic level. Some parasites and diseases common to one geographical area may be rare or absent in another, and species having cosmopolitan distribution may succumb to different representatives of a genus or family of parasites in different geographical ranges. Parasites and diseases may be significant at any stage in the development of the fish. While many parasites and diseases cause mass mortalities among fish populations, some others have an indirect effect by way of rendering the host more vulnerable to predation and restricting the growth of individuals limiting the reproductive potential and reducing the value of the fish as food. Since confined fish populations are subjected to the stress of an unnatural environment, the parasite and disease problems are more severe in aquaria, hatcheries and fish farms (Sinderman, 1970).

The composition of the parasite fauna of all species of fish living in an area depends on the geographical location of the habitat, the season of the year, the water characteristics such as temperature and salinity, the type of the bottom, the fauna present in and around the habitat etc. It is also affected by the physiological and biological features of the host, such as food habit, locomotion, digestive secretions, ability to develop immunity towards a particular parasite, the age of the host, the time of spawning or migration, and the changes effected by the environmental changes (Bauer, 1958).

The most important problem of the people of our country today is food. Over 50% of our people suffer from undernutrition or malnutrition (Nair, 1975), and protein deficiency of the diet of our people requires immediate attention. The only solution to this serious problem is to make available to the common man the required quantity of protein-rich food.

Fish is perhaps the cheapest, but the best animal protein available tc man. Even though India has a coast line of about 6,100KM (George, 1930) and three seas around, the annual fish landings in India are not sufficient to meet even the minimum requirement. As a result of planned efforts to develop fisheries, the fish production has gone up from 0.75 million tonnes in 1950-51 to 2.54 million tonnes in 1977-78 (George, 1980) and to 2.84 million tonnes in 1984 (MPEDA, 1984). However, the per capita consumption of fishes by an Indian is a staggering low figure of 3 Kg. per man per year (RAPA, 1985). The present exploitation of these resources, inspite of this achievement, is still fractional. The resources, both on the marine and inland sides, are very vast, capable of enabling production to several million tonnes.

To meet this challenge aquaculture and fish farming should be given prime importance at the earliest. But in such attempts, the major hazard one has to face is no, doubt, parasites and diseases. As Pal (1975) has aptly put it "In India success of aquaculture depends to a great extent on the role of the fish pathology played in it, particularly no attention has been paid to this branch of science so far".

In order to check the damage caused by the parasites, even though it is difficult in open waters, a proper understanding of the seasonal variation in the distribution of the parasite and other factors like age of the host, sex of the host, which affect distribution of parasite is a must. Although several workers have carried out investigations on the taxonomy of metazoan parasites of marine and brackish water fishes of India, very little attempt is made to correlate such investigations with the host and the environment. In my studies, such an attempt is made.

The present work is broadly divided into three chapters. Chapter one gives a review of the literature. Chapter two describes the distribution pattern of parasites in relation to the age of the host, sex of the host and season of the year. Chapter three deals with the histopathological changes caused by the parasites in the host body.

CHAPTER I

REVIEW OF LITERATURE

In almost all the studies on parasite fauna of fishes of Indian waters emphasis was invariably given for the description of new taxa. However, some works are available illustrating the damage caused by the parasites on their fish host. But information on the distribution of parasite fauna of fishes in an area over a period of time is almost lacking. In the Arabian coast some work has been carried out by Nair. S.R. during the period 1980-'82. But this is also fragmentary due to the non-availability of selected host species throughout the period. Considering the economical and ecological importance of parasites a proper understanding of the distribution and the pathological changes they induce in host fishes is a must. Apart from the "Bibliography of parasites and diseases of marine and fresh water fishes of India", published by Natarajan and James (1977) not much information is available in a review form. Hence an attempt is made here to review the maximum possible literature on these two aspects of the parasite and the host.

Studies on the pathology of fish parasites had begun very early. Giard (1888) had commented upon the sterilization of sardines due to infection by the copepod Peroderma cylindricum. The pathology of the same parasite, which result in the complete destruction of kidneys of the host fish, was explained by Monterosso (1923). Neuhaus (1929) has reported loss of weight and even death of Tinca tinca caused by the mass attack of Ergasilus sieboldi. The emaciation of the haddock Melanogrammus aelefinus has been attributed to infection by the copepod Lernaeocera branchialis (Scott, 1929).

That salinity of water acts as a limiting factor for parasite distribution was first reported by Dogiel and Bykhovski (1934). This was supported by the work of Shulman (1950). Earlier, Manter (1934) had established the relation between the parasite fauna and the depth of the host's habitat and Dogiel (1947) studied the impact of host's diet and habitat on the parasite fauna.

Scheer (1934) observed the mechanical obstruction of the gut of Gammarus pulex by the acanthocephalan Echinorhynchus truttae. The retardation of the growth of the trout due to the infection of Ergasilus sieboldi was brought to notice by Lechler (1935). The effect of the fish mucous on Epibdella mellani (Monogenea) was reported by Nigrelli (1935). Stolyarov (1936) commented upon the pathogenic influence of Lernaea cyprinacea on the skin of Carassius carassius. Remley (1936) was successful enough to elucidate the effect of the monogenetic trematode Microcotyle spinicirrus on the gills of Aplodinotus grunniens. He (Remley, 1936) had also given the relation between the age of the host and parasite infection. The damage caused by Sphyrion lumpi on the rectal ceaca and eye of Sebastes marinus was explained by Nigrelli and Firth (1939).

Shore (1940) reported the direct and indirect effects of the fish louse Argulus foliaceus affecting the surface of the eye of stickle back Gasterosteus aculeatus. The deleterious effects of the copepod parasite Tracheliastes maculatus on its host Abramis brama was pointed by Guseva (1940). Panikkar and Sproston (1941) had made some critical observations on the osmotic relations of some metazoan parasites (Lernaeocera, Bopyrus). The damages caused by Argulus due to penetration of the stylet of the proboscis deep into the body of the fish host during feeding was adequately explained by Becker (1942). Duguid and Sheppard (1944) recorded a number of epizootics in trout from British waters caused by Diphyllobothrium dentricum and D. ditremum. The retardation of Merlangius merlangus due to the infection with Lernaeocera branchialis was commented upon by Desbrossess (1948). Li and Hsu (1951) had made some observations on the frequency distribution of helminth parasites in their naturally infected hosts. The obstruction of the gut of young carp was attributed to the presence of Caryophyllaeus fimbriceps (Ivasik,1952).

Sachlan (1952) pointed out an odd case of poisoning of human consumers after ingestion of fish infected with Ichthyoxenus jellinghaussi (Isopoda). The poison, believed to be chemically related to protamine produced by the partial decomposition of the crustacean, is not a normal component of isopods. An inflamatory response followed by proliferation and fibrosis was pointed by Wardle and Mcleod (1952) due to the injurious interaction of cestodes. The studies conducted by Chubrik (1952) and Uspenskaya (1953) have revealed the possibility of using the parasites as indicators of the host. A study of the seasonal cycle of a protocephalan cestode, Protocephalus stizostethi, found in the yellow pike perch,Stizostedion vitreum was carried out by Connor (1953). Mann (1953) studied the changes in the weight, respiration and haemoglobin content of Merlangius merlangus due to infection with Lernaeocera branchialis.

Sinderman (1966) studied the trematode infection on herring, and showed that heavy infestations can and probably cause mortalities under natural conditions, although usually the invasion seems light enough to have little or no effect on fish. It has been demonstrated experimentally that massive continuous invasion of herring by such worms will cause death whereas light infestations or massive expossure of short duration appear to have little effects. Earlier, Sinderman and Rosenfield (1954) had drawn the attention towards the possibility of mortalities of fry and juvenile fish by Cryptocotyle lingua (Monogenea). Ganapathy and Hanumantha Rao (1954) had reported the black-grub diseases in freshwater carp Catla catla caused by the metacercarial cyst of Diplostomum sp.

Reshetnikova (1955) was able to bring in to light the relation between the age of the host fish and parasitic infestation during his studies on the parasite fauna of Sarda sarda Bloch in the black sea. A rise in the water content of the fish body followed by anaemia was reported by Goreglyad (1955) due to the attack of Caligus lacustris. Strelkov (1956) pointed out the possibility of using the composition of the parasite fauna as an indication of the food habit of the host fish during his studies on the endoparasitic helminths of marine fishes. From Japan, Shiino (1956) reported the hitherto unknown copepod Ophiolernaea formosana making the liver of the fish as its primary target and the possible pathogenic effects caused by it in the liver. Some aspects on the host specificity, microecology, adhesive attitudes, and comparative morphology of some trematode gill parasites were given by Llewellyn (1956). Seasonal variations in host-parasite relations between fish and their protozoa was studied by Noble (1957). The changes in the blood picture of Tinca tinca and Leuciscus caused by Ergasilus sieboldi infection were described by Layman (1957). Growth retardation, loss of weight and fact content, and pathology of the gonads in Melanogrammus aeglefinus due to the infection by Lernaeocera obtusa was explained by Kabata (1958). Wales (1958) had observed severe heamorrhage when eggs of two eyeflukes hatched, and the miracidia burst out of the gills.

The seasonal variations in the incidence and development of the cestode Proteocephalus filicollis in Gasterosteus aculeatus was given by Hopkins (1959). The blisters on the skin and corneal surface, blackening of the skin and even death of the fish Hyphessobrycon flammeus with the infection of a single Argulus larva was reported by Kollatsch (1959). The influence of environmental factors on the reproduction of fish parasites was reviewed by Bauer (1959 b). The twisting and deformation of both jaws of young fishes due to the attachment of Lernaea cyprinacea and the ill effects of the toxin produced by Argulus were pointed out by Bauer (1959 a). Abrosov and Bauer (1959) noticed the weight loss of the whitefish Coregonus peled following the attack of Ergasilus sieboldi. The variation in the loss of weight in various organs of the host fish Merlangius merlangus due to the attack of Lernaeocera branchialis and the loss of weight of host with particular emphasis on liver weight and fat content of Tinca tinca attacked by Ergasilus sieboldi were brought into light by Mann (1960 a,b). A number of epizootics had been observed by Fraser (1960) in British waters caused by Diphyllobothrium dendriticum and D. ditremum, attacking trouts.

The relation between the depth of the host habitat and rate of infection was elucidated by Templeman and Squires (1961) during their studies on the incidence and distribution of Sphyrion lumpi on the red fish Sebastes marinus. The relation of ectoparasite load to host size and standard range was pointed out by Mohr (1961). The adverse effect of the larvae of Diphyllobothrium which migrate through the viscera, including the heart, of brook trout was ~~was~~ explained by Hoffman and Dunbar (1961). The severe loss of condition in the wild population of corregonids due to attack by the digenitic trematode Ichthyocotylurus erraticus was given by Petrushevski and Shulman (1961). Dogiel et al. (1958) has reviewed in detail the ecology of marine and freshwater parasites, relationship between host fishes and their parasites, specificity and physiology of fish parasites, the life cycles of fish helminths and the biology of their larval stages, zoogeography of marine and freshwater parasites, and parasitic diseases of marine and freshwater fishes.

The seasonal variation of Ergasilus lizae in the fishes Lepomis macrochirus, L. microlophus and Micropterus salmoides was given by Kelly and Allison (1962). They also reported the influence of temperature on the development of egg and larvae of Ergasilus lizae and the damage caused by mass attack on the hosts, especially fingerlings. The life histories and population dynamics of the monogenean gill parasites of Trachurus trachurus was given by

Llewellyn (1962). Pal(1963) had made some observations on the fluctuations in parasitization of the Indian shad, Hilsa ilisha of the Hooghly estuary. Schad (1963) had given a detailed account of the niche diversification in a parasite species. Noble et al.(1963) discussed the ecology of the gill parasites of Gillichthys mirabilis with special reference to age and sex of the host and season of the year. Sinderman (1963) had brought the following factors as mediating factors in marine disease out-breaks. These are: a population explosion of an introduced pathogen, changes in the physical environment of the host population, changes in the virulence and infectivity of a pathogen already present in an enzootic form in a population, changes in the effectiveness of transmission of the pathogen and changes in the susceptibility of the host population to an enzoctic disease. The changes in the fat content and damage of the gill of Coregonus peled caused with the infection of Ergasilus sieboldi were reported by Abrosov et al.(1963). An illustrative work on the intestinal histology of some salmonids fishes with particular reference to the histopathology of acanthocephalan infection was carried by Bullock (1963).

Mann (1964) described the changes in the body weight and blood parameters of Pomatoschistus minutus infected with Lernaeocera minuta. A comparison between helminth parasite burdens of male and female brown trout, Salmo trutta was done by Thomas (1964 a, b). Some observations on the occurrence of the plerocercoides of Traienophorus nodulosus in the Perch Perca fluviatilis was made by Chubb (1964).

Awachie (1965) has given an account of the ecology of the acanthacephalan Echinorhynchus truttae affecting trouts. The population dynamics of the monogenan gill parasites Discocotyle sagittata from Salmo trutta in relation to the age and sex of the host was brought into picture by Paling (1965). Observations on the occurrence of Discocotyle coeliaca and Calicotyle kroyeri (Monogenea) with special reference to the age of the host Raja radiata was done by Williams (1965). Halton and Jenning (1965) made some studies on the nutrition of monogenetic trematodes.

Changes in the spawning behaviour and swimming of Scardinius erythrophthalmus infected with plerocercoides of Ligula intestinalis were reported by Orr (1966). James and Srivastava (1967) had reported the relation between incidence and intensity of helminth infection and host lenght, and also the seasonal variation. The ecology of Nececchinorhynchus rutili (Acanthocephala) was given by Walkey (1967). Rosenthal (1967) had observed the mass mortality of herring fry in aquaria infected with Contracaecum sp. (Nematoda). A review of the seasonal variation and maturation of tapeworms in British waters was done by Chubb (1967). Changes brought about in the behaviour and damages occuring in various body parts of the host body due to the invasion of Diphyllobothrid plerocercoides had been pointed out by Williams (1967). The pathological effects of the plerocercoid larvae of Schistocephalus solidus on the three-spined stickle back Gasterosteus aculeatus was given by Arme and Owen (1967). Hoffman (1967) described the damage to the viscera and musculature of many fish species, both wild and cultivated forms, produced by infection with the metacercariae of Clinostomum marginatum. Changes in the fat content of Coregonus lavaretus and C. fera due to infection with Ergasilus sieboldi were brought into picture by Reichenbach-Klinks et al.(1968). The biology and control of the anchor worm, Lernaea cyprinacea was explained by Rogers (1968).

Observations of Lawler (1969) revealed the relationship between the incidence of Triaenophorus nodulosus and size of the host, Perca flavescens. Rai (1969 a,b) studied the histopathology of opisthorchid, plagiorchid, and isoparochid metacercarial invasion, and on the morphology and pathogenic significance of the strigeoid metacercariae in some Indian freshwater fishes. Perca flavescens was made as the study material by Tedla and Fernando (1969) to establish the seasonal changes in the parasite fauna. Kennedy (1969) had commended upon the seasonal incidence and development of the cestode Caryophyllaeus laticeps.

Pippy (1969) elucidated the possibility of using the acanthocephalan, Pomphorhynchus laevis, found in the intestine of salmon, as a biological indicator to find out the place of origin of the salmon. The use of the tramatode population in the Atlantic Argentine, Argentina silus as biological indicators was worked out by Scott (1969).

The nature of damage and metamorphosis of the copepod Phrixocephalus cincinatus in the eyes of Atheres stomius were reported by Kabata (1969). The deleterious effects produced by the larvae of Proteocephalus ambloplitis during their migration through the viscera of small mouth bass were observed by Fisher and Freeman(1969). The seasonal variation, and variation with the sex and size of the host, in the case of the parasites infecting three-spined stickle back, Gasterosteus aculeatus were coined by Chappel (1969 a,b). Rizvi (1969) observed the structure of the sucker and seasonal incidence of Argulus foliaceus on some freshwater fishes. Aspects on the biology and pathology of Ergasilus cyprinaceus from cyprinid fishes of Alabama coast were studied by Rogers (1969).

Papers on nematode diseases of marine fishes were reviewed by Margolis (1970). The effects of season, host age, and sex on endohelminths of Catastomus commersoni were observed by Lawrence (1970). Rai (1970) had reported pathological significance of Clinostomatid metacercaria in some of the edible fishes. Mann (1970) had reviewed the diseases caused by copepod and isopod parasites of marine fishes. Hoffmann and Hutchenson (1970) had reported a case of muscular pathogenecity produced by Posthodiplostomum minimum on centrarchid and cyprinid fishes. Millemann and Knap (1970) described the pathogenecity of the salmon poisoning trematode Nanophyetus salminicola on salmon fry. Emaciation and ulcerations produced by nematodes of the genus Capillaria found in the intestine of aquarium fishes were observed by Amalcher (1970). Kabata (1970) had given an extensive review of crustacean parasites - covering aspects on systematics, local effects, general effects and treatment.

Crofton (1971 a,b) made a quantitative study on parasitism, and gave a model of host-parasite relationship. Pennycuick (1971 a,b,c,d) had studied the frequency distribution, seasonal variation, difference in the parasite fauna of different sex, age and size, and the quantitative effects of threee species of parasites on a population of three-spined stickle back Gasterosteus aculeatus. Gaines and Rogers (1971) reported fish mortalities due to the infection by Goezia sp. (Nematoda).

Lester (1972) had studied the reactions of Gasterosteus to remove the Gyrodactylus sp. (Monogenea). A survey was conducted by Davey (1972) to find out the incidence of Anisakis sp. larvae (Nematoda) in the commercially exploited stocks of herring (Clupea harengus) in British waters. Bibby (1972) analyzed the population biology of the helminth parasites of Phoxinus phoxinus and had made comments on the seasonal variation and the relations between infestation and sex and age of the host. Arme and Halton (1972) observed the occurrence of Diclidophora merlangi (Monogenea) on the gills of the whitting, Gadus merlangus in relation to the sex and age of the host and also in relation to the various gill arches. The effect of temperature and other factors upon the establishment and survival of Pomphorhynchus laevis in gold fish Carassius auratus was studied by Kennedy (1972). The ecology of Papillose allocreadid trematodes of the yellow perch was studied by Cannon (1972), elucidating the relation with depth of the host habitat, length and age of the host and season. The seasonal abundance of Ancyrocephalinaen (Monogenea) parasites of blue gill Lepomis macrochirus was reported by Rawson and Rogers (1972).

Population dynamics of Hunterella nodulosa (Cestoda) Caryophyllidae) were worked out by Mudry and Arai (1973). Rawson and Rogers (1973) observed the seasonal dynamics of Gyrodactylus macrochiri on Blue gill and large mouth bass. Abnormalities in growth, swimming and behaviour of sockey salmon (Onchorhynchus nerka) infected with the cestode Eubothrium salvelini were studied by Smith (1973). Pathogenic effects of the copepod Lernaea elegans, and the digenetic trematode Sanguinicola were brought into picture by Bauer et al.(1973). Effects of the nematode Cystidicola farionis on the swimbladder of rainbow trout were discussed by Otto and Korting (1973). Crompton (1973) made some critical observations on the site preference of some parasitic helminths in the alimentary tract of vertebrates. Some ecological observation on Metabronema truttae and Cystidicola farionis in their intermediate and definitive hosts was made by Awachie (1973). Olson and Pratt (1973) had traced the possibility of using Echinorhynchus lageniformis and Philometra americana as indicators of English sole Parophrys vetulus. The gonadial histopathology of bass, infected with helminths was given by Esch and Huffines (1973). Dzidziual (1973) reported the pathogenecity of Lernaea cyprinacea in the cases of heavy infestations in Carassius carassius.

The effect of the Gyrodactylus alexandri (Monogenea) infection on its host Gasterosteus aculeatus was studied by Lester and Adams (1974 a). Following this, they had given a mathematical model to elucidate the mode of infection of the parasite (Lester and Adams 1974 b). The population dynamics and dispersion pattern of Lepeophtheirus pectoralis were studied by Boxhall (1974). An analysis of the influence of host morphometric features on the population dynamics of Diplozoon paradoxum was made by Anderson (1974). Joy (1974) studied the incidence and intensity of Spirocamallanus pereirai on Micropogan undulatus and Leistomus xanthurus. The seasonal infection of Clarius batrachus by Lytocestus indicus and haematological and histopathological changes were observed by Satpute and Agarwal (1974). Osmotic relations of Lernaea cyprinacea were studied by Shields and Sperber (1974). Hine and Kennedy (1974 a,b) had made some observations on the population dynamics, distribution, specificity and pathogenecity of the acanthocephalan Pomphorhynchus laevis. Paperna (1974) has reported the infection of fishes with larvae of Eustrongylides (Nematoda) with emphasis on prevalence, distribution, sites of infection and pathology of the infected organ systems. The extensive damage of the liver of the white bass, Morone chrysops infected with the plerocercoids of Triaenophorus nodulosus was reported by Stromberg and Crites (1974).

Rumpus (1975) had compared the seasonal cycles of incidence and intensity of the helminth parasites of Cottus gobio (L) and Neomacheilus barbatulus (L). He had also discussed the influence of diet of the host and temperature on the rate of infection. The data given by Stromberg and Crites (1975) had shed light on the seasonal cycle in the population structure, site selection, intensity of infection, maturation and reproduction of Camallanus oxycephalus (Nematoda) infecting white bass. Studies by Amin (1975) have given a clear picture of the parasitic load by Acanthocephalus parksidei on different hosts. He had also discussed the variation in relation to the size and sex of the host, collection site, season and concurrent infection. The seasonal periodicity of Acanthocephalus jacksoni was given by Muzzall and Rabalis (1975).

Abundance and population dynamics of parasites infecting Atlantic salmon (Salmon salar) were studied by Hare and Burt (1975). The pathology of the major diseases of cat fish was reviewed by Meyer (1975). Reports on lesions due to the internal helminths of fresh water fishes were reviewed by Hoffman (1975). Ko et al.(1975) had observed the prevalence and histopathology of Echinocephalus sinensis in natural and experimental hosts. Kennedy (1975) studied the distribution and zoogeographical characteristics of the parasitic fauna of char Salvelinus alpinus. Paperna (1975) had described the parasites and diseases of the Grey mullet. The sublethal effects of three ectoparasites relating predation, temperature tolerance, weight-length relationship, etc. were given by Vaughan and Coble (1975). The general histopathology of the gonads of Mugil cephalus infected with Philometra cephalus was given by Ramachandran (1975).

A survey to determine the presence of disease causing parasitic organisms and their effect on estuarine population of striped bass, Morone saxatilis was conducted by Paperna and Zwerner (1976 a). The biological parameters which generate seasonal fluctuations in the size of the populations of Caryophyllaeus laticeps were examined in detail by Anderson (1976 a) and he formulated a mathematical model to describe the dynamics of adult parasite within the fish host Abramis brama, and the predictions were compared with observed population data. Five fishes from the Australian coast belonging to the family Scombridae were examined for monogenean parasites by Rohde (1976 a) and described their distribution on the gills. The population biology of the monogenean gill parasites of Mugil cephalus with emphasis on development, seasonal abundance in relation to the environmental variables and biology of the fish host was given by Rawson (1976). The economical, ecological and biological importance of parasites and development of marine parasitology in Australia and Indopacific region was discussed by Rohde (1976 b). Aspects on distribution, life cycle and seasonal abundance of Ergasilus labracis, parasitic on striped bass Morone saxatilis were studied by Paperna and Zwerner (1976 b). The ecology of Acanthocephalus clavula was given by Andrews and Rojanapaibul (1976). Host responses to parasites was reviewed by Wakelin (1976). Hastein and Bergsjo (1976) had given the nature of infection and pathology of the salmon lice Lepeophtheirus salmonis.

The growth dynamics and seasonal prevalence of Crepidostomum isostomum and Phillodistomum pearsei in Aphredoderus sayanus (pirate perch) were described by Elkins and Corkum (1976). Grabda (1976) had made an extensive review of the ecological problems in fish parasitology. The effect of host captivity on the incidence of parasitic fauna was studied by Moller (1976). The dynamic aspects of parasite population ecology were reviewed by Anderson (1976 b). The seasonal periodicity of three species of Caryophyllaeid cestodes in the creek chub sucker, Erimyzon oblongus was studied by Grimes and Miller (1979).

A bibliography of parasites and diseases of marine and freshwater fishes of India was given by Natarajan and James (1977). Rawson (1977) reported the development, seasonal abundance and distribution of crustacean parasites infecting the striped mullet Mugil cephalus. Kabata and Cousens (1977) studied the distribution of the parasitic copepod, Salmincola californiensis, on two size-groups of sockeye salmon Onchorhynchus nerka giving the details of site preference by the parasite and macroscopic and microscopic mechanical damage to fish tissues, resulting from the presence and activity of the copepod. They further reported the "burrowing phenomenon" (failure on the part of the copepod to cease excavation of a completed activity of implantation, resulting in perforation of body wall and penetration of viscera) for the first time. Samples of Gammarus pulex and Leuciscus leuciscus were examined for a period of nine years for the presence of the Acanthocephalan Pomphorhynchus laevis by Kennedy and Rumpus (1977). Changes in the incidence and intensity of infection of P. laevis in L. leuciscus and G. pulex and in the frequency distribution of P. laevis in L. leuciscus were used as indicators of the population size of the parasite. Factors responsible for the observed constancy of population were also discussed.

Cooper et al.(1978) studied the population biology and behaviour of larval Eustrongylides tubifex (Nematoda) in channel cat fish (Ictalurus punctatus), freshwater drum (Aplodinotus grunniens), small mouth bass (Micropterus dolomeui), and yellow perch (Perca flavescens) and observed changes in the intensity of infection with the size and sex of the host fish. Olson (1978) examined the parasites of

English sole, _Parophrys vetulus_ from U.S.A. and showed the difference in the prevalence and mean intensity of parasite infection between size classes of juvenile sole and between sole occupying the upper and lower estuary. His attempt to use parasite data to indicate the presence of distinct English sole stock along the Orgeon coast was inconclusive. After conducting an extensive survey, Rohde (1978) has shown the variation in host specificity in different climatic zones. The reasons for the variations were also discussed by him. The influence of season, host age, sex and feeding habit on the occurence of _Asymphylodora kubanicum_ infecting _Rutilus rutilus_ was shown by Evans (1978).

The effects of salinity and temperature on the development and survival of fish parasites with reference to _Contracaecum aduncum_, _Cryptocotyle lingua_, _Acanthochondria depressa_, _Lepeophtheirus pectoralis_, _Piscicola geometra_ and _Argulus foliaceus_ were given by Moller (1978). Banning and Becker (1978) conducted a long-term survey on the occurence of _Anisakis_ larvae (Nematoda) in herring, _Clupea harengus_ L. from the North sea, and tabulated the data on abundance of infestation in several herring stocks during the period from 1965 to 1972. The status of brown and rainbow trouts, _Salmon trutta_ and _S. gairdenri_ as hosts of the Acanthocephalan, _Pomphorhynchus laevis_ was given by Kennedy et al (1978).

The first report of skin-infecting species of the copepod _Ergasilus_ was given by Rogers and Hawke (1978) in the gizzard shad _Dorosoma cepidanum_. Egg-bearing _Ergasilus_ specimens were found causing epidermal lesions. The host-parasite relationship of _Menidia_ berylina and M. peninsulae with two copepod parasites, Ergasilus manicatus and Bomolochus concinnus was described by Bortone et al. (1978). The changes in the intensity of infection with the size of the host and intraspecific avoidance of the parasite were also discussed. George and Nadakkal (1978) had made some observations on the intestinal pathology of the marine fish, Rachycentron canadus (Gunthur) infected with the Acanthocephalid worm Serrasentis nadakali from the Arabian sea near the Trivandrum coast. The effects of Lernaeocera branchialis on the Merlangius merlangus population in the midway estuary was given by Vadenbroek (1978). Shields and Goode (1978) had given an account of the reaction of fish, infected with Lernaea leading to the rejection of viable and normally attached parasites. Natarajan and Nair (1978) had made some observations on the incidence and infestation of copepod parasites of marine fishes from Arabian sea. Seasonal occurence and host parasite relationships of Neoechinorhynchus saginatus in the fall fish, Semotilus corporalis were reported by Muzzall and Bullock (1978). The effects of host spawning on the maturation and localization of Echinorhynchus salmonis was given by Amin (1978).

A critical evaluation of intrinsic and extrinsic factors, such as host species, geographical range, macrohabitat, microhabitat, sex of the host, age of the host, season and hyperparasitism, responsible for niche restriction in parasites has been done by Rohde (1979). Seasonal changes in the levels of copepod ectoparasitic infection on Merlangius merlangus and Platichthys flesus were examined and related to the annual migration of young fish into the estuary by Vandenbroek (1979). Reasons for the preference shown by different parasites to attach on particular sites were also discussed. Boxrucker (1979) made some comments on the effects of thermal effluents on the incidence and abundance of the gill and intestinal metazoan parasites of the black bull head (Ictalurus melas). The relation between the seasonality of infection and availability in the infective larvae and variability in the feeding habit of the host was also discussed. Williams (1979 a,b) reported the seasonal incidence of Isoglaridacris wisconsinensis, Glaridacris laruei and G. catastomi from wisconsin fishes.

Izyumova and Mashtakov (1979) have discussed the seasonal occurence of Dactylogyrus in Abramis brama, Rutilus rutilus and Abramis ballerus, and May and Anderson (1979) have reviewed the population biology of infectious diseases. While Shulman (1979) described the dependence of seasonal dynamics of fish parasites on some environmental factors, Chubb (1979) reviewed the seasonal occurrence of trematodes in freshwater fishes. Infection rates of Argulus africanus and Dolops ranarum on Bagrus docmac were worked out by Benda (1979). The damage caused by the Isopods of the genus Anilocra on some West Indian fishes was pointed out by William and Williams (1979). Bloom (1979) has reviewed the mechanisms whereby parasites evade the immune responses of the host.

Madhavi (1980) made a comparison of the parasitic fauna of Aplocheilus panchax and A. melastigma. Morphological, behavioural and ecological features of the host that may affect parasite population are discussed. The variation in the parasite fauna of the centrarchid, Micropterus salmoides (Lacepede), and large mouth bass was pointed out by Pomales and Williams (1980) after twenty eight years of the transfer of fishes from a temperate region to a tropical region. The factors for the variation in the tropical fauna are analyzed. Hatchery-reared and wild brown trout, Salmo trutta L. were examined for skin ectoparasites during their spawning period in 1977 and 1978 by Pickering and Christie (1980). It was found that sexually mature male fish were more frequently or more severely infected by parasites. Their findings were discussed in relation to the defence mechanisms of the teleost fish and to some of the endocrinological changes that occur is salmonid fishes during the spawning season. Metazoan parasites of the pike Esox lucius L. were studied by Watson and Dick (1980) and discussed on the effect of host age, sex, location and season of capture on the species composition of the parasites.

Samples of the perch, Perca fluviatilis L. from Norway, were examined for the contents of their gastrointestinal tract and for the nematode Camallanus lacustris by Skorping (1980) and discussed on the seasonal dynamics, dispersal pattern and site preference of the nematodes. Timmons and Hemstreet (1980) had commented on the monthly prevalence and intensity of infection with Lernaea cyprinacea on the large mouth bass Micropterus salmoides. Variation in the carotenoid level in the tench, Tinca tinca infected with Ergasilus sieboldi was reported by Czeczuga (1980). Malhotra and Cahuhan (1980) made a statistical analysis of cestode infection in relation to some ecological aspects of hillstream fishes in Garhwal, Himalayas, India. Seasonal infection of Clarius batrachus by Lytocestus indicus was pointed out by Satpute and Agarwal (1980). Nammaiwar (1980) made a note on parasitised ovaries in the perch Pomadasys hasta. Campbell et al. (1980) studied parasitism and ecological relationships among deep-sea benthic fishes. Siegel (1980) made some quantitative investigations on parasites of Antartic channichthyid and nototheniid fishes. The biology and the incidence of the parasitic isopod Olencira praegustator were reported by Fannaly (1980). Janusz (1980) described the influence of the parasite Clavella adunca on the cod Gadus morhua from north-west Atlantic waters.

Population biology and host-parasite relationships of Triganodistomum attenuatum (Trematoda) infecting the white sucker Catostomus commersoni (Lacepede), and seasonal distribution and ecology of three Caryophyllaeid cestodes and three Acanthocephalan species infecting white sucker were described by Muzzall (1980 a,b,c). A comparative study on the microhabitat utilization by ectoparasites of some marine fishes from New Guinea was made by Rohde (1980). After studying the parasites of Pacific herring (Clupea harengus), Arthur and Arai (1980) discussed the possibility of using parasites as indicators of geographical origin for spawning herring. The effect of season, attachment site in the intestine, and size of the host on the infection rate, sex ratio, body length and embryo development of Metechinorhynchus salmonis (Acanthocephalan) were pointed out by Valtonen (1980 a, b).

Ancylodiscoidosis, the disease caused by Ancylodiscoides vistulensis (Monogenea), and its histopathological effects that led to the mortality of the sheath fish Silurus glanis were given by

Molnar (1980). A histopathological study, explaining the damage caused by the eye fluke Diplostomum sp. during their acute and chronic infection of rainbow trout Salmo gairdneri was rendered by Shariff (1980). The causative agents, symptoms and remedies for human anisakiasis have been summarised by Jackson and Bier (1980). The parasites of the smooth flounder, Liopsetta putnami from the Great bay estuary were studied by Burn (1980) and revealed their seasonal variation, variation with the age and diet of the host, and the pathological changes in the affected organs. Ocvirk et al. (1980) had commented upon the patho-anatomical changes caused by Cystidicola farionis on the wild Brown trout. The spatial distribution of the copepod parasite Lernanthropus kroyeri on the gills of bass, Dicentrarchus labrax was described by Davey (1980). The sex ratio of Acanthosentis oligospinus infecting the brackish water fish Mystus gulio was given by Anantharaman (1980). Bauer (1980) had reviewed the population ecology of fish parasites and discussed the recent state and perspectives. Hirsch (1980) reported the distribution of Polymorphus minutus among its intermediate hosts. The prevalence and intensity of Capillaria catostomi in white sucker, (Catostomus commersoni) were studied by Bell and Hoyt (1980).

Chinabutr (1981) studied the seasonal variation of Monogenea, Acanthocephala, and Ergasilus infecting Kryptopterus apogon. Long term studies on the population biology of two species of eye flukes, Diplostomum gasterostei and Tylodelphys clavata (Digenea) concurrently affecting the eyes of perch, Perca fluviatilis were carried out by Kennedy (1981 a,b) and he showed the intraspecific interaction among parasites in the same host. He has also worked on the population biology of T. podicipina. Sadowsky and Soaresmoreira (1981) brought into picture the incidence of the parasitic isopod Lironeca splendida in Squalus cubensis from western south Atlantic ocean. Holloway and Hagstrom (1981) critically evaluated the factors affecting the development of parasite fauna in North Dakota impoundment. The transmission, life span and population biology of Cystidicola cristivomeri infecting white charr Salvelinus sp. were studied by Black and Lankaster (1981). Jilek and Crites (1981) made some observations on the prevalence of Spinitectus carolini and Spinitectus gracilis in fishes from lake Erie. Cone and Burt (1981) traced the invasion route of the gill parasite Urocleidus adspectus. The changes in the composition of Ancyrocephaline (Monogenea) population of parasites with age of thick-lipped grey mullets at Plymouth were studied by Anderson (1981). The influence of seasons and sex on the intensity of Pseudolamproglena annulate (Lernaeidae) infection in Cyprinion macrostomus was given by Kasim and Rahemo (1981).

The variation in the site preference and mean intensity of Gyrodactylus atratuli infecting spot fish shinners (Notropis spilopterus) with the variation of water temperature was described by Kirby (1981). The variation in the niche width of parasites in species - rich and species - poor communities was evaluated by Rohde (1981). Amin (1981) had pointed out the seasonal periodicity in the prevalence, intensity development and maturation of Echinorhynchus salmonis (Acanthocephala) among rainbow smelt Osmerus mordax. Seasonal dynamics in abundance, development and pattern of infection of Bunodera lucioperca in the perch Perca fluviatilis were reported by Skorping (1981). Black (1981) was successful enough in pointing out the validity of using metazoan parasites of the brook charr (Salvelinus fontinalis) as indicators of the anadromous movements. The seasonal dynamics of the invasion cycle of Dactylogyrus extensus was given by Zintan and Hanzelova (1981). The use of parasites of arctic charr Salvelinus alpinus in separating sea-run and non-migrating charr was shown by Dick and Belosevic (1981). Lee (1981) had studied the ecology of Acanthocephalus lucii in perch Perca fluviatilis. The incidence of cymathoan parasites on white sardine was brought into light by Rao(1981). Underwood(1981) made an exhaustive study on the ecology of the endohelminths of fishes from the Upper Sanmarcos river. Ashley (1981) observed the population biology of three acanthocephalans in the Great Plain reservoir. The occurrence of Cirolana borealis (Isopoda) in the hearts of sharks from Atlantic coastal waters of Florida was studied by Bird (1981), Nair et al. (1981) had given the host specificity and biochemical changes in fishes owing to the infestation of the isopod Alitropus typus.

The significance of larval anisakis roundworms on Public Health was pointed out by Dailey et al. (1981). Rand (1981) compared the parasite burden and diet of two species of Burmuda mangrove fishes. Paperna and Overstreet (1981) reviewed the parasites and diseases of the mullets (Mugilidae). Nair (1981 a,b,c,d,e) had thrown light on the nature of infestation and histopathology of Peniculisa wilsoni on Didon hystrix, histopathology of Caligus uruguayensis on Trichurus savala, the nature of infestation of Lernanthropus gibbosus along the south west coast of India, and pathology of infection by Nybelina sp. on the oesophagus of Didon hystrix. The histopathology of the eye of big head carp, Aristichthys noblis infested with Lernaea piscinae was given by Shariff (1981). Thune and Rogers (1981) described the gill lesions in blue gill, Lepomis macrochirus infested with Cleidodiscus robustus (Monogenea). The histopathology in the Rainbow darter, Etheostoma caeruleum resulting from infections with the Acanthocephalans Pomphorhynchus bulbocolli and Acanthocephalus dirus was brought into picture by Mc Donough and Gleason (1981).

Heggberget and Johnson (1982) discussed infestations by Gyrodactylus sp. in Atlantic salmon, Salmo salar in Norway and the reasons for the out break of Gyrodactylus were analysed. Koya and Mohandas (1982) had made a survey of helminth parasites of marine fishes in Cochin area and came to the conclusion that the south-west coast of India provides a suitable habitat for the icthyoparasitic fauna. The relation between the size of the fish and intensity of infection was also discussed. The relation between the age group of the fish and rate of prevalence and intensity with parasites in the case of Merluccius capensis from the Namibian Shelf was pointed out by Aleshkina (1982). Reimehem (1982) studied the incidence and intensity of Cyathocephalus truncatus and Schistocephalus solidus infection in Gasterosteus aculeatus. He has correlated the rate of intensity and incidence with size of the host, abundance of intermediate host, season of the year and food habit of the host.

The seasonal dynamics of the invasion cycle of Gyrodactylus katharineri (Monogenea) was given by Hanzelova and Zitnan (1982). Studies on the infestation of the Jack mackeral, Trachurus declivis with the cymathoid isopod, Cerrtothoa imbricatus in south eastern Australian water were made by Maxwell (1982). Chubb (1982) reviewed the seasonal occurrence of adult Cestode, Nematoda and Acanthocephala in freshwater fishes. The occurrence of Cystidicoloides ephemeridarum in greyling (Thymullus thymullus) was analyzed by Fagerholm et al. (1982). Nascimento and Vergar (1982) had given the relationships between some inherent host factors and the size of infrapopulations of Proleptus acutus (Nematoda) within the stomach of its definitive host, Schroederichthys chilensis. Izyumova et al. (1982) analyzed the factors determining the density and structure of dactylogyrid population in carps, and Izyumova and Zharikova (1982) studied the salient features of the distribution of Dactylogyrus anchoratus and D. chranilowi (Monogenea).

The relationship between the weight of the nematode with that of host body, and log-normal distribution was pointed out by Malhotra (1982 a,b). An analysis of the ecological factors that determine the occurrence of monogeneans on roach and perch was done by Kazakov (1982). The use of parasites as biological tags was discussed by Jennings and Hendrickson (1982) during their observations on the parasite fauna of Chinook salmon (Onchorhynchus tshawytscha) and Coho salmon (O. kisuth). A quantitative study of economically important parasites of walleye pollock (Theragra chalcogramma) from British Columbia waters and effects of postmortem handling on their abundance in the musculature was made by Arthur et al.(1982). Molnar et al.(1982) had made some remarks on the occurrence and development of philometrid nematodes infecting the white sucker, Catastomus commersoni. Nagasawa et al. (1982) compared the occurrence of Acanthocephalus minor in two types of goby. Habitat specificity of the Acanthocephalan, Acanthocephalus clavula in the eels Anguilla anguilla was studied by Kennedy and Lord (1982). Black (1982) had elucidated the ideal nature of the gills as an attachment site for Salmincola edwardsii (copepod).

Pandey et al.(1982) described the pathology caused by Philometra abdominalis infecting Glossogobius giuris. George and Nadakal (1982) had given an account of the histopathological changes in the intestine of the fish, Synaptura orientalis, parasitized by an acanthocephalid worm, Echinorhynchus veli. The intestinal nodules produced by infection with nematodes in fishes and their effect on man was recorded by Eiras and Reichenbach-Klinke (1982). Host-parasite relationship of Ergasilus labracis and the striped bass Morone saxtilis was described by Paperna and Zwerner (1982). Elarifi (1982) had reported the histopathology and larval anisakid nematode infections in the liver of whiting, Merlanguis merlanguis (L) with some observations on blood leucocytes of the fish. The intestinal histopathology of the common blue gill Lepomis macrochirus infested with Spinitectus carolina (Nematoda) was described by Jilek and Crites (1982). Cheung et al. (1982) had standardised a treatment of skin lesions in captive lemon sharks, Negaprion brevirostris caused by monogeneans.

Changes in the attachment site with increase in number of parasites were discussed by Black (1983) during the study on the abundance and distribution of Salmincola edwardsii (copepoda) on anadromous brook trout, Salvelinus fontinalis. The effect of temperature and other factors which regulate the seasonal dynamics, mortality, egg maturation and hatching of Bothriocephalus acheilognathi (Cestoda) in Gambusia affinis was reported by Granath and Esch (1983). Variation in the number of helminth parasites in freshwater fishes with geographic range of the host, size of the host and feeding habit of the host was explained by Price and Clancy (1983). Seasonal occurrence, sex ratio, and site preference of Argulus coregoni (Crustacea) parasitic on cultured freshwater salmonids in Japan was reported by Shimura (1983). Muller (1983) had probed into the effects of Lernaeocera infestation on cod (Gadus morhua), and commented upon the inability of the infected fish to adapt with additional stress.

After conducting a fourteen month survey on the parasitic fauna of brook stickle back Culea inconstans, Font (1983) had unfolded the seasonal changes in the population of five species of enteric helminths. Hirshfield et al.(1983) brought into light the increased prevalence of Eustronglylides sp. (Nematoda) infecting Fundulus heteroclitus from the discharge canal of a power plant and had entered into the details of the changes in the dry weights on infected and uninfected fishes.

The abdominal distension in Hawaiian Puffer fish (Canthigaster jactator) due to the heavy infestation of the body cavity with the nematode Philometra sp. was illustrated by Deardorff and Stanton (1983). Dunn et al.(1983) had drawn a clear picture of the cetal histopathology caused by Truttaedacnitis truttae (Nematoda) in the rainbow trout, Salmo gairdneri. In addition to the pathological changes, differences in the growth and swimming habits were also brought into light. The requirement of an optimum host size for parasitic infestation with Colobomatus (Copepoda) in the mandibular canals of haemulid fishes was reported by Cressey and Schotte (1983).

The variation in the prevalence and abundance of larval anisakines with host size in cod and flat fishes from Scotian Shelf was given by Clelland et al.(1983). Nascimento et al.(1983) were successful in interpreting the occurrence of Anisakis sp. larvae in the Chilean jack mackeral (Trachurus murphyi). Besides factors, such as size of the host, sex and maturation were also taken into account to elucidate the variations. Changes in the haematological parameters like plasma glucose concentration, erythrocyte and leucocyte count, haematocrit value, concentration of plasma protein, cholesterol and calcium, number of immature erythrocyte and thrombocyte were described by Shimura et al.(1983) after experimentally infecting Onchorhynchus masou with Argulus coregoni. A similar observation was made by Nair et al.(1983) in Trichiurus lepturus infected with Scolex pleuronectis (Cestoda). Bose and Sinha (1983 a,b,c) studied the gastric pathology and higher mucoid secretion in Heteropneustes fossilis infected with the nematoda Procamallanus spiculogubernaculus, histopathology of Clarius batrachus infected with the cestode Lytocestus indicus, and on the effects of helminth parasites on the hydrogen ion concentration of infected organs of fishes.

Valtonen (1983 a,b) had described the relationship between Corynosoma semerone and C. strumosune (Acanthocephala), their paratenic fish host, and the ecology of Echinorhynchus salmonis. The seasonal dynamics of the invasion cycle of Dactylogyrus vastator in the carp fry was studied by Hanzelova and Zitnan (1983). The structure and dynamics of population abundance of Discocotyle sagittata (Monogenea) were given by Ieshko (1983). The seasonal variation of Dolops striata and D. carvalhoi was given by Malta and Varella (1983). Linear distribution pattern of Acanthosensis oligospinus in the alimentary canal of Mystus gulio was studied by Najib (1983).

Lester (1984) has reviewed the methods for estimating mortality due to parasites in wild fish populations. The six methods he described are: (a) through autopsies, (b) determining the frequency of infections known to be eventually lethal, (c) observing a decrease in the prevalence of a long lived parasite with host age,(d) observing a decrease in the variance/mean ratio for the parasite with the host age, (e) comparing the observed frequency of a combination of two independent events with the calculated probability of their occurrence, and (f) comparing the observed frequency distribution of the parasite with a projected frequency based on data from lightly infected fish.

Rhode (1984) had commented upon the ecological characteristics of parasites, such as host range and specificity, microhabitat, macrohabitat, food, lifespan, aggregated distribution, number and kinds of parasites, pathogenecity, mechanisms of reproduction and infections, and on how such characteristics are affected by environment and hosts.

The 4.5 year survey, carried out by Kennedy (1984) had elucidated the continuous decline of the population of *Acanthocephalus clavula* infecting *Anguilla anguilla*, and the reason was attributed to the decrease in the intermediate hosts. Population composition and dispersal pattern of *Pomphorhynchus bulbocoli* in *Hypentelium nigricans* were investigated by Gleason (1984) who reported the seasonal prevalence and intensity of infection, infrapopulation composition and dispersion pattern. Polyanski (1984) had edited a 30 year period icthyoparasitological studies concerning the effect of ecological situation on the formation of fish parasitofauna.

Using the study of parasite specificity in Dactylogyridae in relation to their host, Cyprinidae, Lamberta and Romand (1984) had discussed the possibility of using representatives of Dactylogyridae as biological tags. The investigations for helminths of grey notothenia (*Notothenia squamiforms*) of different age from the subantartic sector of the Indian ocean, by Parukhin and Zajtsev(1984), had brought into picture the dynamics of invasion with the food habit of the host and climatic conditions of the environment. Scott and Nokes (1984) have rendered an account of the temperature dependent reproduction and survival of Gyrodactylus bullatarudis on guppies. Gaevskaya (1984) pointed out the possibility of using the copepod Sphyrion lumpi (Kroeyer) as a biological label in the population studies of deep sea red fishes. Mackenzie and Mehi (1984) have discussed the use of the cestode parasite Grillotia angeli as a biological tag for mackeral in the eastern north Atlantic. Aho and Kennedy (1984) studied the seasonal population dynamics of the nematode Cystidicoloides tenuissima in England. A similar study on the helminth parasites of three species of cichlids was conducted by Vijayabatra (1984).

Detailed investigations by Kennedy (1985) had illustrated the site specificity and distribution of five species of acanthocephala within the intestine of the host. The relation between salinity and infection with trematodes and monogenea in three species of Mugil from the Azoa and Black seas was reported by Solonchenko and Tkachuk (1985). The dependence of the parasite fauna on the feeding habit of the host and on the geographic location of the macroenvironment was pointed out by Gaevskaya and Kovaleva (1985) in the case of the shad Trachurus picturatus. After describing 46 parasite species from Saurida undosquamis and Merluccius capensis, Tkachuk (1985) suggested a possibility of using parasites as biological tags to detect local commercial fish stocks. Some data on the distribution of Acanthocephala in the population of mallards were given by Balciunas and Petkeviciute (1985). Kabata (1985) has reviewed recently the parasites and diseases of fishes cultured in the tropics.

Aspects on site specificity, variation in the rate of infection with host size, and the lesions caused by Lernaea cruciata in large mouth bass, Micropterus salmoides were discussed by Noga (1986). He had also thrown light into the secondary infection through the lesions caused by L. cruciata. Susceptibility of different host species to Lernaea cyprinacea, and the treatment to eradicate them were pointed out by Shariff et al.(1986). Eiras (1986) had studied the lenght-weight relationship of uninfected Trisopterus luscus with those infected with Lernaeocera lusci. He had also noted the variation in the intensity of infection with host size. Ecological factors like sampling period, host habitat, patterns of intermediate hosts, piscivorous birds, age and sex of the host which affect the composition of the parasite fauna of the European eel, Anguilla anguilla in Ireland were analysed by Conneely and Mc Carthy (1986). Evidence for density - dependent establishment and survival of Pomphorhynchus laevis in laboratory infected Salmo gairdneri and its bearing on wild population of Leuciscus cephalus was given by Brown (1986).

The histopathology of infestation of Paranthias furcifer by Nerocila acuminata (Isopoda) was described by Rand (1986). Aspects on seasonal variation in the body dimension of a parasite of the genus Lernaea and its site preference on cyprinid fish in south Africa were investigated by Vilijoen (1986). Leong (1986) had investigated the seasonal variation and effects of host size on the distribution of the metazoan parasites of Puntius binotatus.

Szalai and Dick (1987) have given an account of the intestinal pathology and site specificity of the acanthocephalan Neochinorhynchus carpiodi in Quill back Carpiodes cyprinus from Manitoba.

Undoubtedly, there have been some minor omissions in the above review. Since the scientific articles are in several languages, and published in too many journals, spread all over the world, accumulation of all the literature is rather difficult. Even then, maximum possible efforts have been made to prepare the above review with particular emphasis on the ecology of copepods, nematodes, acanthocephalans and isopods in fishes and the pathological changes they induce in various tissues of the host fish.

CHAPTER II

DISTRIBUTION

INTRODUCTION

Marine parasites play an important role in the ecology of oceans and many are of great economic importance since they inhabit small and well defined habitats in a comparatively constant environment. They also provide excellant opportunities for elucidating ecological principles. "The ecology of parasites is unique in that the biotic factors of the environment assume a greater and more direct and continuous role than is true for non-parasite species. Although physical factors such as temperature have an important impact on parasites, the intimate relationship between parasite and host is of paramount importance and there is a continual interplay between the biochemistry of the parasite and that of its host" (Rhode, 1982).

An annual survey of parasites might help to determine, if these parasites had evolved mechanisms to aid in maintaining their population within optimal limits and what factors might cause fluctuations in parasite abundance (Stromberg and Crites 1975). The variation in the prevalance and mean intensity of parasites during different months can be utilized to elucidate the influence of season, host age, and sex, feeding habit of the host and habitat of the host on parasite fauna (Rawson, 1977).

The awareness about the period of abundance of the parasite is a condition when maximum benefit can be obtained from prophylactic treatment to reduce the stress on adult stock and to prevent infection of young fish (Rawson & Rogers 1973). Another advantage of the knowledge of seasonal abundance of parasites is that it will allow us to anticipate potential disease problems and suggest management procedures, where feasible. The seasonal trends indicating the favourable conditions for parasitic infestations will be valuable tools in determining potential disease problems (Rawson & Rogers 1972).

The biotic factors of predation, competition, and population size of the parasites can be compared easily by assessing the intensity and frequency of infection and the area of distribution of the host and parasites (Rohde 1978).

Moller (1978) has observed that the influence of salinity and the absence of intermediate host on the parasites could be properly understood by studying the distribution pattern of parasites. The studies of Banning and Becker (1978) have shown that population studies help to detect the migratory route of host fish, and the changes in the habitat of the intermediate host. The feeding behaviour of the host can also be understood (Chubrick, 1952; Uspenskaya, 1953; Strelkov, 1956).

That parasites can be used as indicators of geographical origin for spawning of pacific herring Clupea harrengus was shown by Arthur and Arai (1980). The anadromous movements of the brook charr Salvelinnus fontinalis were traced by studying its metazoan parasites (Black 1981). The sea-run and non-migrating arctic-charr Salvelinnus alpinus can be separated by noting their parasite fauna (Dick and Belosevic 1981). Parasites are used as biological tags for chinook salmon, Onchorhynchus tshawytscha and cohosalmon, O. kisuth (Jenning and Hendrikson, 1982). The host specificity of the Dactylogyridae was used as a biological indicator of their cyprinid hosts (Lambert and Romand, 1984). The presence of the deep sea-redfishes was noticed by studying the parasite Sphyrion lumpi (Gaevskaya, 1984). The possibility of utilising the cestode parasite Grillotia angili as a biological tag for mackeral in the eastern north atlantic was pointed out by Mackenzie and Mehi (1984). The presence of the acanthocephalan Pomphorhynchus lavies was used as a biological indicator to find out the place of origin of the salmon (Pippy, 1969). Scott (1969) pointed out the validity in using Echinorhyachus lageniformis and Philometra americana as indicators of English sole Parophrys vetulus.

The changes in the incidence and intensity of infection of Pomphorhychus laevis in Leuciscus leuciscus and Gammarus plulex, and the frequency distribution of P. laevis in L. leuciscus were used as indicators of the population size of parasites (Kennedy and Rumpus, 1977). Tkachuk (1985) suggested a possibility of using parasites as biological tags to detect local commercial fish stock.

All these reports clearly indicate the importance of the study of the distribution of metazoan parasites in fishes in relation to biotic and abiotic factors.

There are about 1,500 species of marine fishes native to Indian waters (Hafeezullah and Siddiqui, 1970) of which about 250 are common to Kerala coast (Eapen and Menon, 1973). In order to get a proper understanding of the ecology of parasites infecting those fishes a proper survey is necessary. It is encouraging that a beginning on this line in the west coast of India has already been made by Radhakrishnan and Nair(1979,1980), and Koya and Mohandas (1982). It was, therefore, decided to conduct a survey of the most commonly occuring parasites of three selected fishes from Cochin area. Data obtained from the present study would help to get more clear knowledge of zoogeography, ecology, seasonal pattern of infection, variation with age and sex of the host, host specificity, and other aspects of host-parasite relationship.

DESCRIPTION OF THE STUDY AREA

The study area includes the inshore and offshore waters of Cochin. Collection of fishes were made from the chinese dipnets operating in Fort Cochin, and from the boats operating from Cochin Fisheries Harbour.

The coastal waters of Fort Cochin, where the chinese dipnets are being operated, are subjected to constant fluctuations, in hydrographic parameters mainly due to the monsoons. The maximum surface temperature occurs before the onset of the southwest monsoon season and the minimum occurs during the southwest monsoon season (Banse 1959, 1968). The maximum surface temperature of the inshore waters recorded in April-May is about 30°C and the minimum in July-August is about 26°C (Banse 1959, 1968; Damodaran and Hridayanathan 1966). The bottom water temperature is 28-29°C in April and the minimum, 23.5 - 26.5°C in August (Hridayanathan 1981).

The maximum surface salinity of 34‰ in inshore waters recorded during May dropped to 17.64‰ in August (Damodaran and Hridayanathan 1966). The southwest monsoon, extending from June to September, is a season of heavy rainfall, strong wind and rough sea (Darbyshire 1967). After the commencement of the monsoon season, the most striking feature near the shore is the increase in discharge of fresh water from the rivers through the Cochin back water system. This results in a marked drop in the salinity of the surface waters near the shore during certain periods. Kurup and Samual (1987) reported the lowest salinity of 0.1‰ during July-August 1978-80. Darbyshire (1967) observed the maximum offshore water salinity in summer months (35.5‰) and the minimum in January (30‰).

An important feature of Kerala is the influence of the southwest monsoon which affects the hydrographic conditions of the area in a remarkable manner. The effects of the north east monsoon is rather indirect. Based on the influence of monsoon and the associated environmental conditions, the year can be conveniently split into three well-defined periods having characteristic hydrographic features. The premonsoon period (February-May) has comparatively very little rainfall and is characterised by fairly uniform high salinity, and high temperature, the monsoon period (June-September) is characterised by heavy rainfall and high inflow of fresh water resulting in considerable drop in salinity, and the post-monsoon (October-January) period shows an increase in salinity and temperature than in the monsoon period (George and Kartha 1963; José Anto 1975).

These changing patterns in the hydrographic conditions are sequential to the changing pattern in the climatic conditions. The main circulation in the Arabian sea results in the establishment of a surface current along this coast which reverses itself in the course of the year. The flow is southernly when the circulation in the open sea is clock-wise during the southwest monsoon season, and northerly during northeast monsoon season when the circulation is counter clock-wise (Ramamirtham and Jayaraman, 1960; Varadachari and Sharma, 1967; Sharma et al. 1982). Associated with these drifts are the upwelling and sinking along this coast (Ramamirtham and Jayaraman, 1960; Sastry and D'souza, 1972). A strong upwelling is regularly observed during the whole period of south west monsoon (Banse, 1959; Darbyshire, 1967). It is believed that the prevailing current systems, and not the wind, are mainly responsible for this upwelling (Banse 1959).

Generally, by the onset of south west monsoon season, an over all decrease in the surface temperature of 1°C to 1.5°C occurs, and this trend continues during June to October.

Annual rainfall in Cochin region is 328.9 cm, an average of 70 years, with fluctuations noticeable from year to year (Ananthakrishnan et al.1979).

MATERIALS AND METHODS

The following three fishes identified following the taxonomical guidelines given by Munro (1955), and Day (1958) were the study materials in the present study. They are *Tachysurus maculatus*

Thunberg, Nemipterus japonicus Bloch and Valamugil speigleri Blecker. Fishes were collected from Fort Cochin and Cochin Fisheries Harbour.

Weekly collections of the fishes were made and brought to the laboratory. The period of collection of the three fishes were as follows Tachysurus maculatus - January 1986 to December 1986; Nemipterus japonicus - May 1985 to April 1986; Valamugil speigleri - May 1984 to April 1985. Maximum effort was made to analyse the whole sample on the same day, except on occasions when the sample was too large. In the latter case they were kept in deep-freezer and analysed later. The sample size was maintained constant every month to have a uniformity in calculating the prevalance and mean intensity of infection. Margolis et al.(1982) had defined prevalence and mean intensity as follows.

Prevalence :- Number of individuals of a host species infected with a particular parasite species ÷ number of hosts examined.

Mean intensity :- Total number of individuals of a particular parasite species in a sample of a host species ÷ number of infected individuals of the host species in the sample = Mean number of individual of a particular parasite species per infected host in a sample.

Standard length and sex of the fishes were noted. Details regarding prevalence, mean intensity and nature of infection, location of parasites etc. were recorded. The fishes were dissected out and individual organs were examined thoroughly for parasites.

The crustacean parasites recovered from the fishes were transferred to 10% aquous solution of sodium bicarbonate and the specimens were cleaned off mucous and other debris adhering to the body using a brush. The cleaned parasites were washed in tapwater and then transferred to 5% formalin. Nematodes were fixed in glacial acetic acid and stored in 70% alcohol containing 5% glycerin. Specimens were subsequently cleared in glycerine to facilitate examinations. Acanthocephalan parasites were washed in 0.7% normal saline and then kept in refrigerator until the proboscis became fully extended. 10% neutral buffered formalin was used to fix the specimens. Whole mount preparations were stained with Harris haematoxylin and counter stained with fast green.

In order to find out whether there is any significant difference in the prevalence and mean intensity in different months, and with the change in the host age and sex, analysis of variance test was conducted and the results are presented in tabular forms. In doing so, the prevalence values were converted into angles and the values of mean intensity were transfered as x + 1 where "x" is the mean intensity of parasites.

OBSERVATIONS

The different types of most commonly occuring parasites collected during the present study with their host and site of infection are given below:

Ergasilus sp. Host-*Tachysurus maculatus*, site of infection-Gills

Rhadinorhynchus indicus Chauhan; Host-*Tachysurus maculatus*; site of infection-intestine.

Lernaeenicus ramosus Kirtisinghe; Host-*Nemipterus japonicus*; site of infection-Body surface.

Agarna malayi Tiwari; Host-*Valamugil speigleri*; site of infection-opercular chamber.

Philometra cephalus Ramachandran; Host-*Valamugil speigleri*; site of infection-Gonads.

I (a) Prevalence of *Ergasilus* sp. in *T. maculatus* during different seasons.

Table I, VI. Fig. I

The prevalence was 38.32 and 60.12 during premonsoon period in the case of male and female fish, respectively. It increased to 43.63 and 68.24 during the monsoon season. But during postmonsoon season it decreased to 26.96 and 36.97. Generally the females were more infected than the males.

I (b) Prevalence of *Ergasilus* sp. in various length group of *T. maculatus*.

Table I, VI. Fig. II

In fishes belonging to the length group 8-10 cm the prevalence was 26.98. But in 10-12 cm group it showed a decrease to 25. In the case of 12-14 cm group the prevalence was 26.32. Even though the value is higher than that of the 10-12 cm group it is smaller when compared to 8-10 cm group. In 14-16 cm group prevalence was 34.27. It again increased to 57.31 in the case of 16.18 cm group, 78.57 in the case of 18-20 cm group, and reached the maximum of 84.26 in the case of 20.22cm group. Then the prevalence decreased to 80.77 for 22-24 cm group. There is a general trend of increase in prevalence with increase in the length of fishes.

I (c) Mean intensity of infection Ergasilus sp. in I. maculatus during different seasons.

Table I, VII. Fig. III

Just like the prevalence, the mean intensity also showed an increase from 11.44 in the premonsoon period to 11.85 in the monsoon but decreased to 6.44 in post monsoon period, in the case of female fish. In the case of male fish, the mean intensity in the premonsoon period was 9.2. It increased to 9.48 in monsoon but decreased to 4.71 in postmonsoon period. Here also females had shown a higher mean intensity of infection than the males.

I (d) Mean intensity of infection of Egasilus sp. in various length group of fishes.

Table I, VII. Fig. IV

Mean intensity of infection also showed a similar trend as prevalence. Except in the case of 10-12 length group it showed a continuous increase. The mean intensity of infection of 8-10 cm group was 3.65 and it decreased to 3.63 in the case of 10-12 cm group. It increased to 5.34 for 12-14 cm group, 5.43 for 14-16 cm group, 8.18 for 16-18 cm group 11.10 for 18.20 cm group, 15.05 for 20-22 cm group, and reached the maximum of 15.76 for 22-24 cm group.

LENGTH GROUP OF FISHES (MEASUREMENTS IN CM)

MONTH / YEAR	8-10		10-12		12-14		14-16		16-18		18-20		20-22		22-24	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Jan/1986	2/1	0/0	0/0	3/0	6/0	6/1	16/2	4/1	9/2	6/3	9/4	2/1	0/0	3/3	1/1	3/3
	1	0	0	0	0	1	3	5	7	17	25	3	0	36	12	37
Feb/1986	1/0	0/0	2/0	9/3	4/1	4/0	12/2	8/3	10/5	12/7	2/1	3/3	0/0	3/3	0/0	0/0
	0	0	0	8	12	0	11	21	38	69	4	49	0	44	0	0
Mar/1986	0/0	2/2	7/1	5/3	6/0	7/3	8/4	9/3	5/4	6/5	0/0	10/9	0/0	5/4	0/0	0/0
	0	9	3	9	0	15	35	9	18	45	0	97	0	44	0	0
April/1986	1/1	3/1	5/1	1/0	3/0	1/0	9/2	3/1	10/5	9/4	1/1	15/12	1/1	8/7	0/0	0/0
	3	1	3	0	0	0	14	9	37	58	13	104	9	83	0	0
May/1986	5/1	2/1	5/1	6/1	4/3	4/2	3/1	9/4	4/4	9/9	1/1	8/7	1/1	6/5	0/0	3/2
	7	3	5	7	27	23	7	42	78	175	20	182	33	152	0	52
June/1986	2/1	5/0	4/2	4/2	3/1	6/3	3/1	5/5	10/8	5/4	3/3	9/8	1/1	7/7	0/0	3/3
	3	0	10	8	3	17	7	51	103	49	67	128	16	141	0	95

TABLE I

Distribution of Ergasilus sp in Tachysurus maculatus. For each month, in the upperline, the figures left to the slash refer to the number of host fish examined and the figures right to the slash refer to the number of host fish infected. The figures in the lower line refer to the number of parasites collected. M = Male; F = Female.

(Contd...)

MONTH / YEAR	8-10		10-12		12-14		14-16		16-18		18-20		20-22		22-24	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
July/1986	3/3	3/0.	6/3	3/0	9/2	7/3	4/4	7/5	0/0	7/6	4/3	8/8	0/0	7/7	0/0	2/2
	12	0	19	0	11	7	40	68	0	72	29	109	0	116	0	42
Aug/1986	5/2	2/0	7/1	1/0	5/1	5/1	5/1	2/2	6/4	10/8	0/0	10/7	0/0	8/5	0/0	4/4
	28	0	3	0	6	6	4	18	34	71	0	60	0	69	0	42
Sept/1986	6/0	3/1	5/1	5/1	3/1	8/2	3/1	1/0	6/3	9/7	1/0	11/10	1/1	6/4	0/0	2/2
	0	1	1	1	10	6	2	0	27	57	0	65	10	47	0	19
Octo/1986	3/1	5/0	7/1	2/0	8/1	9/2	1/0	8/2	4/1	8/4	2/1	5/5	1/1	3/3	0/0	4/2
	3	0	3	0	1	3	0	4	3	24	11	45	9	31	0	17
Nov/1986	4/1	6/0	6/1	5/0	5/3	10/2	3/0	6/1	3/0	7/1	1/0	7/5	0/0	4/2	0/0	3/1
	2	0	7	0	18	7	0	3	0	7	0	38	0	17	0	11
Dec/1986	0/0	0/0	5/2	5/2	4/2	6/1	7/2	7/1	5/1	11/3	3/2	11/8	1/1	4/3	0/0	1/1
	0	0	8	3	4	1	8	5	2	11	11	39	8	24	0	4

	Source of variation	DF	SSQ	MSSQ	F-ratio	Significance
1.	Between length	7	12246.9289	1749.561271	5.272811257	1 % level
2.	Between sex	1	175.74782	175.74782	0.529667122	NIL
3.	Between season	2	549.24888	274.62444	0.827660547	NIL
4.	Error	37	12276.8982	331.8080594		
5.	Total	47	25248.8238			

TABLE VI

Analysis of variance table of prevalence of infection with *Ergasilus* sp. in *Tachysurus maculatus*.

	Sources of variation	DF	SSQ	MSSQ	F-ratio	Significance
1.	Between length	7	19.7005135	2.814359071	4.370644299	1 % level
2.	Between sex	1	0.1353629	0.1353629	0.210215922	NIL
3.	Between season	2	5.5820792	2.7910396	4.334429619	5 % level
4.	Error	37	23.8251568	0.643933156		
5.	Total	47	49.2431124			

TABLE VII

Analysis of variance table of mean intensity of infection with *Ergasilus* sp. in *Tachysurus maculatus*.

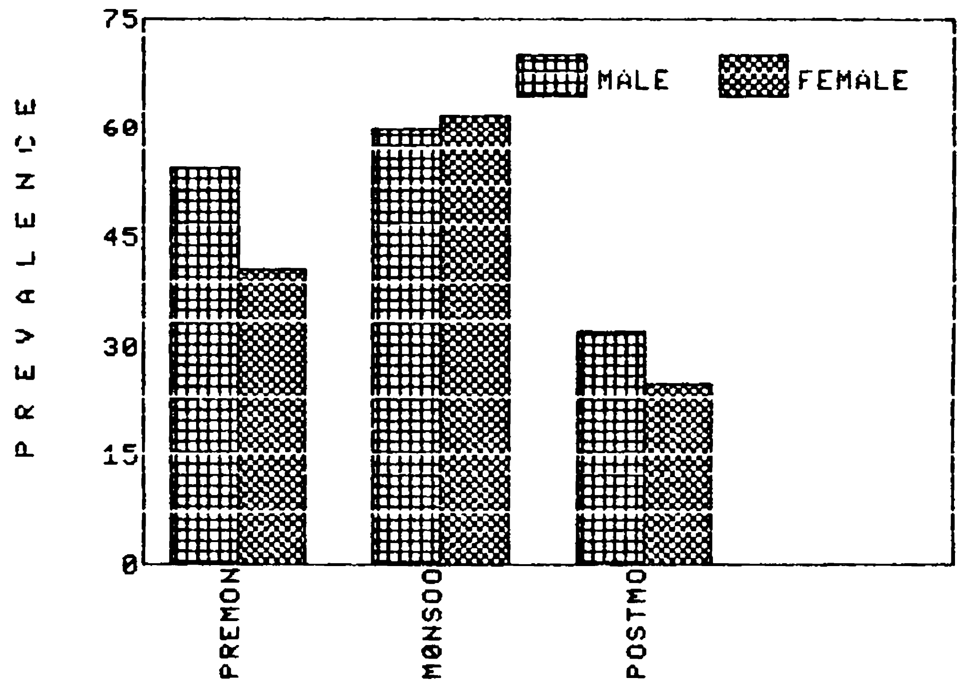


Fig. I

Prevalence of Ergasilus sp. in T. maculatus during different seasons. Premon-Premonsoon, Monsoo-Monsoon, Postmo-Postmonsoon.

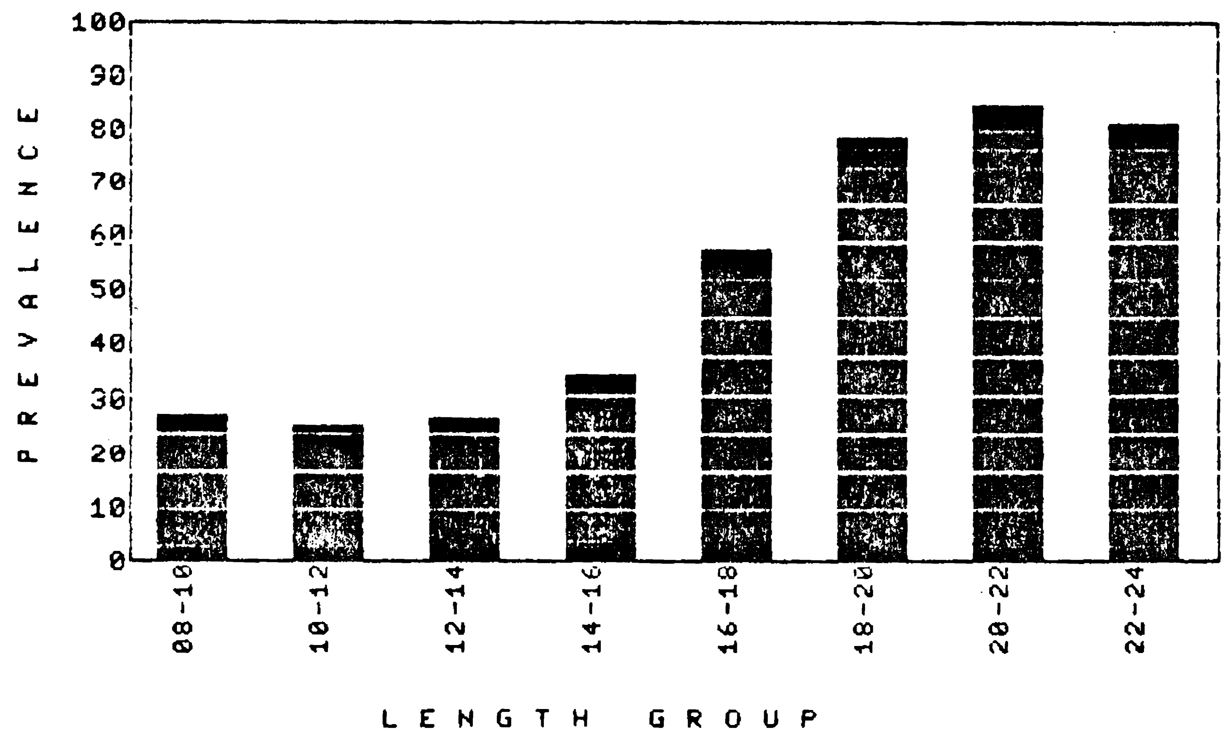


Fig. II

Prevalence of _Ergasilus_ sp. in various length groups (in cm) of _T. maculatus_.

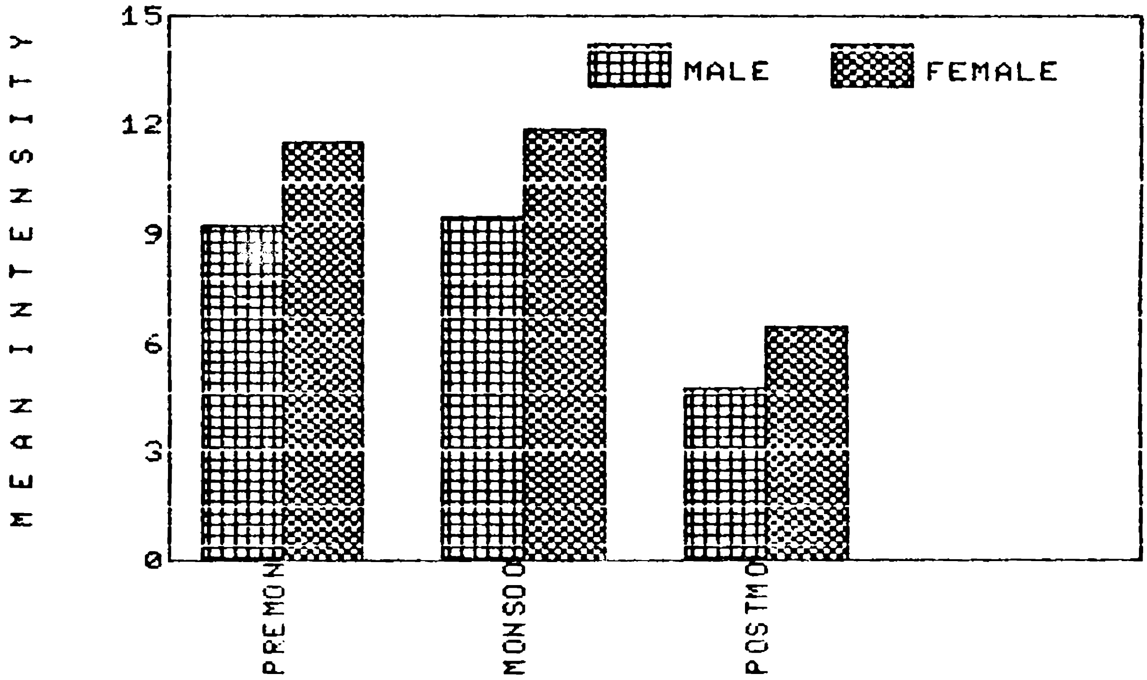


Fig. III

Mean intensity of infection of Ergasilus sp. in *T. maculatus* during different seasons. Premon-Premonsoon, Monsoo-Monsoon, Postmo-Postmonsoon.

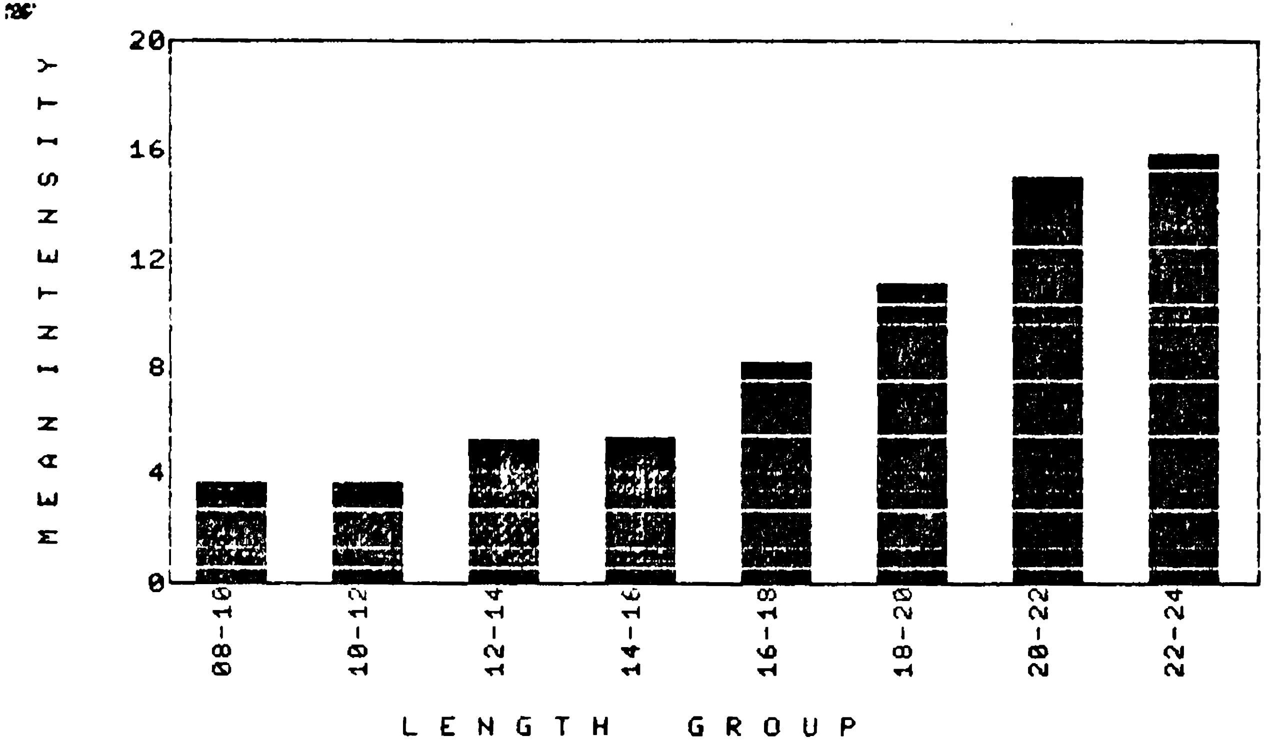


Fig. IV

Mean intensity of infection of _Ergasilus_ sp. in various length-groups (in cm) of _T. maculatus_.

II(a) Prevalence of *Radinorhynchus indicus* in *T. maculatus* during different seasons.

Table II, VIII. Fig. V

During premonsoon period, the prevalence was 54.21 for male fishes and 40.46 for females. It increased to 60 and 61.76 during monsoon period for males and females, respectively. In postmonsoon period the values decreased to 32.17 and 34.85 for males and females, respectively. Here, the males had shown a higher rate of prevalence than the females during premonsoon and postmonsoon periods. But during monsoon period females had shown a slight higher prevalence.

II(b) Prevalence of *Rhadinorhynchus indicus* in various length group of *T. maculatus*.

Table II, VIII. Fig. VI

Prevalence in various length group of fishes was not uniform. 8-10 cm group had shown a prevalence of 53.97 and it decreased to 43.36 for 10-12 cm group, and to 39.85 for 12-14 cm group. Then, it increased to 41.26 for 14-16 cm group, to 43.27 for 16-19 cm group to 45.24 for 18-20 cm group, to 51.43 for 20-22 cm group, and reached the maximum of 57.69 for 22-24cm group. Here, the youngest and the oldest fish showed high prevalence where as the prevalence rate in the middle groups were less.

II(c) Mean intensity of infection of Rhadinorhynchus indicus in *T. maculatus* during different seasons.

Table II, IX. Fig. VII

The mean intensity of infection was 7.60 and 8.7 for males and females, respectively during premonsoon period. It increased to 12.02 and 12.47 during monsoon but decreased to 5.84 and 8.05 in the postmonsoon period. Unlike prevalence the females had shown a high mean intensity than males.

II(d) Mean intensity of infection of Rhadinorhynchus indicus in various length group of *T. maculatus*.

Table II, IX. Fig. VIII

The mean intensity of infection for the 8-10 cm length group was 4.5. It increased to 6.78 for 10-12 cm group and 8.09 for 12-14 cm group. Then it decreased to 7.85 for 14-16 cm group. Again it showed an increase to 9.70 for 16-18 cm group, 11.70 for 18-20 cm group, 15.39 for 20-22 cm group, and reached the maximum of 23.27 for 22-24 cm group. Except for the 14-16 cm group infection showed a continuous increase with increase in length group of the fish.

MONTH / YEAR	8-10 M	8-10 F	10-12 M	10-12 F	12-14 M	12-14 F	14-16 M	14-16 F	16-18 M	16-18 F	18-20 M	18-20 F	20-22 M	20-22 F	22-24 M	22-24 F
Jan/1986	2/0	0/0	0/0	3/0	6/2	6/1	16/4	4/0	9/2	6/1	9/5	2/0	0/0	3/1	1/0	3/0
	0	0	0	0	10	5	16	0	5	2	23	0	0	9	0	0
Feb/1986	1/1	0/0	2/1	9/3	4/2	4/0	12/4	8/2	10/4	12/3	2/1	3/1	0/0	3/1	0/0	0/0
	5	0	4	7	12	0	26	5	23	9	10	6	0	10	0	0
Mar/1986	0/0	2/0	7/3	5/1	6/2	7/2	8/3	9/2	5/2	6/1	0/0	10/2	0/0	5/2	0/0	0/0
	0	0	14	4	9	8	18	14	9	3	0	5	0	18	0	0
April/1986	1/1	3/1	5/2	1/1	3/3	1/0	9/5	3/1	10/6	9/2	1/1	15/5	1/1	8/2	0/0	0/0
	7	4	12	4	15	0	34	6	44	12	12	39	9	21	0	0
May/1986	2/2	5/3	5/4	6/4	4/3	4/3	3/2	9/7	4/3	9/7	1/1	8/6	1/1	6/5	0/0	3/3
	7	6	32	24	31	23	25	63	38	87	19	74	26	88	0	69
June/1986	2/2	5/3	4/4	4/3	3/3	6/3	3/2	5/5	10/7	5/4	3/2	9/6	1/1	7/6	0/0	3/3
	7	6	32	15	31	23	25	17	89	45	30	83	26	88	0	69

TABLE II

Distribution of _Rhadinorhynchus_ _indicus_ in _Tachysurus_ _maculatus_. For each month, in the upperline, the figures left to the slash refer to the number of host fish examined and the figures right to the slash refer to the number of host fish infected. The figures in the lower line refer to the number of parasites collected. M = Male; F = Female.

(Contd...)

MONTH / YEAR	8-10		10-12		12-14		14-16		16-18		18-20		20-22		22-24	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
July/1986	3/3	3/2	6/4	3/2	9/5	7/4	4/3	7/5	0/0	7/5	4/3	8/6	0/0	7/5	0/0	2/2
	33	18	53	24	59	45	48	39	0	67	54	105	0	81	0	50
Aug/1986	5/3	2/1	7/4	1/0	5/3	5/3	5/3	2/1	6/4	10/6	0/0	10/5	0/0	8/3	0/0	4/2
	27	6	35	0	36	30	43	11	80	66	0	83	0	65	0	77
Sep/1986	6/3	3/1	5/2	5/2	8/1	3/3	3/2	1/0	6/2	9/4	1/0	11/5	1/0	6/3	0/0	2/2
	22	8	19	8	10	21	15	0	19	27	0	46	0	51	0	36
Octo/1986	3/2	5/2	7/3	2/1	8/3	9/2	1/0	8/2	4/2	8/3	2/1	5/1	1/1	3/1	0/0	4/1
	10	9	17	6	20	12	0	17	19	26	13	9	14	13	0	16
Nov/1986	4/2	6/2	6/2	5/1	5/1	10/2	3/1	6/2	3/0	7/3	1/0	7/2	0/0	4/1	0/0	3/1
	6	5	10	5	6	13	10	15	0	25	0	24	0	16	0	18
Dec/1986	0/0	0/0	5/1	5/1	4/1	6/1	7/2	7/1	5/1	11/2	3/1	11/3	1/0	4/2	0/0	1/1
	0	0	3	4	6	5	10	6	9	14	9	23	0	19	0	14

	Source of variation	DF	SSQ	MSSQ	F-ratio	Significance
1.	Between length	7	1758.07971	251.1542442	0.847812823	NIL
2.	Between sex	1	4.39227	4.39227	0.014826836	NIL
3.	Between season	2	3038.37804	1519.18902	5.128274606	5 % level
4.	Error	37	10960.80028	296.2378454		
5.	Total	47	15761.6503			

TABLE VIII

Analysis of variance table of prevalence of infection with _Rhadinorhychus indicus_ in _Tachysurus maculatus_.

	Source of variation	DF	SSQ	MSSQ	F-ratio	Significance
1.	Between length	7	12.8174707	1.831067242	2.898305591	5 % level
2.	Between sex	1	0.6692965	0.6692965	1.05939626	NIL
3.	Between season	2	4.7200604	2.3600302	3.735574842	5 % level
4.	Error	37	23.37555025	0.631771628		
5.	Total	47	41.58237785			

TABLE IX

Analysis of variance table of mean intensity of infection with _Rhadinorhychus_ _indicus_ in _Tachysurus maculatus_.

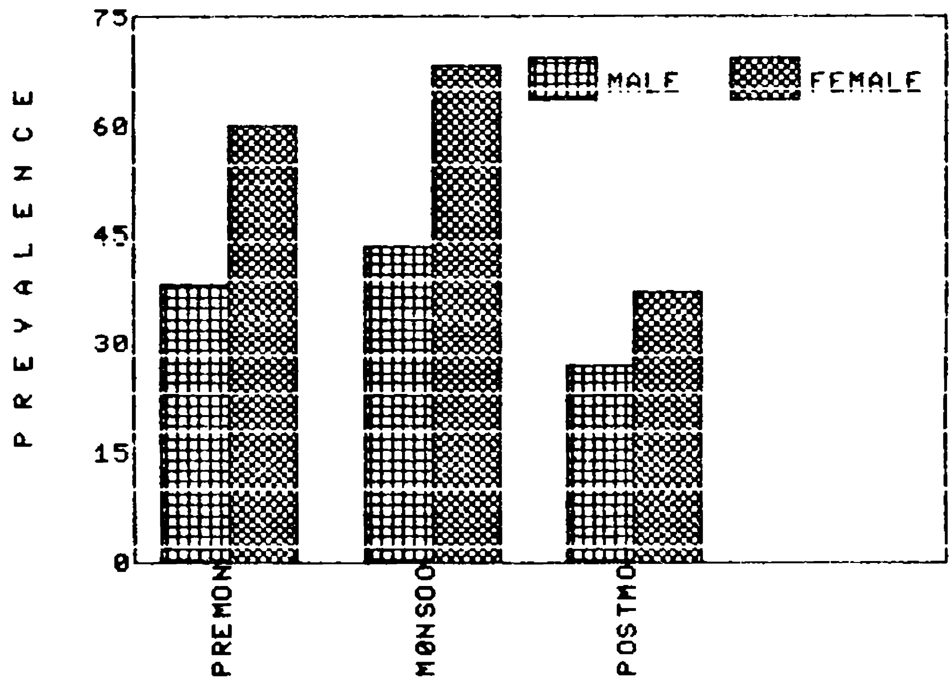


Fig. V

Prevalence of <u>Rhadinorhynchus indicus</u> in <u>T. maculatus</u> during different seasons. Premon-Premonsoon, Monsoo-Monsoon, Postmo-Postmonsoon.

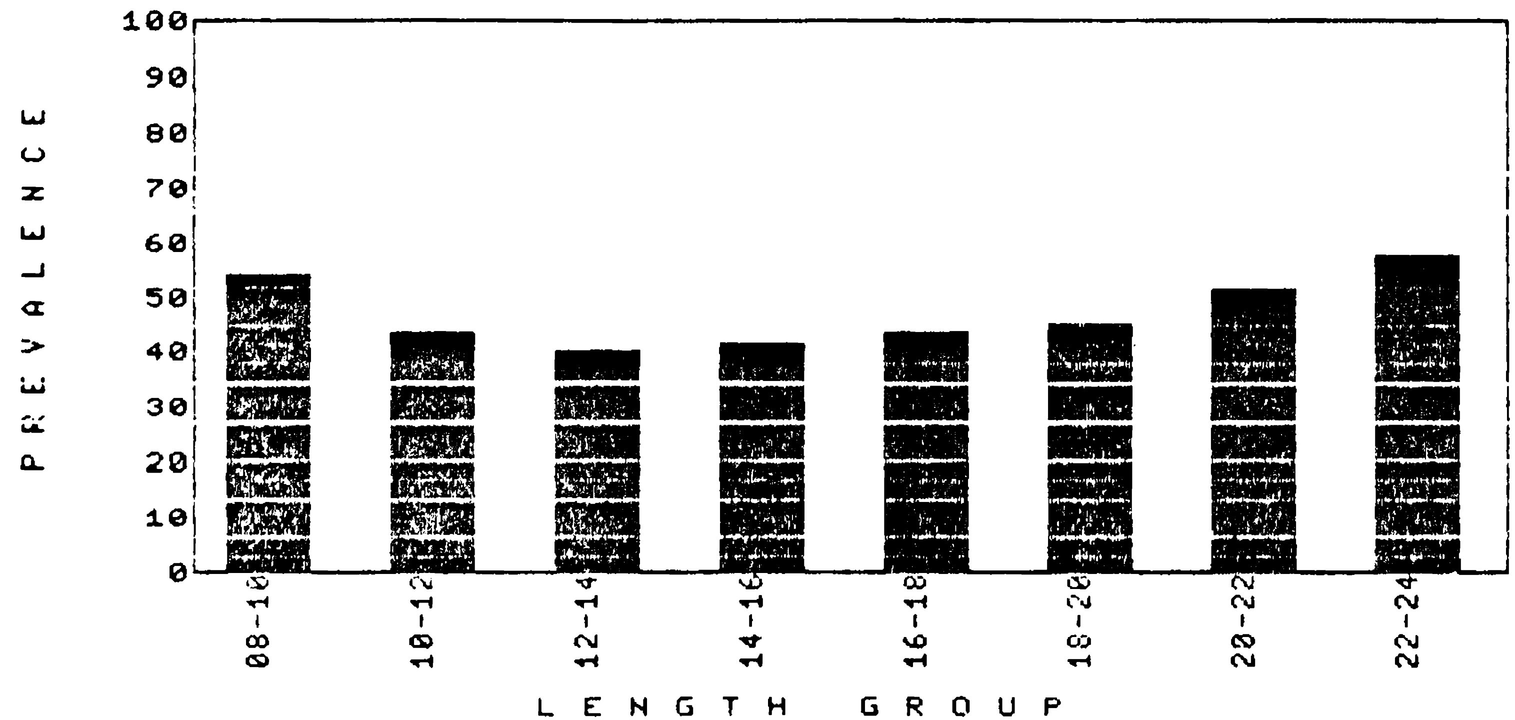


Fig. VI

Prevalence of _Rhadinorhynchus_ _indicus_ in various length groups (in cm) of _T. maculatus_.

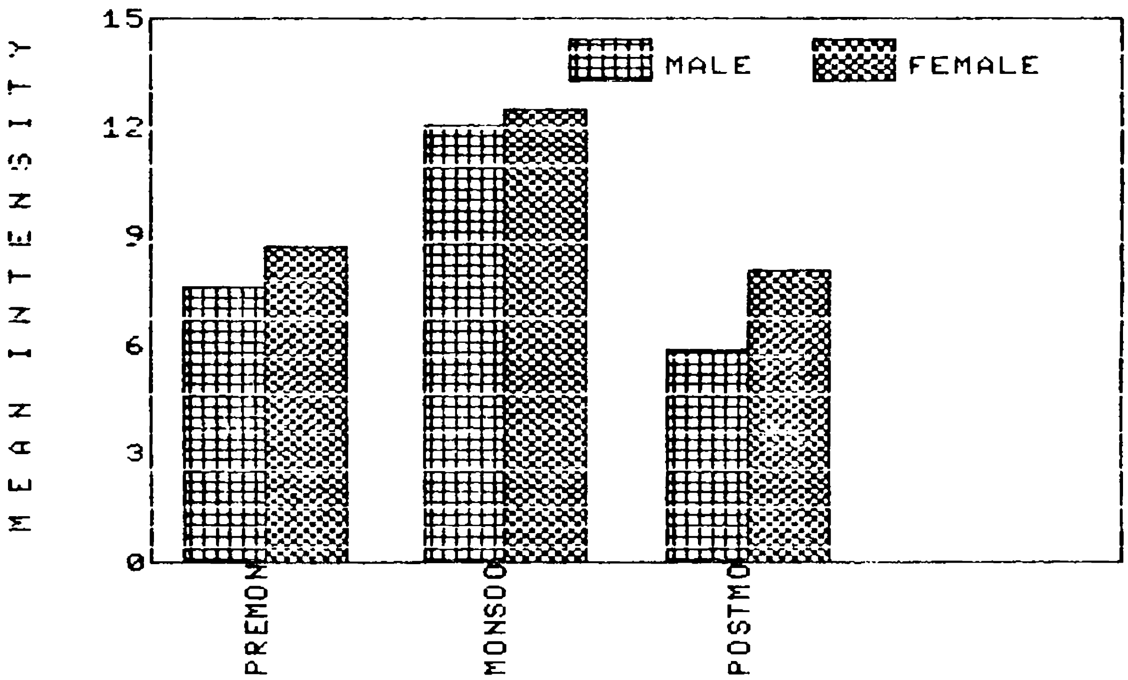


Fig. VII

Mean intensity of infection of Rhadinorhynchus indicus in T.maculatus during different seasons. Premon-Premonsoon, Monsoo-Monsoon, Postmo-Postmonsoon.

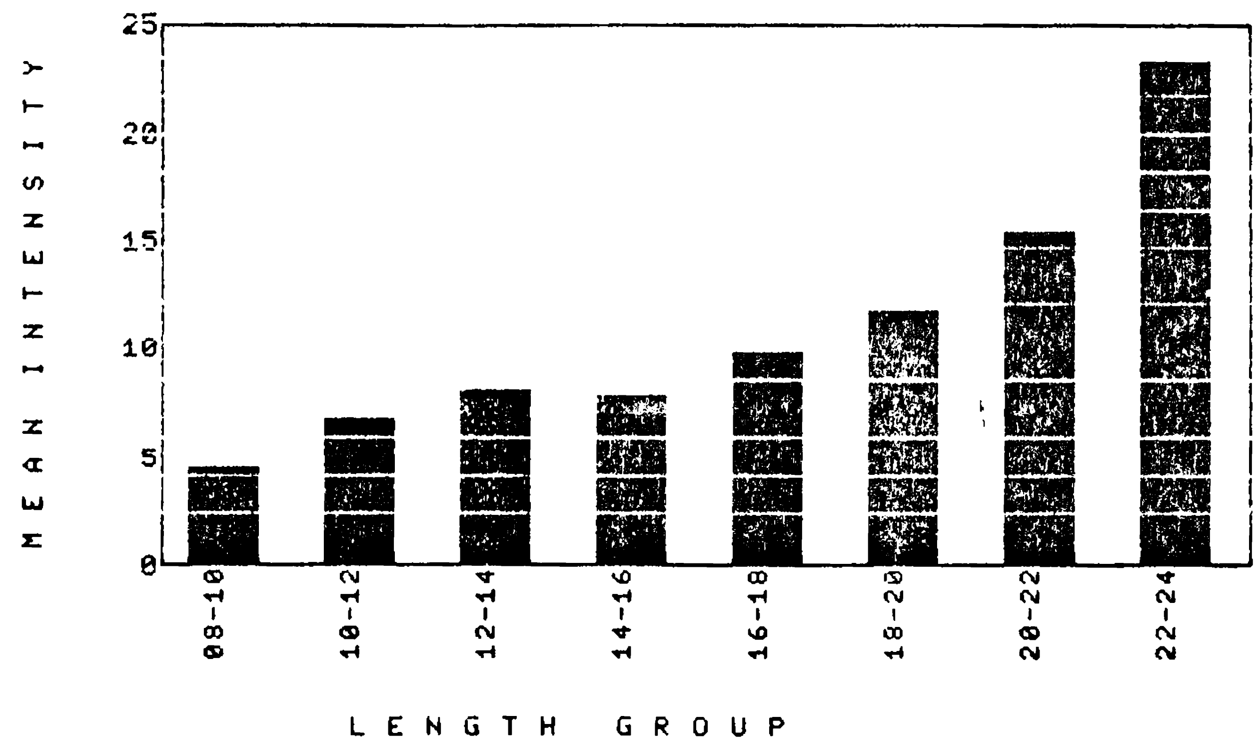


Fig. VIII

Mean intensity of infection of _Rhadinorhynchus indicus_ in various length groups (in cm) of _I. maculatus_.

III(a) Prevalence of *Lernaeenicus ramosus* in *N. japonicus* during different seasons.

Table III, X. Fig. IX

The prevalence of *Lernaeenicus ramosus* was 35.05 and 21.68 for males and females, respectively during the premonsoon period. It increased to 68.75 and 40.97 during monsoon, but decreased to 11.11 and 7.09 during the postmonsoon period. Males had shown a clearcut higher prevalence rate than the females.

III(b) Prevalence of *Lernaeenicus ramosus* in various length group of *N. japonicus*.

Table III, X. Fig. X

For 8-10 cm length group fishes, the prevalence was 41.38. It decreased to 21.72 for 10-12 cm group. Then it increased to 25.81 for 12-14 cm group, 40 for 14-16 cm group and reached the highest value of 62.06 in the case of 16-18 cm group. It was seen that the oldest and youngest fishes were more susceptible to infection when compared to the middle age groups.

III(c) Mean intensity of infection of Lernaeenicus ramosus in N. japonicus during different seasons.

Table III, XI. Fig. XI

During the premonsoon period the mean intensity of infection was 2.91 for males and 3.39 for females. It increased to 3.05 and 3.56 during monsoon but decreased to 1.8 and 1.7, respectively during the postmonsoon season. The male and female fish showed only very little difference in the case of mean intensity of infection, with the females being more infected than males except during the post monsoon period when the males were more affected.

III(d) Mean intensity of infection of Lernaeenicus ramosus in various length group of N. japonicus.

Table III, XI. Fig. XII

The mean intensity of infection for 8-10 cm length group was 2.08 and it increased to 2.17 for 10-12 cm group, to 3.06 for 12-14 cm group, and to 4.52 for 14-16 cm group. Thus, the mean intensity of infection showed an increase with increase in the length group except for the 16-18 cm length group for which mean intensity decreased to 4.17.

MONTH / YEAR	LENGTH GROUP OF FISHES (MEASUREMENTS IN CM)									
	8-10		10-12		12-14		14-16		16-18	
	M	F	M	F	M	F	M	F	M	F
May/ 1985	2/1	1/1	9/5	5/0	12/7	12/4	8/4	11/4	0/0	0/0
	1	3	7	0	24	11	15	28	0	0
June/ 1985	1/1	1/1	8/5	11/2	13/6	10/3	6/3	9/4	1/0	0/0
	5	1	12	5	20	9	15	27	0	0
July/ 1985	1/1	2/1	4/2	7/2	9/6	10/3	4/1	17/6	0/0	6/4
	1	1	4	5	27	10	6	25	0	15
August/ 1985	7/6	7/3	8/7	5/3	6/5	5/1	4/3	7/6	1/1	10/7
	11	7	21	5	18	5	14	23	6	31
Sept/ 1985	9/7	4/0	10/9	5/2	3/2	8/2	1/1	9/3	0/0	11/6
	16	0	17	4	3	6	5	8	0	23
Uct/ 1985	3/0	0/0	11/2	4/0	12/5	9/1	7/2	14/3	0/0	0/0
	0	0	2	0	11	1	4	9	0	0

TABLE III

Distribution of Lernaeenicus ramosus in Nemipterus japonicus. For each month, in the upperline the figures left to the slash refer to the number of host fish examined and the figures right to the slash refer to the number of fish infected. The figures in the lower line refer to the number of parasites collected. M = Male; F = Female.

(Contd...)

MONTH / YEAR	8-10		10-12		12-14		14-16		16-18	
	M	F	M	F	M	F	M	F	M	F
Nov/ 1985	0/0	1/0	21/1	19/2	1/0	18/2	0/0	0/0	0/0	0/0
	0	0	2	3	0	3	0	0	0	0
Dec/ 1985	0/0	0/0	14/1	12/0	9/0	24/1	1/0	0/0	0/0	0/0
	0	0	1	0	0	1	0	0	0	0
Jan/ 1986	3/0	0/0	8/0	18/1	9/0	22/0	0/0	0/0	0/0	0/0
	0	0	0	1	0	0	0	0	0	0
Feb/ 1986	0/0	0/0	13/2	15/1	8/2	23/4	1/1	0/0	0/0	0/0
	0	0	9	1	6	15	5	0	0	0
March/ 1986	7/1	9/1	6/1	18/2	6/2	14/6	0/0	0/0	0/0	0/0
	2	2	3	4	6	19	0	0	0	0
April/ 1986	0/0	0/0	8/2	5/1	16/6	20/4	1/0	10/3	0/0	0/0
	0	0	5	2	16	9	0	11	0	0

	Source of variation	DF	SSQ	MSSQ	F-ratio	Significance
1.	Between length	4	1167.54391	291.8859775	2.28072	NIL
2.	Between sex	1	485.6968	485.6968	3.79507	NIL
3.	Between season	2	6711.04915	3355.524575	26.218942	1 % level
4.	Error	22	2815.58044	127.980929		
5.	Total	29	11179.8703			

TABLE X

Analysis of variance table of prevalence of infection with *Lernaeenicus ramosus* in *Nemipterus japonicus*.

	Source of variation	DF	SSQ	MSSQ	F-ratio	Significance
1.	Between length	4	2.37941887	0.594854717	6.252010704	1 % level
2.	Between sex	1	0.00332853	0.00332853	0.03498334	NIL
3.	Between season	2	2.39669927	1.198349635	12.59483119	1 % level
4.	Error	22	2.0932152	0.095146145		
5.	Total	29	6.87266187			

TABLE XI

Analysis of variance table of mean intensity of infection with _Lernaeenicus ramosus_ in _Nemipterus japonicus_.

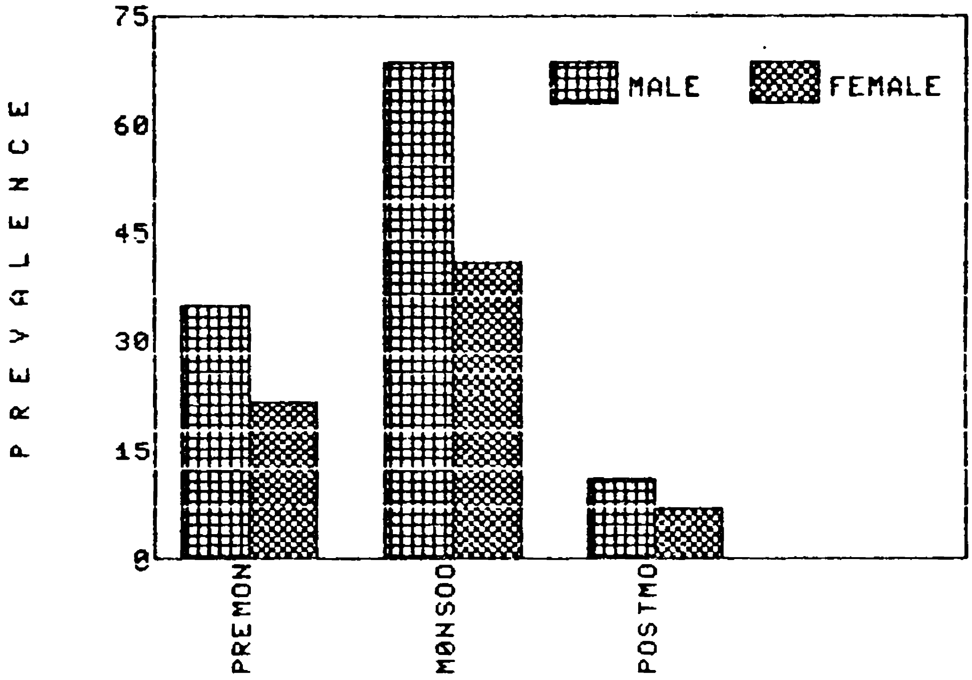


Fig. IX

Prevalence of Lernaeenicus ramosus in N. japonicus during different seasons. Premon-Premonsoon, Monsoo-Monsoon, Postmo-Postmonsoon.

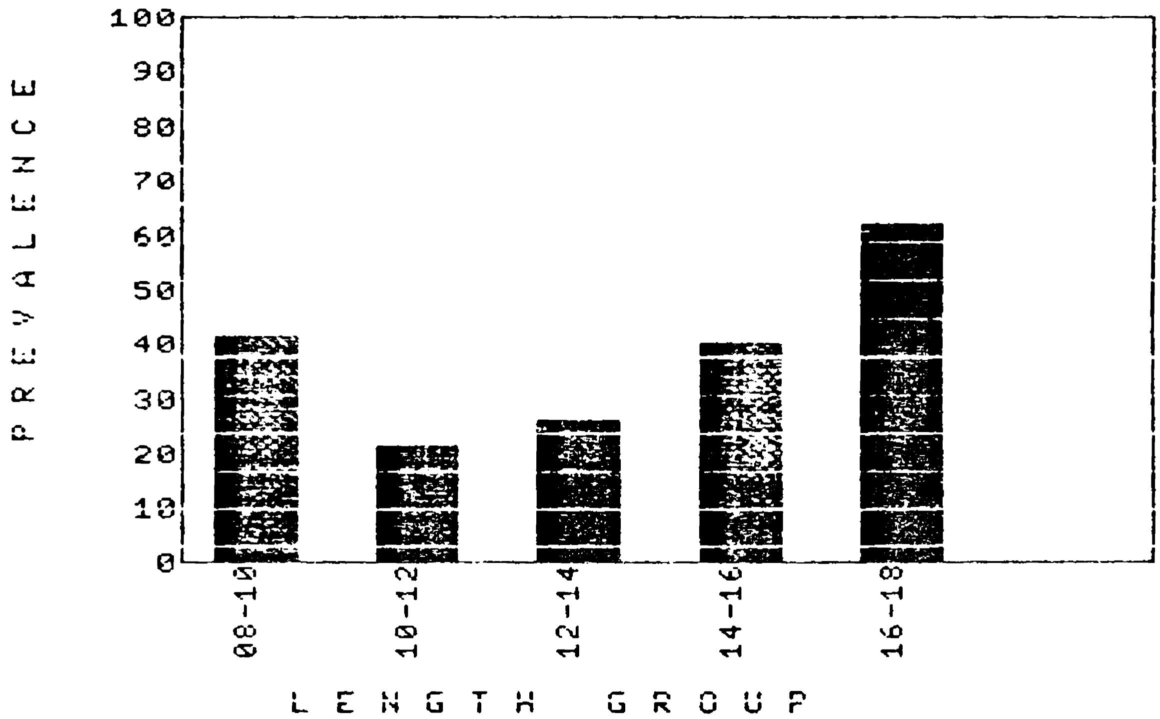


Fig. X

Prevalence of Lernaeenicus ramosus in various length groups (in cm) of N. japonicus.

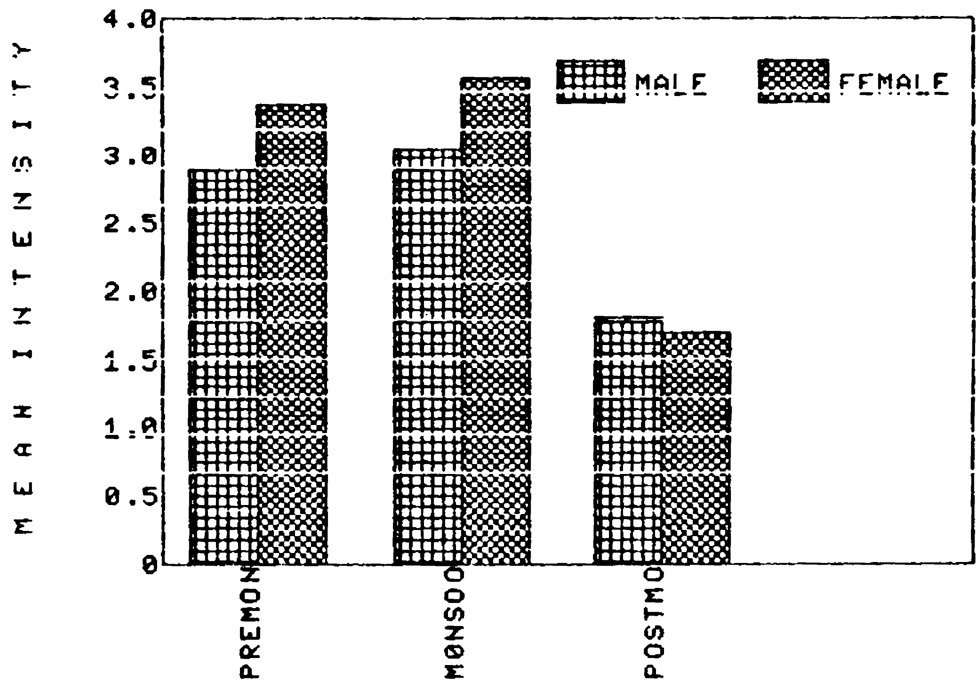


Fig. XI

Mean intensity of infection of Lernaeenicus ramosus in N. japonicus during different seasons. Premon-Premonsoon, Monsoo-Monsoon, Postmo-Postmonsoon.

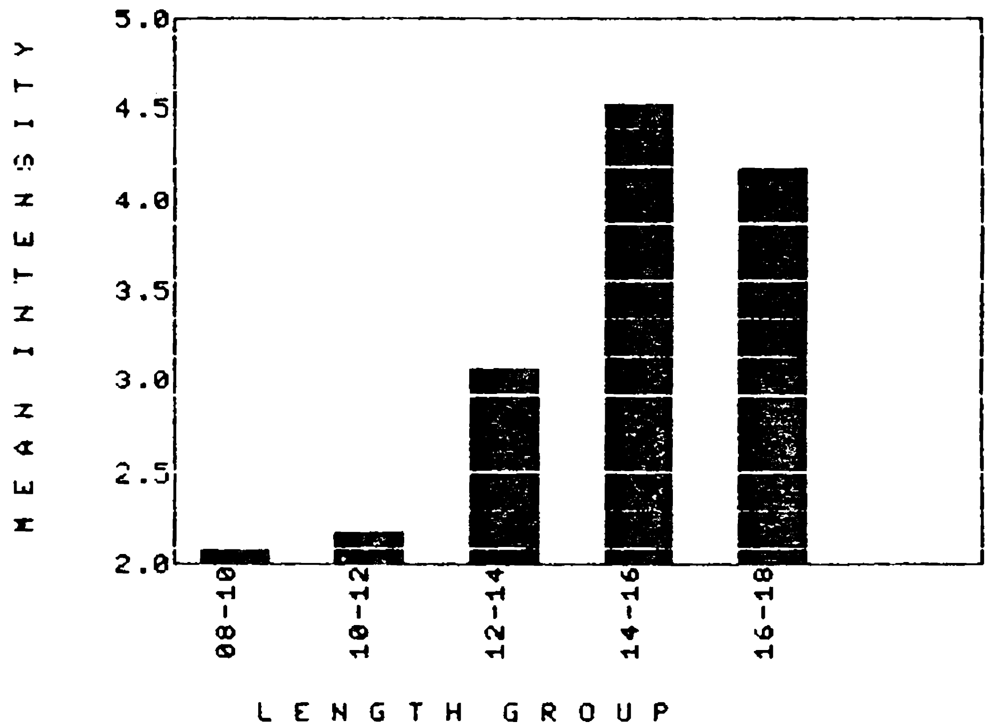


Fig. XII

Mean intensity of infection of Lernaeenicus ramosus in various length groups (in cm) of ... japonicus.

IV(a) Prevalence of Agarna malayi in V. speigleri during different seasons.

Table IV, XII. Fig. XIII

The prevalence of Agarna malayi was 16.67 and 35.89 for males and female fishes, respectively during the premonsoon season. It decreased considerably to 2.5 and 10 during the monsoon period. Then increased and reached the maximum of 28.57 and 39.74 during the postmonsoon season. During all seasons females showed a more prevalence than the males.

IV(b) Prevalence of Agarna malayi in various length group of V. speigleri.

Table IV, XII. Fig. XIV

The prevalence of Agarna malayi infecting Valamugil speigleri showed an increase with the increase in the length group of the fish. For 8-10 cm size group the prevalence was 15.38. It increased to 21.49 for 10-12 cm group, 22.94 for 12-14cm group, and reached the highest value of 34.85 for the 14-16cm length group.

IV(c) Mean intensity of infection of _Agarna malayi_ in _V._ _speigleri_ during different seasons.

Table IV, XIII. Fig. XV

During the premonsoon period the mean intensity of infection was 1.14 and 1.04 for male and female fishes, respectively. It decreased to 1 in the case of male fishes and increased to 1.13 in the case of female fishes during the monsoon season. Then, the mean intensity of infection increased to 1.25 for male fishes and 1.16 for female fishes during the postmonsoon period. Here, the male fishes showed higher mean intensity of infection except in the monsoon season.

IV(d) Mean intensity of infection of _Agarna malayi_ in various length groups of _V._ _speigleri_.

Table IV, XIII. Fig. XVI

Mean intensity of infection of _Agarna malayi_ increased with the increase in size of the fish. It was 1 for 8-10 cm group and increased to 1.09 for 10-12 cm group, 1.13 for 12-14 cm group and reached the maximum of 1.17 for 14-16 cm group fishes.

MONTH / YEAR	LENGTH GROUP OF FISHES (MEASUREMENTS IN CM)							
	8-10		10-12		12-14		14-16	
	M	F	M	F	M	F	M	F
May/1984	0/0	0/0	0/0	2/1	9/1	19/5	0/0	0/0
	0	0	0	1	2	5	0	0
June/1984	0/0	0/0	6/0	13/3	3/0	4/2	0/0	0/0
	0	0	0	3	0	2	0	0
July/1984	0/0	0/0	6/0	12/0	6/0	6/0	0/0	0/0
	0	0	0	0	0	0	0	0
Aug/1984	0/0	0/0	3/0	6/0	5/0	15/0	0/0	1/0
	0	0	0	0	0	0	0	0
Sept/1984	0/0	2/0	2/0	8/0	7/0	8/0	0/0	2/0
	0	0	0	0	0	0	0	0
Oct/1984	0/0	0/0	1/0	1/0	4/0	8/0	3/0	13/1
	0	0	0	0	0	0	0	1

TABLE IV

Distribution of Agarna malayi in Valamugil speiglerii. For each month, in the upperline, the figures left to the slash refer to the total number of host fish examined and figures right to the slash refer to the host fish infected. The figures in the lower line refer to the number of parasites collected. M = Male; F = Female.

(Contd...)

MONTH / YEAR	8-10		10-12		12-14		14-16	
	M	F	M	F	M	F	M	F
Nov/1984	0/0	0/0	6/0	5/0	3/0	6/0	3/0	7/2
	0	0	0	0	0	0	0	0
Dec/1984	0/0	0/0	2/0	3/0	4/0	9/2	8/3	4/3
	0	0	0	0	0	3	7	8
Jan/1985	0/0	0/0	5/4	5/2	2/0	10/5	1/0	7/3
	0	0	5	3	0	6	0	3
Feb/1985	0/0	0/0	2/0	2/1	5/0	5/3	8/2	8/4
	0	0	0	1	0	3	2	5
Mar/1985	0/0	0/0	1/1	5/2	10/1	13/5	0/0	1/0
	0	0	1	2	1	5	0	0
April/1985	2/0	4/2	1/1	14/2	4/1	5/3	0/0	0/0
	0	2	1	2	1	3	0	0

	Source of variation	DF	SSQ	MSSQ	F-ratio	Significance
1.	Between length	3	963.870634	321.256878	2.60012	NIL
2.	Between sex	1	526.594017	526.594017	4.26204	NIL
3.	Between season	2	2922.45556	1461.22778	11.82659	1 % level
4.	Error	17	2100.425129	123.5544193		
5.	Total	23	6513.34534			

TABLE XII

Analysis of variance table of prevalence of infection with *Agarna malayi* in *Valamugil speigleri*.

	Source of variation	DF	SSQ	MSSQ	F-ratio	Significance
1.	Between length	3	0.41215046	0.137383486	3.557198905	5 % level
2.	Between sex	1	0.10362204	0.10362204	2.683031403	NIL
3.	Between season	2	0.41553075	0.207765375	5.379560425	5 % level
4.	Error	17	0.65656135	0.038621255		
5.	Total	23	1.5878646			

TABLE XIII

Analysis of variance table of mean intensity of infection with *Agarna malayi* in *Valamugil speigleri*.

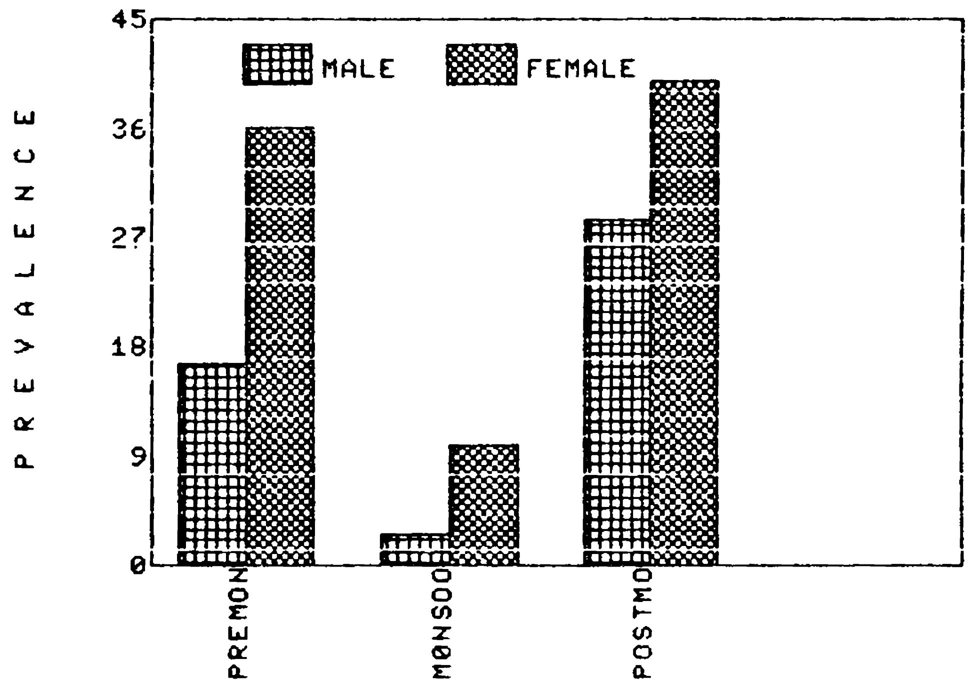


Fig. XIII

Prevalence of Agarna malayi in V. speigleri during different seasons. Premon-Premonsoon, Monsoo-Monsoon, Postmo-Postmonsoon.

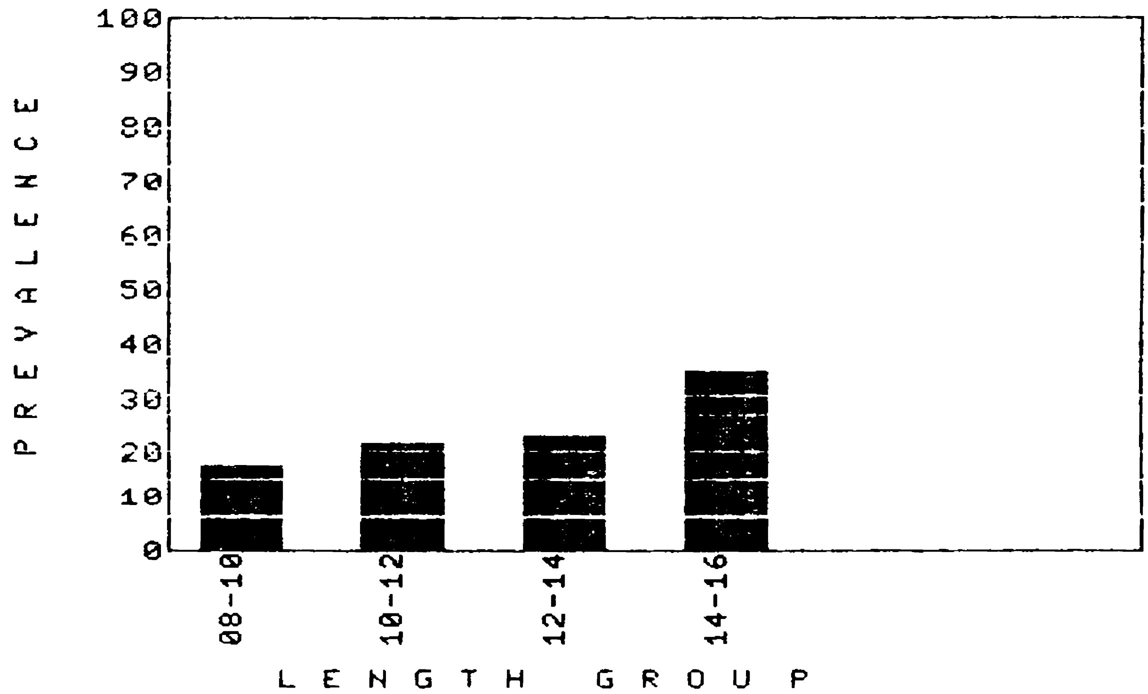


Fig. XIV

Prevalence of <u>Agarna</u> <u>malayi</u> in various length groups (in cm) of <u>V</u>. <u>speigleri</u>.

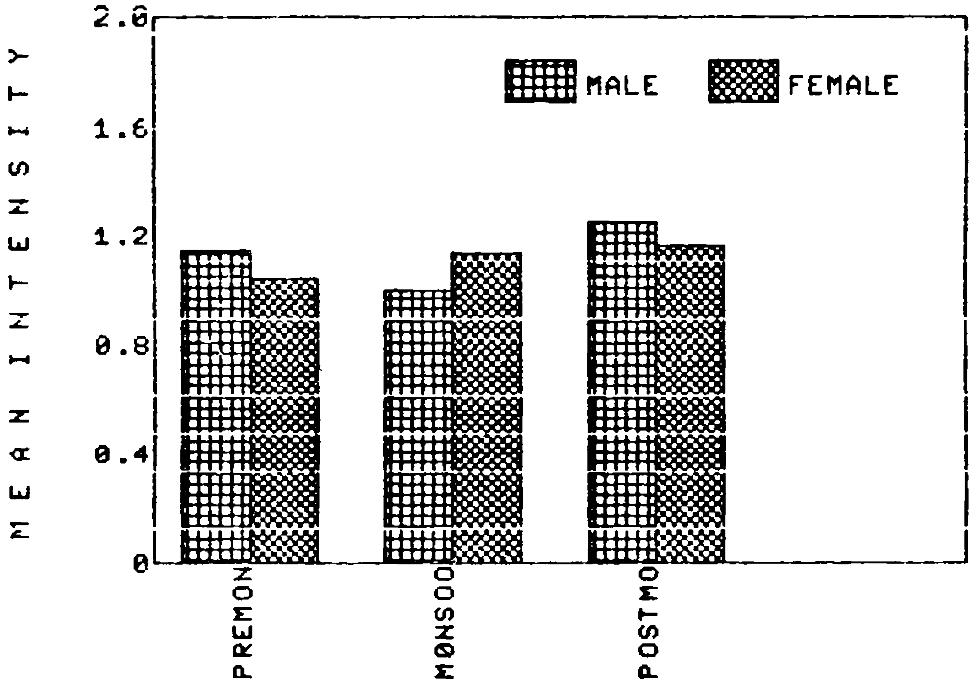


Fig. XV

Mean intensity of infection of Agarna malayi in V. speigleri during different seasons. Premon-Premonsoon, Monsoo-Monsoon, Postmo-Postmonsoon.

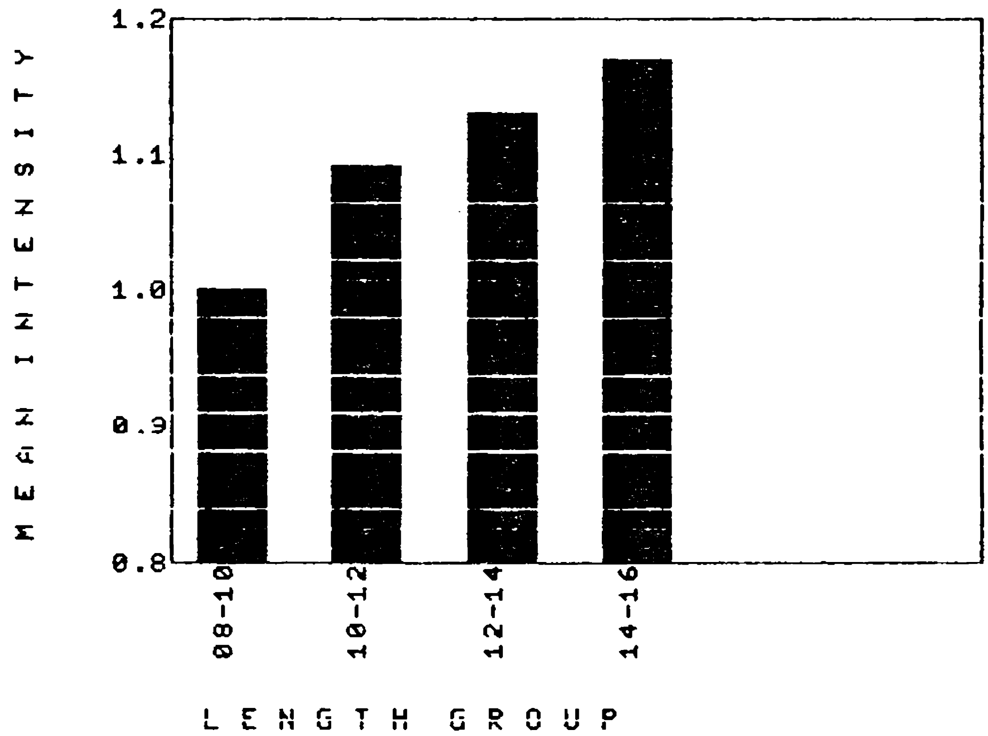


Fig. XVI

Mean intensity of infection of Agarna malayi in various length groups (in cm) of V. speigleri.

V(a) Prevalence of Philometra cephalus in V. speiqleri during different seasons.

Table V, XIV. Fig. XVII

Prevalence of Philometra cephalus was 2.38 for males and 10.26 for females during the premonsoon period. During the monsoon period the parasite was completely absent and the prevalence was zero. But during the postmonsoon period the prevalence increased to 9.52 in the case of male fishes and to 15.38 in the case of female fishes. The female fishes showed a higher rate of prevalence than the males.

V(b) Prevalence of Philometra cephalus in various length group of Valamugil speiqleri.

Table V, XIV. Fig. XVIII

Prevalence was zero in both 8-10 and 10-12 cm group fishes. In 12-14 cm group fish it was 5.29 and increased to 24.24 in the case of the 14-16 cm. Younger fishes were not infected. In older fish, the prevalence increased with the increase in size of the fish.

V(c) Mean intensity of <u>Philometra</u> <u>cephalus</u> in <u>V</u>. <u>speigleri</u> during different seasons.

Table V, XV. Fig. XIX

The mean intensity of <u>Philometra</u> <u>cepahlus</u> was 1.0 for males and 2.5 for females, respectively during the premonsoon period. During the monsoon period the parasite was completely absent and the mean intensity was zero. But during the post monsoon period the mean intensity increased to 2 but decreased to 1.92 for males and females, respectively.

V(d) Mean intensity of <u>Philometra</u> <u>cephalus</u> in various length group of <u>V</u>. <u>speigleri</u>.

Table V, XV. Fig. XX

The mean intensity of infection was zero in both 8-10 cm and 10-12 cm group. For 12-14 cm group it was 1.89 and reached the maximum of 2,19 in the case of 14-16 cm group. Thus, the mean intensity showed an increase with increase in size of the fish.

LENGTH GROUP OF FISHES (MEASUREMENTS IN CM)

MONTH / YEAR	8-10		10-12		12-14		14-16	
	M	F	M	F	M	F	M	F
May/1984	0/0	0/0	0/0	2/0	9/0	19/1	0/0	0/0
	0	0	0	0	0	2	0	0
June/1984	1/0	3/0	6/0	13/0	3/0	4/0	0/0	0/0
	0	0	0	0	0	0	0	0
July/1984	0/0	0/0	6/0	12/0	6/0	6/0	0/0	0/0
	0	0	0	0	0	0	0	0
August/1984	0/0	0/0	3/0	6/0	5/0	15/0	0/0	1/0
	0	0	0	0	0	0	0	0
Sept/1984	1/0	2/0	2/0	8/0	7/0	8/0	0/0	2/0
	0	0	0	0	0	0	0	0
Octo/1984	0/0	0/0	1/0	1/0	4/0	8/0	3/0	13/1
	0	0	0	0	0	0	0	1

TABLE V

Distribution of Philometra cephalus in Valamugil speigleri. For each month, in the upperline, the figures left to the slash refer to the total number of host fish examined and the figures right to the slash refer to the number of host fish infected. The figures in the lower line refer to the number of parasites collected. M = Male; F = Female.

(Contd...)

MONTH / YEAR	8-10		10-12		12-14		14-16	
	M	F	M	F	M	F	M	F
Nov/1984	0/0	0/0	6/0	5/0	3/1	6/0	3/0	7/2
	0	0	0	0	1	0	0	2
Dec/1984	0/0	0/0	2/0	3/0	4/0	9/2	8/3	4/3
	0	0	0	0	0	3	7	8
Jan/1985	0/0	0/0	5/0	5/0	2/0	10/0	1/0	7/4
	0	0	0	0	0	0	0	9
Feb/1985	0/0	0/0	2/0	2/0	5/0	5/0	8/1	8/2
	0	0	0	0	0	0	1	7
Mar/1985	0/0	0/0	1/0	5/0	10/0	13/3	0/0	1/0
	0	0	0	0	0	7	0	0
April/1985	2/0	4/0	1/0	14/0	4/0	5/2	0/0	0/0
	0	0	0	0	0	4	0	0

	Source of variation	DF	SSQ	MSSQ	F-ratio	Significance
1.	Between length	3	1376.0521	458.6840333	8.023059	1 % level
2.	Between sex	1	53.2824	53.2824	0.931987649	NIL
3.	Between season	2	576.428859	288.2144295	5.0412948	5 % level
4.	Error	17	971.90215	57.1707147		
5.	Total	23	2977.6655509			

TABLE XIV

Analysis of variance table of prevalence of infection with *Philometra cephalus* in *Valamugil speigleri*.

	Source of variation	DF	SSQ	MSSQ	F-ratio	Significance
1.	Between length	3	1.13027812	0.376759373	6.153622729	1 % level
2.	Between sex	1	0.1040647	0.1040647	01.699692029	NIL
3.	Between season	2	0.49659858	0.24829929	4.055480139	5 % level
4.	Error	17	1.04083556	0.061225621		
5.	Total	23	2.77177696			

TABLE XV

Analysis of variance table of mean intensity of infection with *Philometra cephalus* in *Valamugil speigleri*.

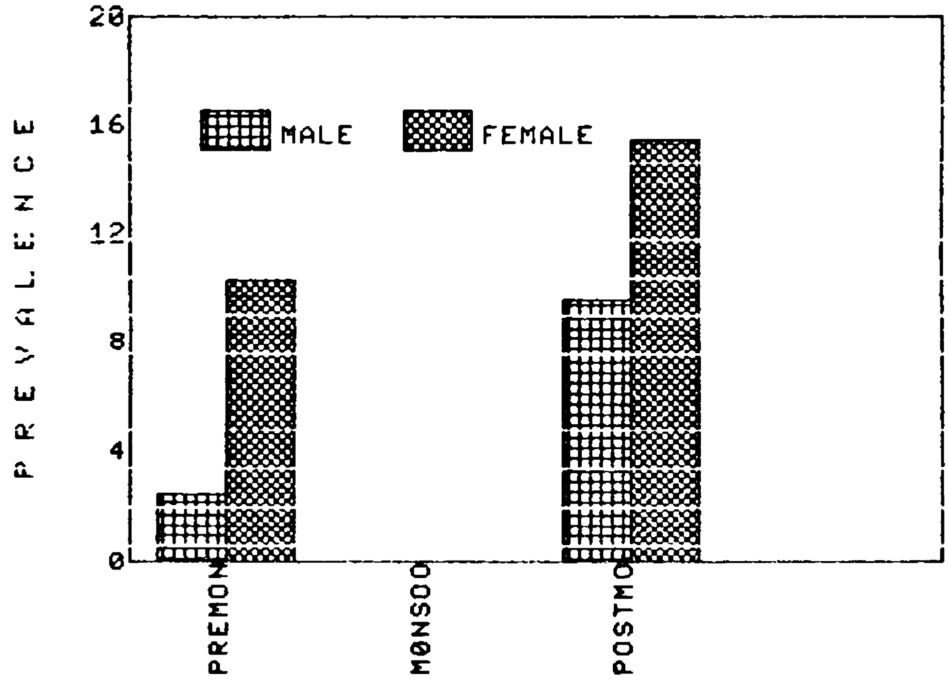


Fig. XVII

Prevalence of Philometra cephalus in V. speigleri during different seasons. Premon-Premonsoon, Monsoo-Monsoon, Postmo-Postmonsoon.

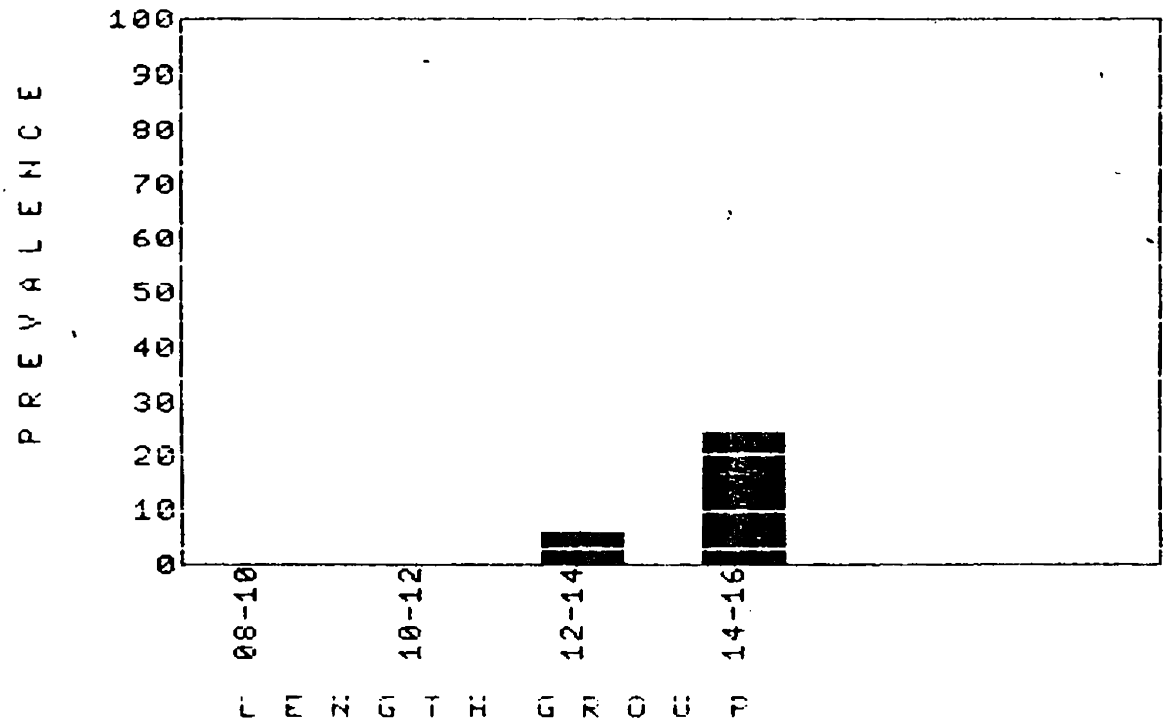


Fig. XVIII

Prevalence of Philometra cephalus in various length groups (in cm) of V. speigleri.

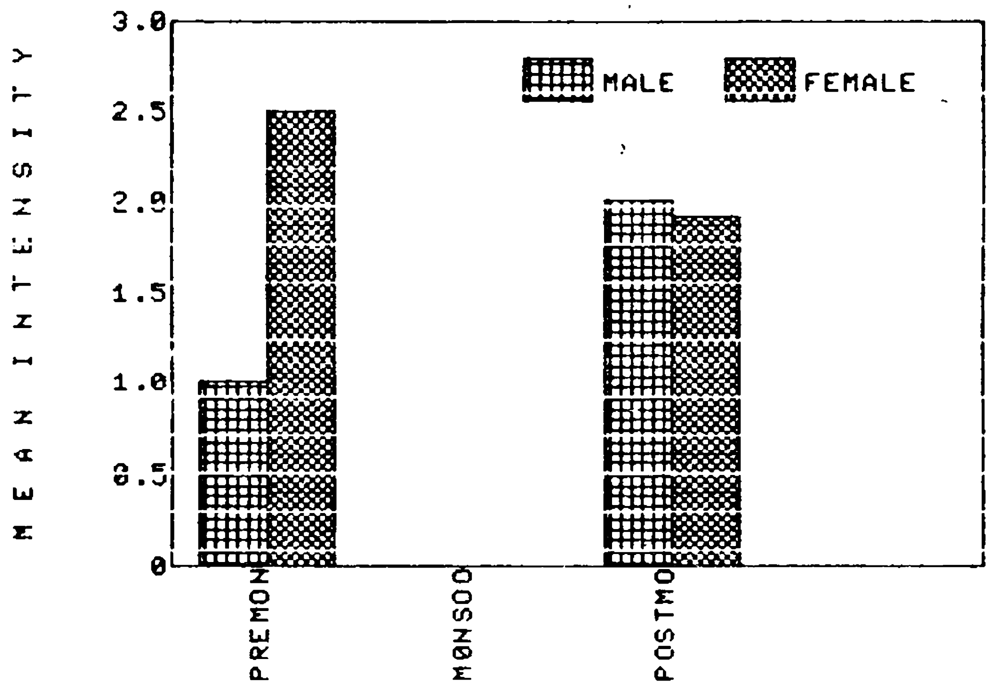


Fig. XIX

Mean intensity of infection of <u>Philometra cephalus</u> in <u>V. speigleri</u> during different seasons. Premon-Premonsoon, Monsoo-Monsoon, Postmo-Postmonsoon.

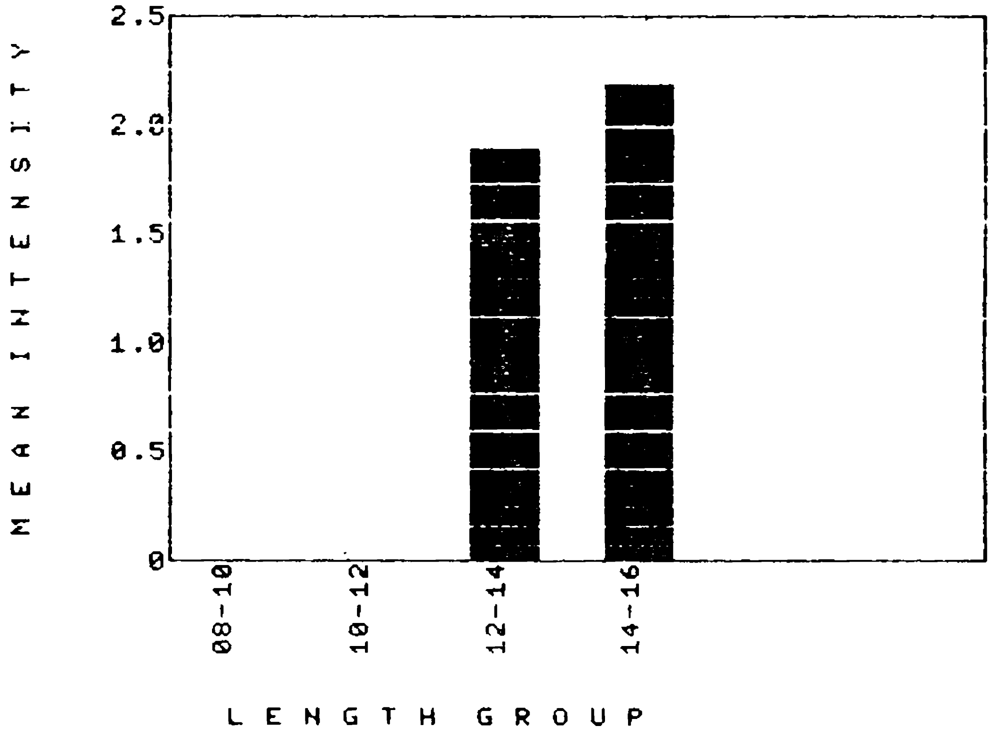


Fig. XX

Mean intensity of Philometra cephalus in various length groups of V. speigleri.

DISCUSSION

In general, infection patterns of parasites in fish populations are influenced by the availability of infective larvae, feeding habit of the host, age and sex of the host, mortality of parasites, and abiotic factors such as salinity, temperature and season of the year. The relationships between prevalence and mean intensity of infection of the parasites under study with these factors are discussed below.

I Helminths:

(a) Sex of the host: It is generally found that female vertebrates are less heavily infected with parasites than males, probably due to the presence of oestrogen (Thomas, 1964). During breeding season this tends to be reversed when oestrogen levels are lower, as Thomas (1964b) found in the trout, *Salmo trutta*. Vijayabatra (1984) has observed a high infection rate in male *Tilapia rendalli* with *Acanthogyrus tilapiae* than in the females. This was in accordance with the observations of Palling (1965) on the parasites of windermere trout. He (Palling, 1965) suggested a higher physiological resistance in the female, and also attributed this to the comparatively larger size of the male.

There are also reports where more female fishes were found infected than males (Kennedy, 1968; Collard, 1970; Madhavi, 1979; Sathyanarayanan, 1982). This was attributed to the sex-related difference in host growth rate or was related to interference with the host hormone balance of female fish as a result of parasitic infection. It was also suggested that female fish provided a more favourable environment because the resources which in the normal course go to the production of eggs would, perhaps, become available to the parasites. According to Rohde (1982) the difference in male and female fishes is due to the difference in feeding habits.

But most of the studies involving the distribution of helminth parasites of fishes, (Awachie, 1965, 1968; Walkey, 1967; Kennedy and Hine, 1969; Chappel, 1969b; Pennycuik, 1971b; Bibby, 1972; Stromberg and Crites, 1975; Aho and Kennedy, 1984) have shown no relationship between host sex and parasite distribution. In the present study also the prevalence and mean intensity of Philometra cephalus and Rhadinorhynchus indicus showed no statistically significant difference between male and female host fish.

(b) Size of the host:

The prevalence and mean-intensity of infection with Philometra cephalus and Rhadinorhynchus indicus increased with increase in size of the host fishes. This was in accordance with the observations made by Awachie (1965, 1968), Walkey (1967), Chappel (1969b), Kennedy and Hine (1969), Pennycuik (1971b), Bibby (1972), Hine and Kennedy (1974b), Stromberg and Crites (1975), Banning and Becker (1978), and others. Changes in the host's diet was invariably the most frequent explanation given for this phenomenon. Older fish consume more and larger prey items in comparison with smaller fish (Cormack, 1962; Elliot, 1967; Egglishaw, 1967; Neveu and Thiabault, 1977). This would potentially expose fish to a greater number of infected intermediate hosts, and account for the increase in infection parameters with age (Aho and Kennedy, 1984). Price and Clancy (1983) have reported the significance of host size on the distribution of nematodes and acanthocephalans. Walkey (1967), and Bibby (1972) showed the significance of host size on the infection parameters of Neoechinorhynchus rutili. It was correlated with the change in the diet of the host. As the host became large, it consumed more and larger ostracodes which are the intermediate hosts. Dogiel (1958) discussed the change in parasitic infection with age of the fish host and stated that these changes could be caused by changes in the amount and type of food, size of prey, and by accumulation with time.

Muzzal (1980c) showed an increase in the infection parameters of Pomphorhynchus bulbocolli with fish length, and remarked that it may be attributed to an increase in the level of feeding. As the fish increase in size, so does the intestine, therefore, there is more space to attach to and occupy (Thomas ,1964b). Because large fish are feeding more, the possibility of their eating infected amphipodes is increased, thus increasing the prevalence as observed in the present study. It may be added that while looking for the gut contents in Tachysurus maculatus fairly large quantities of amphipod remn nts were also observed. The increase in the prevalence of Acanthocephalus parkside with increase in size of the fish was correlated with therelative changes in the diet composition among fishes of different age groups (Amin, 1975).

Interestingly, the nematode Philometra translucida infecting the gonads of Pseudotolithus senegalensis showed no relationship between the size of the host and infection parameters (Anyanwu, 1983). The prevalence of Neochinorhynchus cristatus infecting Catastomus commersoni decreased with increase in mean length of each fish length class. The difference in prevalence and mean-intensity between small and large fish suggests that small fishes feed on intermediate host more than do larger fishes. This may also indicate a changes in diet as fish increase in size (Muzzal, 1980c).

However, in the present study the infection parameters of Philometra cephalus infecting Valamugil speigleri and Rhadinorhynchus indicus infecting Tachysurus maculatus showed an increase with increase in size of their respective hosts.

(c) Season:

Seasonal variations in the populations of fish helminths have been observed by several authors, and summarised by Kennedy (1970). The present data for Philometra cephalus showed a seasonal pattern for both prevalence and mean intensity. The parasite was completely absent during the monsoon season.

Decrease in worm burden may be related to temperature. Kennedy (1969) had showed that changes in the *Camallanus laticeps* population in dace (*Leuciscus leuciscus*) were temperature related, and later Kennedy and Walker (1969) produced evidence for a temperature - dependent immune response. Kupryanova (1954) observed that the rate of development of *Camallanus oxycephalus* is influenced by water temperature. Rapid development of *C. lacustris* with increase in temperature was observed by Skorping (1980). Nematode maturation in salmon and trout was seasonal, and found to be controlled by temperature (Aho and Kennedy, 1984).

Contracaecum spiculigerum did not show any significant seasonal change in incidence and intensity of infection (Tedla and Fernando, 1969). Arme and Walkey (1970), and Shulman (1979) had observed the influence of water temperature on the biology of cestodes, nematodes and acanthocephalans.

The complete absence of *Philometra caphalus*, in the present study, during monsoon season, could not be attributed to temperature change because the fluctuation in water temperature in the study area during monsoon season is only very little (Muhammad Salih, 1973). Drop in salinity on the other hand during monsoon (Kurup and Samuel, 1987) might have affected the egg stages of P. cephalus, or the copepods which are the intermediate host of Philometra Spp. (Hoffman, 1970) might not be available during monsoon season. The absence of infective larvae might be another factor. So, in addition to the salinity the absence of infective larvae and intermediate hosts may also be contributory to the absence of P. cephalus during monsoon season.

The seasonal periodicity in acanthocephalan infection was observed at various places by many scientists. Bibby (1972) had observed a decrease in the incidence of infestation of Neoechinorhynchus rutili during winter and attributed this to the low feeding habit of the host. The decrease in temperature of water would also result in a decrease in the metabolic rate of the fish during the winter and a decrease in food consumption. Chubb (1964) suggested that temperature might play a major part in the determination of well-defined seasonal periodicity of some acanthocephala.

The seasonal change shown by Pomphorhynchus laevis infecting Cottus gobio was attributed to the size distribution of the host (Rumpus 1975). The fluctuation in the population of Echinorhynchus sp. infecting Grasterosteus aculeatus was correlated with the activity of the host (Pennycuik, 1971). Changes in the population of Echinorhynchus clavula were related to the intensity of feeding habit of the host and the availability of intermediate host (Chubb 1964).

The seasonal infection cycles of Pomphorhynchus bulbocoli reflects the movements of large white suckers into the sampling area (Muzzal ,1980c). In the case of Acanthocephalus parkside the differences in size of the host, white sucker, were partially responsible for the steep increase in worm density during spring (Amin, 1975).

Neochinorhynchus cristortus infecting white suckers and Echinorhynchus salmonis infecting Osmerus mordax showed no seasonal periodicity (Muzzal,1980c;Amin,1981). This apparant lack of seasonal fluctuations in prevalence and mean-intensity of infection might indicate itself as a year - round regularity of recruitment and turn over (Amin, 1981). This might partially explain Kennedy's (1975) observation on P. laevis that increased establishment of worms and decreased feeding activity during the colder months are balanced by worm deaths and increased host feeding activity later in the warm season.

The abundance of Rhadinorhynchus indicus infecting Tachysurus maculatus during monsoon season could be attributed to the peculiar hydrographic features prevaling in Kerala coast. A strong upwelling is regularly observed along the west coast during the whole period of southwest monsoon and this results in the replenishment of nutrients and other food materials (Banse, 1959; Darbyshire, 1967). The availability of food materials naturally might have prompted the fish to consume large quantity of food including the intermediate host and the infective stages of Rhadinorhynchus indicus, and resulted in the highest infection rate during monsoon season. Of particular interest is the fact that more females were infected during this season which is also the spawning period of the host fish. Obviously, the crave for more food during this season attracted them to the inshore region where food, as mentioned earlier, is in plenty. The activity of the host as pointed out by Pennicuik(1971b), and the intensity of feeding and availability of intermediate host as indicated by Chubb (1964) could be the major contributory factors for the observed peak during the monsoon season.

II Copepods :

(a) Sex of the host:

The prevalence and mean intensity of infection of Lernaeenicus ramosus on Nemipterus japonicus and Ergasilus sp. on Tachysurus maculatus did not show much statistically significant variation between the two sexes of the host. But Ergasilus auritus showed a preference to female hosts (Noble et al.,1963). It was related to the presence of female sex hormone or to the absence of male sex hormone, or to a certain kind of behaviour of the female host.

(b) Size of the host:

The mean intensity of infection with Lernaeenicus ramosus on Nemipterus japonicus and Ergasilus sp. on Tachysurus maculatus had shown an increase with increase in size of the host. This was also true for Acanthochondria sp. infecting flat fishes, and was attributed to the activity of the host, area of the gill chamber and size of the gape (Kabata, 1959). Gnadeberg (1949) observed that Ergasilus sieboldi did not locate the host through chemoreception but by physical contact or collision. Thus, the chances of the parasites coming in contact with a larger host might be higher. This factor might be contributory for the present observations.

As the fish become older, the reduction in the movements of the host might have facilitated the parasites for an easy attachment. Accumulation of parasites with time could also be a factor for the increase in mean intensity with age.

As far as prevalence is concerned Lernaeenicus ramosus showed higher prevalence rate in 8-10 cm group and 16-18 cm group. Even though there was some decrease in the intermediate length group, it was not significant statistically. In the case of Ergasilus sp. the prevalence had shown a continuous increase with increase in size of the host. Polyanski (1958) remarked that intensity and prevalence of infection increase with age, and changes in parasite composition reflects changes in host habitat or behaviour. These are applicable to the present observations also.

(c) Season:

The prevalence of Ergasilus sp. did not show any statistically significant variations during different seasons.

This appears to be in agreement with the observations of Sportson and Hartly (1941) that parasites generations are produced continuously. The greater mobility of the free living infective stages of the parasite must also be significant in this respect (Kabata, 1970). But the mean intensity of infection of Ergasilus sp. showed a slight statistically significant variation during different seasons. The highest intensity was during the monsoon period. The reason for this is rather obscure.

The prevalence and mean intensity of Lernaeenicus ramosus showed a clear cut seasonal pattern. As in the case of helminths, the peculiar hydrographic features prevailing during the monsoon season might be one of the factors for the observed peak. Abundance of organic matter and other food materials might have attracted the host towards the inshore waters where free living stages of the parasite might be in plenty which resulted in heavy infestation.

III Isopods

(a) Sex of the host:

In the case of the isopod Agarna malayi infecting Valamugil speigleri, the sex of the host had shown no statistical significance on the distribution. This might be due to the similar behaviour of male and female fish.

(b) Size of the host:

The length of the fish showed some relation to the prevalence and mean intensity of infection. Both increased with increase in size of the fish. As the fish increases in size, so does the branchial chamber. This would provide more area for accomodation of the parasite and might be one of the reasons for increased infection rate.

(c) Season:

The distribution of *Agarna malayi* had shown a clear cut seasonal cycle. The reduction in the prevalence and mean intensity during monsoon period might be due to the unavailability of the free living infective stages or intermediate hosts because of the hydrographical conditions, prevailing during this season. The sudden drop in salinity might have adversely affected the intermediate hosts and free living stages of the parasites.

In conclusion the higher prevalence rate of *Rhadinorhynchus indicus*, *Lernaeenicus ramosus* and *Ergasilus* sp. during monsoon season might be due to the movement of the hosts towards the inshore waters where nutrients as well as infective stages of the parasites and intermediate hosts are present in plenty. A comparison between the prevalence of infection in monsoon, postmonsoon and premonsoon seasons indicated that salinity had apparently no role in determining the prevalence of these organisms. This is due to the fact that during monsoon season the salinity of the inshore waters drops considerably and in pre and postmonsoon it is comparatively high. If salinity had any influence on prevalence, there would not have been a fairly high rate of infection during monsoon and premonsoon seasons when the salinity of water will be low and high, respectively. The effect of host hormone on the prevalence is also doubtful as there is no clear cut variation between the two sex of the host.

Interestingly, the prevalence rate of Agarna malayi and Philometra cephalus have shown that too high and too low salinity might be unfavourable. The higher prevalence rate during post monsoon season substantiate this. They have also shown an affinity towards female fishes, though statistically not significant, and this could be attributed to the presence of female hormones. However, it may be noted that attraction of parasites towards male and female hosts varies from species to species, and a general conclusion is practically impossible.

In general, the prevalence and mean intensity of infection in all host species with parasites increased with increase in size of the host fishes.

CHAPTER III

HISTOPATHOLOGY

Introduction

With the hightened interest in aquaculture throughout the world, and in the developing countries in particular, there will be concurrent increase in problems involving parasites and other disease causing agents. Disease is defined as "any departure from normal structure or function of the animal, due to infectious diseases, parasite invasions, and genetic or environmentally induced abnormalities" (Sinderman, 1970).

Under the heading "invasive diseases" or "parasitic diseases", are included diseased conditions of fishes arising from infections with larger parasites which are non-multiplicative in the host (Sinderman, 1970). The helminth parasites which include trematodes, cestodes, nematodes, and acanthocephalans are of primary importance in this respect. Even though the adult worms are less harmful to fishes, their invasive stages invading the flesh, viscera, visceral organs, the circulatory, nervous, and reproductory systems of the host are of much importance in fish pathology. The effects of the worm larvae on the host are growth retardation, tissue disruption, metabolic disturbances, and death. The fish will also become unable to escape predators and to survive variations in physical environments. These parasites can also affect the fish by blinding them, by making them more conspicuous, or by altering their behaviour in ways that render fish more vulnerable for predation.

Sinderman (1970) had postulated three possibilities for the outbreak of fish disease: (a) the pathogen may be newly introduced in a susceptible population (b) infection pressure (dosage) or virulence of the pathogen must increase, and (c) resistance of the population must be lowered. Besides helminths, crustaceans are also equally dangerous to fishes.

Damage to the host tissue caused by crustaceans appears to be constant with the type and intensity of the mechanical activity, and its attendant influence exerted by the crustaceans. The severity of the effects also depends on the intensity of infection. But the most dangerous ill effects produced by crustaceans are the secondary infections by bacteria through the wounds produced by crustaceans.

The importance of disease caused by metazoan parasites in marine fish population of commercial significance has not been adequately studied. Only in recent years more than sporadic attention has been given to diseases of marine animals (Kinne, 1980) and even now this attention is often restricted to periods of disease outbreak in a particular species. The recent review by Sinderman (1984) clearly indicates the shortcomings in dealing with disease problems in marine aquaculture programmes. The economic effects parasitism include discarding of otherwise edible fish products, delay in processing technology, possible loss of oil yields, reduction in the numbers of food fish available to the fishery, weight loss by diseased individuals and rejection of abnormal fish by consumers. The reason for the fluctuation shown in the supply of commercially exploited fishes may be attributed to diseases.

Bauer (1958) had reviewed the effects of parasites on the host under the following sub-headings. They are:- (a) mechanical effects, (b) consumption of host food, (c) parasites act as vectors of other parasites, (d) influence of infestation on non-specific sites, (e) the influence of parasites on the growth condition of fishes, and (f) influence of parasites on the size of the fish population. He had also catagorised the reactions of the host as, hypertrophy, inflammation, metaplasia, and immunity.

In order to understand the actual changes produced in the host body as a result of parasitic invasion, a gradual change in emphasis from pathogen to pathology is unavoidable in the course of development of fish pathology.

The importance of histopathology in elucidating the influence of parasites on the host has been pointed out by many authors. Kabata (1970, 1981) had made two extensive reviews on the histopathological changes of fish body brought about by the attack of crustaceans. A few acanthocephalan parasite-host system had been studied with respect to intestinal histopathology by Venard and Warfel (1953), Prakash and Adams (1960), Bullock (1963), Chaicharan and Bullock (1967), Abe (1973), and George and Nadakal (1978). The literature on the pathology of nematodes are very scanty. But the works of Ekbaum (1933), Wierzbicki (1960) and Ramachandran (1975) are some milestones laid in this field.

Considering the importance of histopathology an attempt is made to study the histopathological changes brought about by Ergasilus sp. on Tachysurus maculatus, Agarna malayi and Philometra cephalus on Valmugil speigleri, and Lernaeenicus ramosus Nemipterus japonicus. This study becomes relevant considering the fact that all the three host fishes are of immense commercial importance.

Materials and methods:

The infected gonads of V. speigleri with the nematode, Philometra cephalus insitu were fixed in Bouin's fluid. Paraffin sections were cut at 6-8 micron thickness, stained with Harris haematoxylin and counterstained with eosin, dehydrated in graded series of ethyl alcohol, cleared in xylene, and mounted in Canada balsm.

The intestine of T. maculatus infected with the acanthocephalan, Rhadinorhynchus indicus was washed in physiological saline, and fixed in Carynoy's fluid. Subsequently, it was split longitudinally in to two and cut into small peices. Paraffin sections of 6-8 micron thickness were taken, stained with Harris haematoxylin and counter-stained with eosin, dehydrated in graded series of ethyl alcohol, cleared in xylene, and mounted in canada balsm.

The gills of _T. maculatus_ and _V. speigleri_ infected with _Ergasilus_ sp. and _Agarna malayi_, respectively and the body part of _N. japonicus_ where _Lernaeenicus ramosus_ were attached were fixed in Bouin's fluid and decalcified in 8% formic acid for 24-48 hrs. Paraffin sections of 6-8 micron thickness were taken. Sections were stained with Harris haematoxylin, counterstained with eosin, dehydrated in graded series of ethyl alcohol, cleared in xylene, and mounted in Canada balsm.

The same tissues from uninfected specimens processed exactly in the same manner served as controls.

Observations:

In _V. speigleri_, the ovary infected with _Philometra cephalus_ was less glossy in appearance. Infected ovary was swollen when compared with the uninfected one. Fibrosis of the ovarian tissue, atrophy, displacement, and haemorrhage of primary and secondary oocyte was observed. The movement and feeding of the worm produced severe mechanical damage to the ovary. A continuous increase in the deposition of a black pigment was observed (Plate I, Figs. XXI, XXII).

The acanthocephalan parasites, _Rhadinorhynchus indicus_ found in the intestine of _T. maculatus_ was not found attached to the intestinal wall. They were lying freely in the intestine. Except the partial blocking of the intestinal lumen not much pathological changes could be observed (Plate II, Figs. XXIII, XXIV).

The gill filaments of _T. maculatus_ infected with _Ergasilus_ sp. showed hypertrophy at the point of attachment. The irritation and damage produced by the feeding activity of the parasite caused hypertrophy. Fusion of adjecent gill filaments was also observed(Plate

The operculum of V. speigleri which harboured Agarna malayi became transperent due to the complete destruction of tissues covering it leaving the calcarious skelton alone. Presence of the parasite on the gills resulted in the destruction of gill filaments. Filaments were found broken at many places, thus reducing the surface area of gill available for respiration. There was excess mucours production (Plate IV, Figs. XXVII, XXVIII, XXIX, XXX).

The copepod Lernaenicus ramosus infecting N. japonicus produced ulcer-like opening at the point of attachment. The scales at the point of attachment were distrorted. The skin surface was found to be hyperaemic and swollen. Degeneration of muscular bundles was found around the bulla of the parasite that penetrated in to the muscle (Plate V, Figs. XXXI, XXXII).

Discussion:

Pathological effects of Philometra sp. had not been studied extensively. Ekbaum (1933) observed swellening of host fishes infected with P. americana. Wierzbicki (1960) reported mass mortality of Carassius carassius infected with P. sanguines. The destruction of the ovary of Otolithus argentius due to infection with Philometra sp. was pointed out by Annigeri (1962). Ramachandran (1975) studied the pathology of P. cephalus infecting Mugil cephalus and reported that heavily infected fishes were less glossy and more silvery in appearance, and were lacking in flavour and taste of healthy fish. Heavily infected ovary was much swollen. Atrophy of the ova, fibrosis and hemorrahage and deposition of black pigment were also observed. This was true in the present study also. Anyanwu (1983) reported that the low facundity observed in the infected ovaries of Pseudotolithus typus with Philometra translucida could be due to the feeding of matured eggs by the parasite. He had also indicated the posibility of preventing germinal epithelium from producing ovarian follicles. However, in the present study the fecundity of host fish was not studied.

The extent of damage causeu by acanthocephalan worms on their fish host depends mainly on the amount of worm burden and the degree of penetration of proboscis ofworm into the host tissue. Observations of George and Nadakkal (1978, 1982) on the intestinal pathology of Rachycentron canadus infected with Serrasentis nadakali, and Synaptura orientalis infected with Echinorhynchus veli showed hyperplasia of connected tissue, metaplasia of epithelial cells, and hypertrophy of muscles cells. This was agreeable with the observations of Bullock (1963) in salmonid fishes infected with Acanthocephalus jacksoni. Necrosis of cells due to acanthocephalan infection was reported by Prakash and Adams (1960). Neither deep penetration nor nodule formation was observed in the gut of brown trout infected with Echinorhynchus truttae by Marochino (1926). The present observation of complete absence of pathology due to the presence of Rhadinorhynchus indicus in the intestine of T. maculatus agrees with report of Hyman (1951) which showed that massive worm infections apparantly had no harmfull influence on their host and it was attributed to the fact that only certain host parasite combinations alone are capable of producing any pathogenic responses.

The present observations on the nature of damage caused by Ergasilus sp. on the gills of T. maculatus agree with work of Neuhas (1929). It is an established fact that the diet of Ergasilus sp. mainly includes host's blood (Kabata, 1970). The hypertrophy and fusion of gill filaments is due to the feeding activity of the parasite. The mucus production may be an immune response of the fish to remove the parasite. But the mucus layer cutts off the contact of the gill filaments with water by which respiration is hindered. Since gills become ulcerated secondary bacterial infection may result. Paperna (1975) had reported heavy loss of mullets due to Ergasilus in Israel.

The harmful influence of isopoda on their fish host is a controversial matter as experts are uncertain about their mode of feeding. The most serious effect of isopod is the destruction of the gill filaments resulting from the pressure exerted by the parasite (Kabata, 1985). This was found to be true in the present study also In addition to the destruction of the tissues of the opercular chamber as observed in the present study, the presence of the parasite in the operculum might hinder the movements of operculum thus causing respiratory disorders as reported by Kabata (1985). The destruction of the gill filaments due to the presence of the parasite will considerably reduce the surface area of gills and thus respiration is affected which may lead to emaciation. Borgea (1933), Bowman (1960), and Turner and Roe (1967) had reported partial atrophy of the gill filaments due to the presence of isopods. Deformation of the mouth due to isopod infection was reported by Hildebrand (1963).

Details regarding the pathology of parasites of the genus _Lernaeenicus_ are very scanty. The present observations on the pathology of _Lernaeenicus ramosus_ on the skin and muscles of _N. japonicus_ agree with the works of Baudouin (1905, 1910, 1917), Joubin (1888) and Musselius (1967). Boudouin (1905) reported the damage produced in the vertebral column of fish infected with _Lernaeenicus encrasicholus_. He, (Baudouin, 1910) had also studied the damage caused by _Lernaeenicus sprattae_ in the eye of infected fishes. The pigmented swelling around the point of attachment of _Lernaeenicus sprattae_ infecting sardine on the atlantic coast of France was studied by Baudouin (1917) and it agrees with the present observation. Joubin, way back in 1988 had reported the production of very deep abscesses in the sardine by the same parasite and it is true in the case of _L. ramosus_ also. The formation of tissue ulcers, and damage to the scales can be attributed to the mechanical activity of the parasite during penetration.

Conclusion:

In conclusion, except the Acanthocephalid worm, _Rhadinorhynchus indicus_, all other parasites produced damages of varying extent on their hosts. The extent of damage invariably depends on the severity of attack. The direct adverse effects of the damage also vary from minor irritations to death of the host fish, and indirectly it leads to secondary microbial infection.

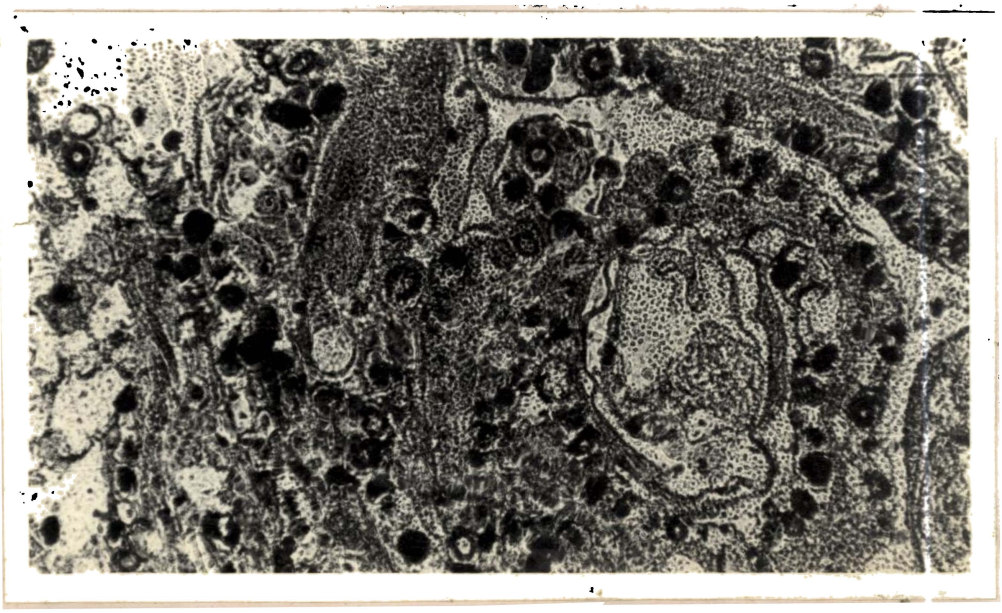
......

PLATE I

Fig. XXI Normal ovary of Valamugil speigleri. (x 400)

Fig. XXII Ovary of Valamugil speigleri infected with Philometra cephalus. (x 400)

PLATE I



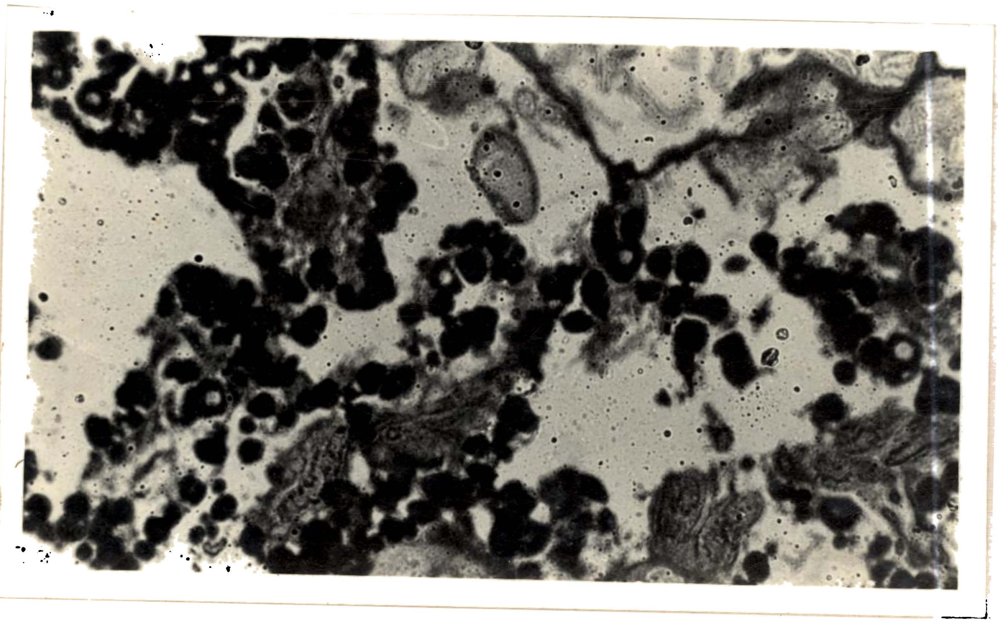


Fig. XXII

PLATE II

Fig. XXIII Normal intestine of Tachysurus maculatus. (X 400)

Fig. XXIV Intestine of Tachysurus maculatus infected with Rhadinorhynchus indicus. (X 400)

PLATE II

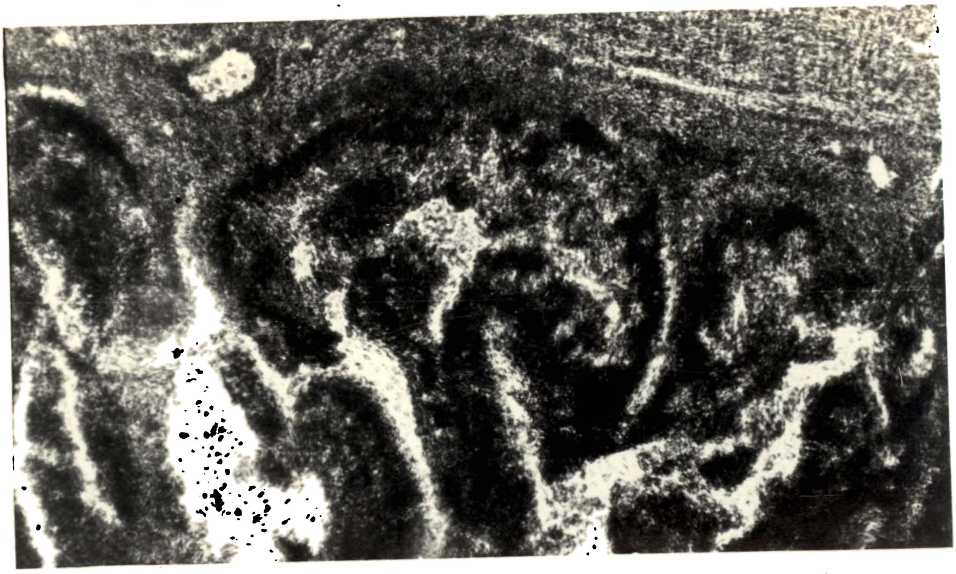


Fig. XXIII

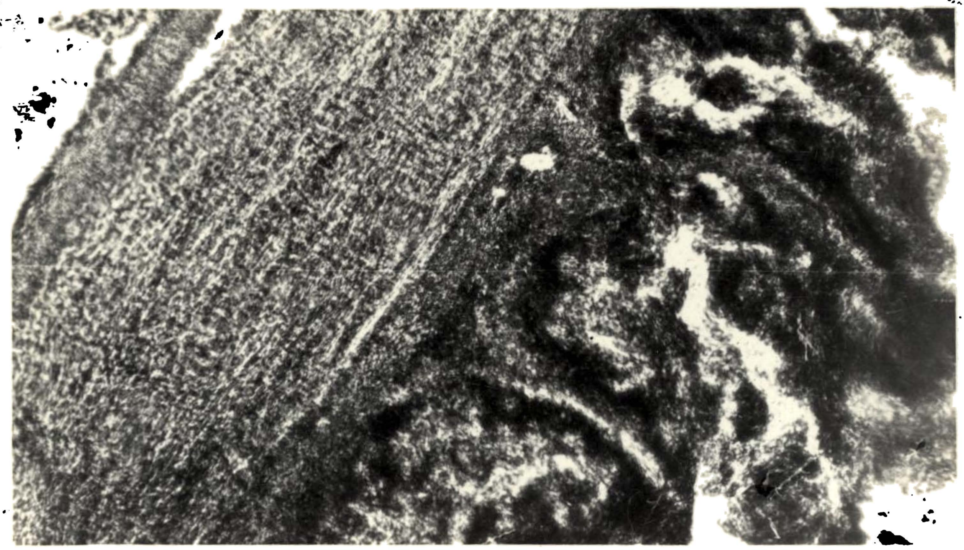


Fig. XXIV

PLATE III

Fig. xxv Normal gill filament of Tachysurus maculatus. (x 200)

Fig. XXVI Gill filament of Tachysurus maculatus infected with Ergasilus sp. (x 200)

PLATE III

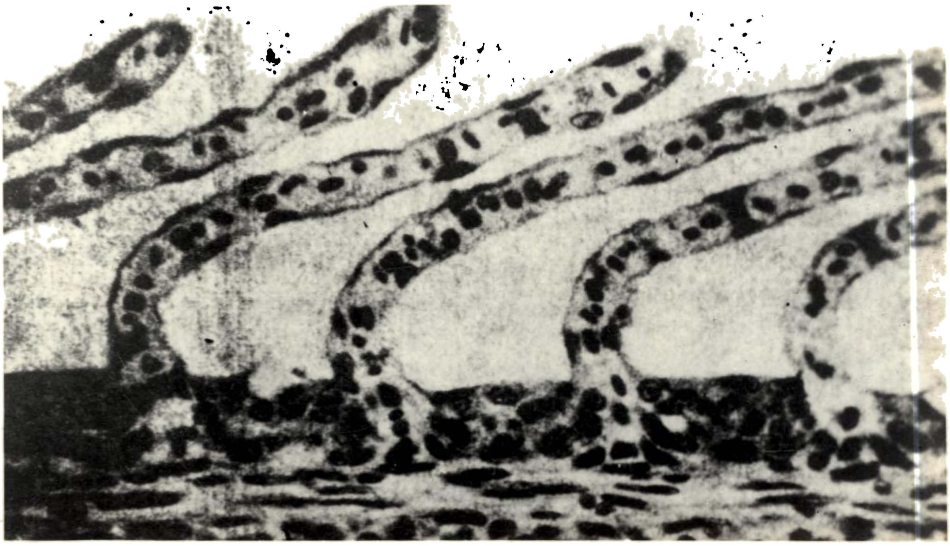


Fig. xxv

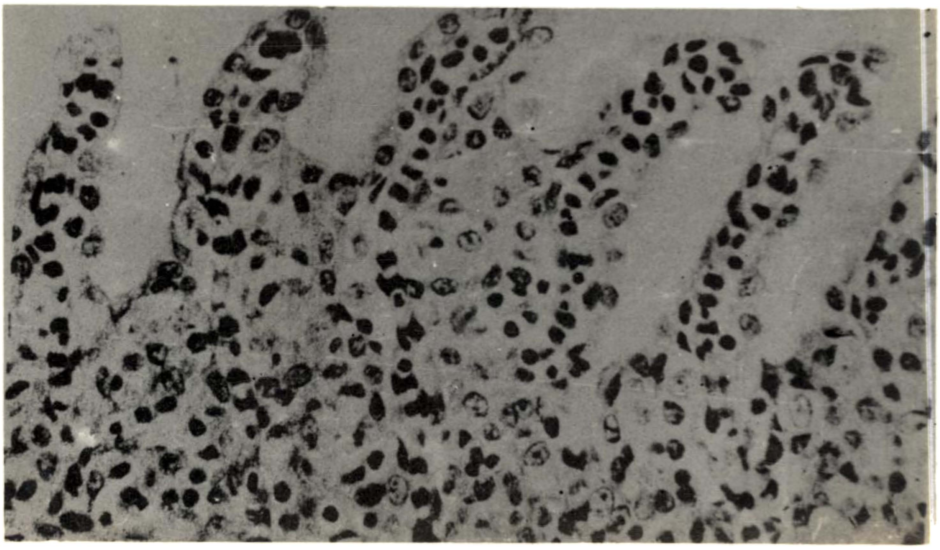


Fig. XXVI

PLATE IV

Fig. XXVII Operculum of Valamugil speigleri infected with Agarna malayi.

Fig. XXVIII Operculum of Valamugil speigleri with Agarna malayi showing mode of attachment of the parasite.

PLATE IV

Fig. XXVII

Fig. XXVIII

PLATE V

Fig. XXIX Normal gill filament of Valamugil speigleri. (x400)

Fig. XXX Gill filament of Valamugil speigleri infected with Agarna malayi. (x400)

PLATE V

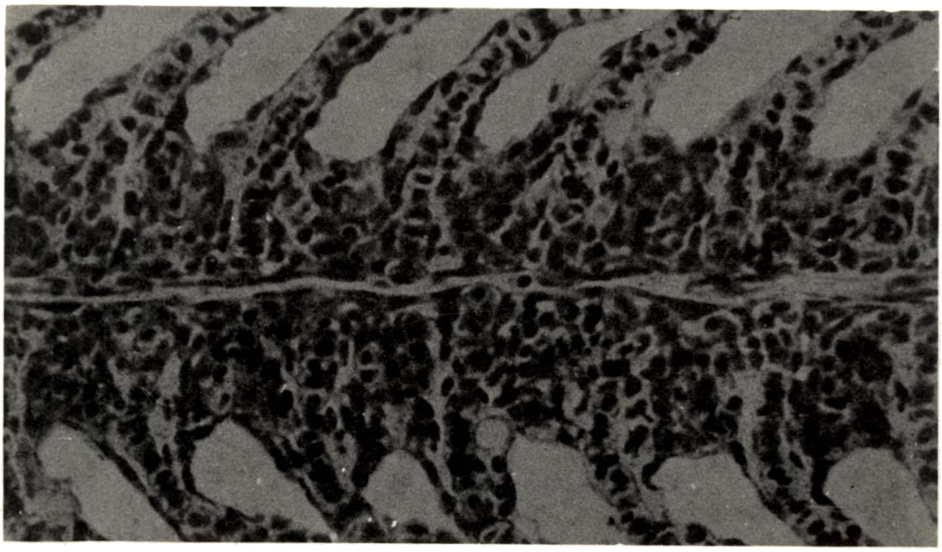


Fig. XXIX

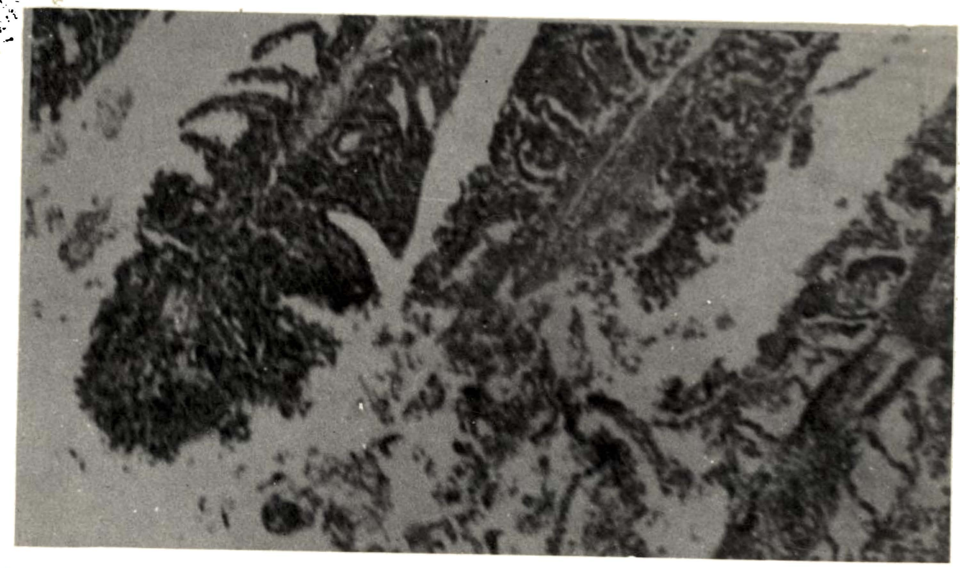


Fig. XXX

PLATE VI

Fig. XXXI Normal muscle of *Nemipterus japonicus*. (×400)

Fig. XXXII Muscle of *Nemipterus japonicus* at the point of attachment of *Lernaeenicus ramosus*. (×400)

PLATE VI

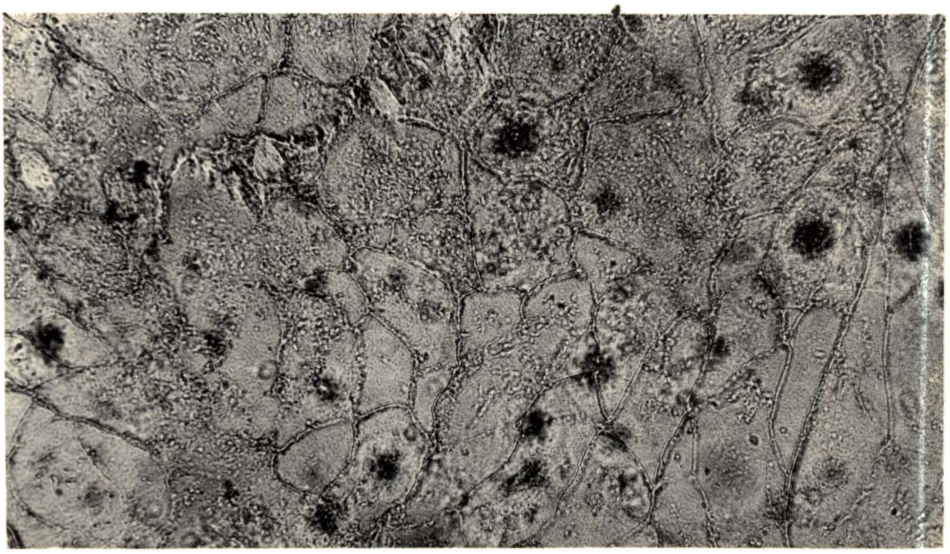


Fig. XXXI

Fig. XXXII

SUMMARY

In chapter one the literature related to the prevalance, mean intensity of infection, and histopathological changes caused by the metazoan parasites, in particular by helminths, copepods and isopods, was reviewed.

Chapter two contains observations on the distribution pattern of parasites in relation to the season, sex, and size of the host. It was found that the prevalence rate of *Rhadinorhynchus indicus* infecting the alimentary canal of *Tachysurus maculatus*, *Ergasilus* sp. infecting the gills of *T. maculatus*, and *Lernaeenicus ramosus* found on the body surface of *Nemipterus japonicus* was higher during monsoon season. But *Agarna malayi* found in the opercular chamber and *Philometra cephalus* infecting the gonads of *Valamugil speigleri* showed a higher prevalence rate during the postmonsoon season. This was discussed on the basis of the hydrographical characteristics prevailing in the study area during the three different seasons. It was also observed that the sex of the host did not influence significantly the distribution pattern of the parasites. The reasons for this were also discussed. Invariably, the size of the host was found to influence the parasite distribution pattern. It was observed that the prevalence rate showed an increase with increase in size of the fish. This was discussed on the basis of food habits of the host, along with other aspects.

An attempt was made in chapter three to study the histopathological effects of the various parasites on their respective sites of attachments on host fishes. It was found that except Rhadinorhynchus indicus, all other parasites produced damages of varying intensity, in the form of hypertrophy, hyperplasia, haemorrhage, tissue disruption and ulcers. Interestingly, *R. indicus*, an acanthocephalid with a powerful proboscis for attachment was found not to cause any serious damage to the intestine of the host fish. All these aspects are included in the third and final chapter of the thesis.

.....

REFERENCES

Abe, I. 1973. Histopathological observations on granuloma caused by acanthocephalan infections in Rainbow trout. Fish. pathology. 7 : 97-102.

Abrosove, V.N; and O.N. Bauer. 1959. Ergasilosis of Coregonus peled in the lakes of the PSKOV District. (In Russian). IZV. Nauch - Issled, Inst. Ozer. Rech. Ryb. Khoz. 49 : 213-126.

Abrosov, V.N; O.N. Bauer; R.I. Bikkulov and I.A. Pavlov. 1963. Further observations on ergasilosis of Coregonus peled in the lake of the Leningrad economic region, (In Russian). Izv. Nauch - issled, Inst. Ozer. Rech. Ryb. Khoz. 54 : 100-105.

Aho, J.M; and C.R. Kennedy. 1984. Seasonal population dynamics of the nematode Cystidicoloides tenuissima (zeder) from the river Swincombe, England. J. Fish. Biol, 25 : 473-489.

Aleshkina, L.D. 1982. Parasite fauna of the cape lake : species composition as depend on the host age. Girdobiol. ZH. 18 : (1) : 65-68.

Amalcher, E. 1970. Text book of fish diseases. Trans: D.A. Conroy and R.L. Herman. Neptune, N.I.T.F.H. Publishes.

Amin, O.M. 1975. Host and seasonal associations of Acanthocephalus parksidei, Amin,1974,(Acanthocephala : Echinorhynchidae) in Wisconsin fishes. J. parasit. 61 : (2) : 318-329.

Amin, O.M. 1978. Effect of host spawning on Echinorhynchus salmonis Muller, 1784 (Acanthocephala : Echinorhynchidae) maturation and localization. J. Fish. Disease. 1 : 195-197.

Amin. O.M. 1981. The seasonal distribution of Echinorhynchus salmonis (Acanthocephala : Echinorhynchidae) among rainbow smelt, Osmerus mordax. Mitchell, in lake Michigan. J. Fish. Bio. 19 : (4) : 467-474.

Amin, O.M. and J.M. Burrows. 1977. Host and seasonal associations of Echinorhynchus salmonis (Acanthocephala : Echinorhynchidae) in the Lake Michigan fishes. J. Fish. Res. Bd. of Canada. 34 : 325-331.

Ananthakrishnan, R; B. Parthasarathy; and J.M. Pathan. 1979. Meteorology of Kerala. In : "contributions to marine sciences". 60-125.

Anantharaman, S. 1980. Sex ratio in Acanthosentis oligospinus an acanthocephalan parasite of the brackish water fish Mystus gulio. Current Sci. 49 : (22) : 876.

Anderson, R.M. 1974. An analysis of the influence of host morphometric features on the population dynamics of Diplozoon paradoxum (Nordmann, 1832). J. Anim. Eco. 43 : 873-887.

Anderson. R.M. 1976a. Seasonal variation in the population dynamics of Caryophyllaeus laticeps. Parasitology, 72 : 281-305.

Anderson, R.M. 1976b. Dynamic Aspects of parasite population ecology. In. (Kennedy. C.R. ed.) "Ecological aspects of parasitology." 431-461. Amsterdam. North-Holland Publ. Co.

Anderson, R.M. 1981. The change with host age of the composition of the Ancyrocephaline (monogenea) populations of parasites on thick-lipped grey mullets at Plymouth. J. Mar. Biol. Ass. U.K. 61 : (4) 833-842.

Anderson, R.M; and R.M. May. 1979. Population biology of infectious diseases. Part. I. Nature, 280 : 361-367.

Andrews, C.R, and A. Rojanapaibul. 1976. The ecology of Acanthocephalus clavula in the fish of Llyn Tegid, North wales. Parasitology. 73 : 11-12.

Annigeri, G.G. 1962. A viviparous nematode, Philometra sp. in the ovaries of Otolithus argenteus (cuvier) J. Mar. Biol. Assoc. India. 3 : 263-265.

Anyanwu, A.O. 1983. Parasitic infestations of Pseudotolithus sp. off the coast of Lagos. Nigeria. J. Fish. Biol. 22 : 29-33.

Arme, C; and D.W. Halton. 1972. Observations on the occurrence of Diclidophora merlangi (Trematoda : monogenea) on the gills of whiting, Gadus merlangus. J. Fish. Biol. 4 : 27-32.

Arme, C; and R.W. Owen. 1967. Infection of the three-spined stickle back, Gasterosteus aculeatus, L. with the plerocercoid larvae of Schistocephalus solidus (Muller, 1776) with special reference to pathological effects. Parasitology 57 : 301-324.

Arme, C; and M. Walkey. 1970. The physiology of fish parasites. In. "Aspects of fish parasitology". (A.E.R.Taylor and R. Muller, eds) . 79-101. Blackwell, Oxford.

Arthus, J.R; and H.P. Arai. 1980. Studies on the parasites of Pacific herring, Clupea harengus : a preliminary evaluation of parasites as indicators of geographical origin for spawning herring. Can. J. Zool. 58 : (4) : 521-527.

Arthur, J.R; M.L. Margolis; D. Whitaker; T.E.Mc Donald. 1982. A quantitative study of economically important parasites of Walleye pollock (Theragra chalcogramma) from British Columbea waters and effects of postmortom handling on their abundance in the musculature. Can. J. Fish. aquat. sci. 39 : (5) : 710-726.

Ashley, D.C. 1981. Observations on the population biology of three acanthocephalans in a Great Plains reservoir. Dissertation Abtr. inter(B). 41 : (11) : 4030-4031.

Awachie, J.B.E. 1965. The ecology of Echinorhynchus truttae Schrank, 1788 (Acanthocephala) in a trout stream in north wales. Parasitology. 55 : 747-762.

Awachie. J.B.E. 1968. On the bionomics of Crepidostomum metoecus (Braun, 1900) and Crepidostomum farionis (Muller, 1784) (Trematoda : Allocreadidae). Parasitology. 58 : 307-324.

Awachie, J.B.E. 1973. Ecological observations on Metabronema truttae Baylis, 1935 and Cystidicola farionis Fischer V.Waldheem 1798. (Nematoda, Spiruroidea) in their intermediate and definitive hosts, in Afon Terrig.Acta.Parasit. Pol. 21 : 661-670.

Baker, R.O. 1977. "An ecological study of parasitism in estuarine fishes". Dissertation. Abst. Inter. 378 : 4272.

Balciunas, D; R. Petkeviciute. 1985. Some data on the distribution of Acanthocephalans in the populations of mallards in lake zuvintas. ACTA. Parasitol. Litu. 21 : 114-124.

Banning, P.V; and H.B. Becker. 1978. Longterm survey data (1965-1972) on the occurence of Anisakis larvae (Nematoda:Ascardida) in herring, Clupea harengus L. from the North Sea. J.Fish. Biol. 12 : 25-33.

Banse, K. 1959. On upwelling and bottom trawling off the south west coast of India. J. Mar. Biol. Assoc. India. 1 : 33-49.

Banse, K. 1968. Hydrography of the Arabian sea shelf of India and Pakistan and effects on demersal fishes. Deep ea es. 15 : 45-79.

*Baudouin, M. 1905. Du mode fixation dorsale du Lernaeenicus sardinae sur son hote. C.R. Acad. Sci. Paris. 140 : 326-327.

*Baudouin, M. 1910. Mode of fixation du Lernaeenicus sardinae M.B.Sur I'ocil de la sardine (Clupea pilchards). Ass. Franc.Adv. Sci. Not. Mem. 38 : 651-662.

*Baudouin, M. 1917. Une nouvelle maladie du spratt (Clupea spratta) causee par un copepode parasite (Lernaeenicus sardine). C.R. Acad. Sci. Paris. 165 : 410-411.

Bauer, O.N. 1958. Relation between host fishes and their parasites. In "Parasitology of fishes"(V.A.Dogiel,G.K.Putrushevski, Yu.L.Polyanski eds.), Leningrad Univ.Press, Leningrad. (Transl. Z. Kabata. 1961. 364 pp. Oliver and Boyd. Edinburgh. 84-103).

Bauer. O.N. 1959a. Ecology of parasites of the fresh water fishes (In Russian). Izv. Nauch-issled. Inst. Ozer. rech. Ryb. Khoz. 49 : 5-206. (English) transilation-Israel program for scientific Translations 1962, Cat. No.662: 3-189.

Bauer, O.N. 1959b. The influence of environmental factors on reproduction of fish parasites. Translation. , Fish.Res. Bd. of Canada. Transilation No. 1099.

Bauer, O.N. 1980. Population ecology of fish parasites recent state and perspectives. Parazitologicheskii sb. Leningrad. 29 : 24-34.

Bauer, O.N; V.A. Musselius; and Yu. A. Strelkove. 1973. Diseases of pond fishes. Jerusalem - Israel programme for scientific transilations.

* Becker, I. 1942. Die Abweshreinrichtungen Von Haut und kiemen besim karpfen gegenuber mechanischen, chemischen und parasitaren Reizen. Intern. Rev. Ges.Hydrobiol.Hydrogr. 41 : 265-344.

Bell, D.E; and R.D. Hoyt. 1980. Prevalence and intensity of Capillaria catostomi (Nematoda : Trichuroidea) in white sucker (Catostomus commersoni) in southern Lake Huron, Canada. Environmental Biol. Fishes. 5 : (3) : 267-271.

Benda, R.S. 1979. Infestation rates of Argulus africanus Thiele,1900 and Dolops ranarum Stuhlmann, 1891 (Brachiura) on Bagrus docmac Forskal, 1775 in Kavirondo Gulf, Lake Victoria. Crustaceana. 36 : (2) : 190-194.

Bibby, M.C. 1972. Population biology of the helminth parasites of Phoxinus phoxinus (L); the minnow, in a Cardiganshire lake. J. Fish. Biol. 4 : 289-300.

Bird, P.M. 1981. The occurence of Cirolana borealis (Isopoda) in the hearts of sharks from Atlantic coastal waters of Florida. Fishery Bull. U.S. natn. ocean. atmos. Admn. 79 : (2) : 376-383.

Black, G.A. 1981. Metazoan parasites as indicators of movements of anadromous brook charr (Salvelinus fontinalis) to sea. Can. J. Zool. 59 : (10) : 1892-1896.

Black, G.A. 1982. Gills as an attachment site for Salmincola edwardsii (copepoda. Lernaeopodidae) J. parasit. 68 : 1172-1173.

Black, G.A. 1983. Abdundance and distribution of Salmincola edwardsii (copepoda) on anadromans brook trout, Salvelinus fontinalis, (Mitchill) in the Moisie River system, Quebec. J. Fish. Biol. 22 : 567-575.

Black, G.A; and M.W. Lankaster. 1981. The transmission, life span, and population biology of Cystidicola cristivomeri white 1941 (Nematoda : Habronematoidea) in charr, Salvelinus spp. Can. J. Zool. 59 : (3) : 498-509.

Bloom, B.R. 1979. "Games parasites play : how parasites evade immune surveillance". Nature. 279 : 21-26.

* Borgea, M.I. 1933. Livoneca pontica nov. sp; copepoda parasite des aloses et sardines de la mer noire. Bull. Museum Nat. Hist. Nat. (Paris). (2) : 5 : 128-129.

Bortone, S.A; W.K. Bradley, and J.L. Oglesby. 1978. The host-parasite relationship of two copepod species and two fish species. J. Fish. Biol. 13 : 337-350.

Bose, K.C; and A.K. Sinha. 1983a. Gastric pathology and higher mucoid secretion in Heteropneustes fossilis infected by the nematode Procamallanus spiculogubernaculus (Agarwal). Science cult. 49 : (7) : 213-214.

Bose, K.C; and A.K. Sinha. 1983b. Histqpathology of Clarius batrachus (L) attributable to the intestinal cestode Lytocestus indicus (Moghe). Proceedings. Nat. Acad. Sci. India(B). 53 : (3) : 226-230.

Bose, K.C; and A.K. Sinha. 1983c. Studies on effects of helminth parasites on the hydrogen ion concentration of infected organs of fishes. Science cult. 49 : (2) : 48.

Bowman, T.E. 1960. Description and notes on the biology of Lironica puhi n sp. (Isopoda : Cymathoidae), parasite of the Hawaiian moray eel, Gymnothorax eurostus. Crustaceana. 1 : 84-91.

Boxrucker, J.C. 1979. Effects of thermal effluent on the incidence and abundance of the gill and intestinal metazoan parasites of the black bull head. Parasitology. 78 : 195-206.

Boxshall, G.A. 1974. The population dynamics of Lepeopththeirus pectoralis (Muller) dispersion pattern. Parasitology. 69 : 373-390.

Brown, A.F. 1986. Evidence for density - dependent establishment and survival of Pomphorhynchus laevis (Muller 1776) (Acanthocephala) in laboratory infected Salmo gairdneri (Richardson) and its bearing on wild populations in Luciscus cephalus (L). J.Fish.Biol. 28 : (6) : 659-669.

Bullock, W.L. 1963. Intestinal histology of some salmonid fishes with particular reference to the histopathology of Acanthocephalan infections. J.Morph. 112 : 23-44.

Burn, P.R. 1980. Density dependent regulation of a fish trematode population. J.parasit. 66 : (1) : 173-174.

Campbell, R.A; R.L. Haedrich; and T.A. Munroe. 1980. Parasitism and ecological relationships among deep-sea benthic fishes. Mar. Biol. 57 : 301-313.

Cannon, L.R.G. 1972. Studies on the ecology of the papillose allocreadid trematodes of the yellow perch in Algonquin park, Ontario. Can. J. Zool. 50 : 1231-1239.

Cannon, L.R.G. 1977. Some ecological relationships of larval ascaridoids from south eastern Queensland marine fishes. Int. J.Parasit.1 : 227-232.

Chaicharan, A; and W.L. Bullock. 1967. The histology of acanthocephalan infections in suckers with observations on the intestinal histology of two species of catastomoid fishes. Acta. Zool. Stockh. 48 : 19-42.

Chappel, L.H. 1969a. The parasites of three spined stickle back. Gasterosteus aculeatus L. from a Yorkshine pond. I. seasonal variation in parasite fauna. J.Fish.Biol. 1 : 137-152.

Chappel, L.H. 1969b. The parasites of three spined stickle back Gasterosteus aculeatus L. from a Yorkshine pond II. variation of parasite fauna with size and sex of fish. J. Fish. Biol. 1 : 339-347.

Cheung, P.J; R.F. Nigrelli; G.D. Ruggieri; and A. Cilia. 1982. Treatment of skin lesions in captive lemon sharks Negaprion brevirostris(Poey), caused by monogeneans Dermophthirius sp. J. Fish. Disease.5 : 167-170.

Chinabutr, S. 1981. Study on parasitic fauna and their seasonal abundance of Kryptopterus apogon (Bleeker) from Ubolratane reservoir. Thai. fish. zaz. 32 : (2) : 179-182.

Chubb, J.C. 1964. Observations on the occurence of the plerocercoids of Traienophorus nodulosus (pallas, 1781) (cestoda: Pseudophyllidae) in the perch Perca fluviatilis L. of Liyn Tegid (Bala lake), Merionethshire. Parasitology. 54 : 481-491.

Chubb, J.C. 1967. A review of seasonal occurence and maturation of tapeworms in British freshwater fish. Parasitology. 57 : 13-14.

Chubb, J.C. 1977. Seasonal occurence of helminths in freshwater fishes part I. Monogenea. Adv. Parasit. 15 : 133-199.

Chubb, J.C. 1979. Seasonal occurence of helminths in freshwater fishes. Part II. Trematoda. Adv. Parasit. 17 : 141-313.

Chubb, J.C. 1982. Seasonal occurrence of helminths in freshwater fishes. Part IV. Audlt cestoda, Nematoda and Acanthocephala. Adv. Parasit. 20 : 1-292.

Chubbrik, G.K. 1952. Larval stage of the trematode Fellodistomum fellis from invertebrates of the Barents sea. Zool. zh. 21 : 5.

Clelland, M.G; R.K. Misra; and D.J. Marcogliese. 1983. Variation in the abundance of larval anisakines, seal worm (Phocanema decipiens) and related species in scotian shelf cod and flat fish. Can. Teh. Rep. Fish. Aquat. Sci. No. 1202.

Collard, J.C. 1970. Some aspects of host-parasite relationships in Mesopelagic fishes. In :. A symposium on Diseases of fishes and shell fishes. Special Publn. No. 5. American Fishery Society, Washington, D.C.

Cone, D.K; and M.D.B. Burt. 1981. The invasion route of the gill parasite Urocleidus adspectus Muller, 1936 (Monogenea. Ancyrocephalinae) Can. J.zool. 59 : (11) : 2166-2171.

Conneely, J.J; and T.K. Mc Carthy. 1986. Ecological factors influencing the composition of the parasite fauna of the European ell. Auguilla auguilla (L) in Ireland. J. Fish. Biol. 28 : 207-219.

Connor, R.S. 1953. A study of the seasonal cycle of a protocephalan cestode, Protecephalaus stizostethi Hunter and Baugham, found in yellow pikeperch. Stizostedion vitreum (Mitchill). J. parasit. 39 : 621-624.

Cooper, C.L; J.L. Crites; and D.J.S. Fastkie. 1978. Population biology and behaviour of larval Eustroqylides tubifex (Nematoda: Dictophymatida) in Poikilothermic hosts. J. parasit. 64 : (1) : 102-107.

Cormack, J.C. 1962. The food of young trout (Salmo trutta) in two different becker. J. Animal. Ecol. 31 : 305-316.

Cressey, R.F; and M. Schotte. 1983. Three new species of Colobomatis (Copepoda : philichthyidae) parasitic in the mandibular canals of haemulid fishes. Proc. Biol. Soc. Wash. 96 : (2) : 189-201.

Crofton, H.D. 1971a. A quantitative approach to parasitism. Parasitology. 62 : 179-193.

Crofton, H.D. 1971b. A model of host parasite relationship. Parasitology. 63 : 343-364.

Crompton, D.W.T. 1973. The sites occupied by some parasitic helminths in the alementary tract of vertebrates. Biol. Rev. 48 : 27-83.

Czeczuga, B. 1980. Carotenoids in fish. II. carotenoid level in tench, Tinca tinca (L) affected by the presence of parasitising Ergasilus sieboldi Nordm. (Crustacea, Copepoda). Acta. Parasit. Pol. 27 : (12) : 101-107.

Dailey, M.D; L.A. Jensen; and B.W. Hill. 1981. Larval anisakis round worms of marine fishes from southern and central California with comments on public health significance. California. Fish. Game. 67 : (4) : 240-242.

Damodaran, R; and C. Hridayanathan. 1966. Studies on the mud banks of the Kerala coast. Bull. Dep. Mar. Biol. Oceano. 2 : 61-68.

Darbyshire, M. 1967. The surface waters off the coast of Kerala, south-west India. Deep-sea. Res. 14 : 295-320.

Davey, J.T. 1972. The incidence of Anisakis sp. larvae (Nematoda: Ascaridata) in the commercially exploited stocks of herring (Clupea harengus) in British and adjecent waters. J. Fish. Biol. 4 : 535-554.

Davey, J.T. 1980. Spatial distribution of the copepod parasite Lernanthropus kroyeri on the gills of bass Dicentrarchus labrax (G). J. Mar. Biol. Ass. U.K. 60 : (4): 1061-1067.

Day, F. 1958. The fishes of India. William Dowson and Sons Ltd., London.

Deardorff, T.L; and F.G. Stanton. 1983. Nematode induced abdominal distention in the Hawain puffer fish, Canthigaster jactator (Jenkins). PAS.Sci. 37 : (1) : 45-48.

*Desbrosses, P. 1948. Le merland (Gadus merlangus) de cote francaise de I' Atlantique (deuxieme partie). Rev. trav. off. peches. Marit. 14 : 71-99.

Dick, T.A; and M. Belosevic. 1981. Parasites of arctic charr Salvelinus alpinus (Linnaeus) and their use in separating sea-run and non-migrating charr. J. Fish. Biol. 18 : (3) : 339-347.

Dogiel, V.A. 1947. Text book of general parasitology 2nd ed. publ. uchpedgiz, Leningr.

Dogiel, V.A. 1958. Ecology of parasites of freshwater fishes. In "parasitology of Fishes".(Ed. V.A. Dogiel, G.K.Petrushvski and Yu. I. polyanski,) Leningrad University Press. English translation Z. Kabata. 1961.

Dogiel, V.A; and B.F. Bykhovski. 1934. Parasite fauna of the fishes of the Arab Sea. Mag. parasit. Moscow, IV.

Duguid, I.B; and E.M. Sheppard. 1944. A diphyllobothrium epidemic in trout. J. Path. Bact. 56 : 73-80.

Dunn, L.J; L.R. Russel; and J.R. Adams. 1983. Cetal histopathology caused by Truttaedacnitis truttae (Nematoda : cuculla-nidae) in rainbow trout Salmo gairdneri. Int.J.Parasitol 13 : (5) : 441-445.

Dzidziul. 1973. The pathogenicity of Lernaea cyprinacea L. in the cases of heavy infestations, in Carassius carassius(L.). Acta. Parasit. Pol. 21 : 281-288.

Eapen, P.K; and K.K.P. Menon. 1973. Common marine and freshwater fishes of Kerala. Sea food. export. J. 5 : 25-38.

Egglishaw, H.J. 1967. The food, growth and population structure of Salmon and trout in two streams in the scotish High lands. Freshwat. Salmon. Fish. 38 : 1-32.

Eiras, J.C. 1986. Some aspects of the infection of bib, Trisopterus luscus (L) by the parasitic copepod Lernaeocera lusci (Basset-smith, 1896) in Protughese waters. J.Fish.Biol. 28 : 141-145.

Eiras, J.C; and H.H. Reichenbach-klinke. 1982. Nematodes as cause of intestinal nodules in freshwater fishes. Aspects of human health in connection with fish and fish food. Contribution to fish biology publ. by Gustav Fischer Verlag, Stutgart (FRG) 1982. 47-55.

Ekubaum, K.E. 1933. Ac case of Dracunculiasis in Pacific coastal fishes. contr. canad. Biol. 8 : 163-168.

Elarifi, A.E. 1982. The histopathology of larval anisakid nematode infections in the liver of whiting, Merlanquis merlanquis (L) with some observations on blood leucocytes of fish. J.Fish. Dis. 5 : (2) : 411-419.

Elkins, C.A; and K.C. Corkum. 1976. Growth dynamics and seasonal prevalance of Crepidostomum isostomum and Phillodistomum pearsei in Aphredoderus sayanus (pirateperch).J.wildlife Dis. 12 : 208-214.

Elliott, J.M. 1967. The food of trout (Salmo trutta) in a Dartmoor stream. J. Appl. Eco. 4 : 59-71.

Esch, G.W; and W.J. Huffines. 1973. Histopathology associated with endoparasitic helminths in bass.J.Parasit.59 : 306-313.

Evans, N.A. 1978. The occurrence and life history of Asymphylodora kubanicum (Platyhelminths : Digenea : Monorchidae) in the worcester-Birmingham canal, with special reference to the feeding habits of the definitive host Rutilus rutilus. J.Zool. Lond. 184 : 143-153.

Fagerholm, H.P; K. Kuusela; and E.T. Valtonen. 1982. On the occurrence of Cystidicoloides ephemeridarum (Nematoda :spiruroidea) in grayling (Thymallus thymallus) in the Oulanka and Kitkajoki rivers. (Kuusamo, Finland) Memoranda. Soc. Fauna. Flora. fenn. 58 : (3) 67-70.

Fannaly, M.T. 1980. Observations on the biology of the parasitic isopod Olencira praegustator and its incidence on gulf Menhaden, Brevoortia partronus in Lake Pontehartrain, Louisiana. Proceedings. La.Acad.Sci. 43 : 26-29.

Fisher, H; and R.S. Freeman. 1969. Penetration of perenteral plerocercoides of Proteocephalus amploplitis (Leidy) in to the gut of the small mouth bass. J. parasit. 55 : 766-774.

Font, W.F. 1983. Seasonal population dynamics of five species of intestinal helminths of the brook stickle back Culaea inconstans. Can.J.Zool. 61 : (9) : 2129-2139.

Fraser, P.G. 1960. The occurrence of Diphyllobothrium in trout with special reference to an outbreak in the west of England. J. Helminth. 34 : 59-72.

Gaevskaya, A.V. 1984. The copepod Sphyrion lumpi (Kroeyer) as a biological label in the population studies of deep-sea red fish. Intraspecific differrenciation in marine commercial fishes and invertebrates pub. by Atlantiniro Kallingrad U.S.S.R. pp. 90-99.

Gaevskaya, A.V; and A.A. Kovaleva. 1985. Parasite fauna of the oceanic scad Trachurus picturatus, ecologo-geographical pattern of its formation. Ehkol Morya. 20 : 80-84.

Gaines, J.L; and W.A. Rogers. 1971. Fish mortalities associated with Goezia sp. (Nematoda : Ascaroidea) in central Florida. Proceedings of the 25th annual conference of the Southeastern Association of Game and Fish commissioners. 496-497.

Ganapati, P.N; and K. Hanumantharao. 1954. On the black grub diseases in the fresh water carp Catla catla. Current. Sci. 23 : 401-402.

George, M.J. 1980. Status of coastal aquaculture in India. In."Present status of coastal aquaculture in countries bordering the Indian Ocean;" Issued by the Marine Biological Association of India, Cochin pp. 28-53.

George, M.J; and K.N. Kartha. 1963. Surface salinity of Cochin back water with reference to tide. J. Mar. Biol. Assoc. India. 14 : 568-577.

George, P.V; and A.M. Nadakal. 1978. Observations on the intestinal pathology of the marine fish, Rachycentron canadus (Gunthur) infected with the Acanthocephalid worm Serrasentis nadakali (George and Nadakal. 1978). Hydrobiologia. 78 : 59-62.

George, P.V; and A.M. Nadakal. 1982. Histopathological changes in the intestine of the fish, Synaptura orientalis parasitised by an Acanthocephalid worm, Echinorhynchus veli (George and Nadakal 1978). Jap. J. Parasit. 31 : (2) : 99-103.

*Giard, A. 1888. Sur le Peroderma cylindricum (Heller), copepode parasite de la sardine. C.R. Acad. Sci. Paris. 107 : 929-931.

Gleason, L.N. 1984. Population composition and dispersal pattern of Pomphorhynchus bulbocolli in Hypentelium nigricans from the west Fork of Drakes Creek, Kentucky. Am.Midl. Nat. 112 : (2) : 273-279.

*Gnadeberg, W. 1949. Beitrage zur Biologie und Entwicklung des Ergasilus sieboldi V. Nordmann. (Copepoda : parasitica) Z. parasitenk. 14 : 130-180.

*Goreglyad, Kh.S. 1955. Diseases and pests of fishes. (In Russian). Gosizdt. Selkhoz. Lit. Moscow. 237 pp.

Grabda, J. 1976. Ecological problems in fish parasitology. Wiad. Parazyt. 22 : 531-541.

Granth, W.O; and G.W. Esch. 1983. Temperature and other factors that regulate the composition and infrapopulation densities of Bothriocephalus acheilognathi (cestoda) in Gambusia affinis. J. parasit. 69 : (6) : 1116-1124.

Grimes, L.R; and G.L. Miller. 1976. Seasonal periodicity of three species of caryophyllaeid cestodes in the creek chubsucker, Erimyzon oblongus (Mitchill) in North Carolina. J. parasit. 62 : 434-441.

Guseva, N.V. 1940. Parasitic copepods causing red pest-like signs in various fishes collected papers. Inst. Fresh W. Fish Leningr. 1-2.

Hafeezullah, M; and A.H. Siddiqi. 1970. Digenetic trematodes of marine fishes of India. Part I. Bucephalidae and cryptogonidae. India. J. Helminth. 22 : 1-22.

Halton, D.W; and J.B. Jenning. 1965. Observations on the nutrition of monogenetic trematodes. Biol.Bull. 129 : 257-272.

Hanzelova, V; and R. Zitnan. 1982. The seasonal dynamics of the invasion cycle of Gyrodactylus katharineri Malberg, 1964. (Monogenea). Helminthologia. 19 : (4) : 257-265.

Hanzelova, V; and R. Zitnan. 1983. The seasonal dynamics of the invasion cycle of Dactylogyrus vastator Nybelin, 1924. (Monogenea) in the carp fry. Hleminthologia. 20 : (2): 137-150.

Hare, G.M; and M.D.B. Burt. 1975. Abundance and population dynamics of parasites infecting Atlantic Salmon (Salmo salar) in Trout Brook, New Brunswick, Canada. J.Fish.Res.Bd. Canada. 32 : 2069-2074.

Hastein, T; and T. Bergsjo. 1976. The salmon lice Lepeophtheirus salmonis as the cause of disease in farmed salmonids. Rev. Ital. Piscic. Ittiopat. 11 : 3-5.

Heggberget, T.G; and B.O. Johnsen. 1982. Infestations by Gyrodactylus sp. of Atlantic Salmon, Salmo salar. L. in Norwegian rivers. J. Fish. Biol. 21 : (1) : 15-26.

Hildebrand, S.F. 1963. Family clupeidae, genus Brevoorita. In "Fishes of the western north Atlantic" part 3. pp. 342-380. Sears Found. for Marine Res. Yale Univ.

Hine, P.M; and C.R. Kennedy. 1974a. Observations on the distribution, specificity and pathogenecity of the acanthocephalan Pomphorhynchus laevis (Muller) J.Fish.Biol. 6 : 521-535.

Hine, P.M; and C.R. Kennedy. 1974b. The population biology of the Acanthocephalan Pomphorhynchus laevis (Muller) in the river Avon. J.Fish.Biol. 6 : 665-679.

Hirsch, R.P. 1980. Distribution of Polymorphus minutus among its intermediate hosts. Int. J. Parasitol. 10 : 243-248.

Hirshfield, M.E; R.P. Morin; and D.J. Hepner. 1983. Increased prevalence of larval Eustronglydes (Nematoda) in the Mummichog, Fundulus heteroclitus (L) from the discharge canal of a powerplant in the chespeak Bay. J.Fish.Biol. 23 : (2) : 135-142.

Hoffman, G.L. 1967. Parasites of North American freshwater fishes. Berkely and Los Angles: University of California Press.

Hoffman, G.L. 1970. Parasites of North American freshwater fishes. Berkely and Los Angles: University of California Press.

Hoffman, G.L. 1975. Lesions due to internal helminths of freshwater fishes. No.5 151-187. In: Ribelin, W.E. Migaki, G.(Eds) "The pathology of fishes". University of Wisconsin Press.

Hoffman, G.L; and C.E. Dunbar. 1961. Mortality of eastern brook trout caused by Plerocercoids (Cestoda : Psuedophyllidae : Diphyllobothridae) in the heart and viscera. J.parasit 47 : 399-400.

Hoffman, G.L; and J.A. Hutcheson. 1970. Unusual pathogenicity of a common metacercaria of fish. J.Wildl.Dis. 6 : 109.

Holloway, H.L; and N.T. Hagstrom. 1981. Comparison of four north Dakota impoundments and factors affecting the development of impoundment parasitofauna. Prairie. Nat. 13 : (3-4) : 86-93.

Hopkins, C.A. 1959. Seasonal variations in the incidence and development of the cestode Proteocephalus filicollis (Rud.1810) in Gasterosteus acuteatus (L.1766). Parasitology. 49 : 529-542.

Hridayanathan, C. 1981. Studies on the macrobenthas of mud banks of south west coast of India. Ph.D. Thesis submitted to the University of Cochin. (Unpublished).

Hyman, L.H. 1951. The invertebrates. 3 : 572 pp. Mc Graw-Hill Book Company, Inc.

Ieshko, E.P. 1983. Structure and dynamics of Discocotyle sagittata (Monogenea) population abundance. Parasitologiya. 17 : (2) : 107-111.

Ivasik, V.M. 1952. Some observations on the pathogenisity of Caryophyllaeus fimbriceps to carp. Tr. nauchno-issled. in-ta ozern.i.rechn.rybn.khoz.Ukr. S.S.R. VIII.

Izyumova, N.A; and A.V. Mashtakov. 1979. Seasonal occurrence of Dactylogyrus in Abramis brama, Rutilus rutilus and Abramis ballerus in the Rybinsk reservoir. Turdy.Inst. Biol. vnutr. 38 : 160-167.

Izyumova, N.A; and M.A. Zharikova. 1982. On some features of the distribution of Dactylogyrus anchoratus and D.chranilowi Monogenoidea Bineden Bychowsky, 1937. Trudy. Inst. Biol. Vnutr. 46 : 89-100.

Izyumova, N.A; T.I. Zharikova; A.V. Mashtakov; and M.S. Stepanova. 1982. Some factors determining the density and structure of dactylogyrid population in carps. In. Ryzhikov, K.M.(Ed) "Helminths of freshwater biocoenoses" Nauka, Moscow. 1-232.

Jackson, G.J; and J.W. Bier. 1980. Review of human Anisakiasis I. WHO Scientific group on intestinal protozoan and Helminth infections. Draft agent item. 3.4.

James, B.L; and L.P. Srivastava. 1967. The occurrence of Podocotyle atomon (Rud; 1802) (Digenea), Bothriocephalus scorpii (Muller, 1776) (cestoda), Contracaecum clavatum (Rud; 1809) (Nematoda) and Echinorhynchus gadi (Muller, 1776) (Acanthocephala) in fivebeared rockling, Onos mustilus (L). J. Nat. Histo. 1 : 363-372.

Janusz, J. 1980. An influence of the parasite Clavella adunca (Strom, 1762) (copepoda, parasitica: Lernaeopodidae) on the cod (Gadus morhua) from North West Atlantic waters. Acta.ichthyol. Piscat. 10 : (1) : 103-118.

Jennings, M.R; and G.L. Hendrickson. 1982. Parasites of the chinook salmon (Onchorhynchus tshawytscha) and Coho salmon. (O. kisuth) from the Mad river and vicinity, Humboldt country, California. Proc. Helminth. Soc. Wash. 49: 279-284.

Jilek, R; and J.L. Crites. 1981. Prevalence of Spinitectus carolini Holl. 1928, and Spinitectus gracilis ward and Magath, 1916 (spirurida : Nematoda) in fishes from Lake Eric. Can. J. Zool. 59 : (1) : 141-142.

Jilek, R; and J.L. Crites. 1982. Intestinal histopathology of the Common blue gill, Lepomis macrochirus Rafinesque, infected with Spinitectus carolina Holl. 1928. (Spirurida : Nematoda) J. fish. Dis. 5 : 75-77.

Jos Anto, V. 1975. Bottom salinity charecteristics of Cochin back waters. In: Recent Researches in Eusturine Biology. (Ed. R. Natarajan); Hindustan Pub. Corp. New Delhi. 233-243.

Joy, J.E. 1974. Incidence and intensity of Spirocamallanus pereirai (Nematoda, Camallanidae) infestations in the croaker, Micropogan undulatus (Linaeus) and spot Leistomus xanthurus Lacepede, from Texas. Contrib. Mar.Sci.Univ. Texas. 18 : 1-6.

* Joubin, W. 1888. Sur un copepode parasite des sardines. C.R.Acad. Sci. Paris. 107 : 1177-1178.

Kabata, Z. 1958. Lernaeocera obtusa its biology and its effects on the haddock Mar.Res.Scot. 3 : 26 pp.

- 64040 -

Kabata, Z. 1959. Ecology of the genus Acanthochondria oakley (Copepoda, parasitica). J.Mar.Biol.Ass.U.K. 38 : 249-261.

Kabata, Z. 1969. Phrixocephalus cincinatus wilson, 1908 (copepoda: Lernaeoceridae) : morphology, metamorphosis, and host parasite relationship. J.Fish.Res.Bd.Can.26 : 921-934.

Kabata, Z. 1970. Diseases of fishes, Book I: crustacea as enemies of fishes (T.F.H. Neptune City, NJ), 171 pp.

Kabata, Z. 1981. Copepoda (crustacea) parasitic on fishes: problems and perspectives. Adv. Parasitol. 19 : 2-63.

Kabata, Z. 1985. Parasites and diseases of fish cultured in the Tropics. Pub: Taylor and Francis, London and Philadelphia. p. 318.

Kabata, Z; and B. Cousens. 1977. Host-parasite relationships between sockeye salmon Onchorhynchus nerka and Salminicola californiensis (copepoda : Lernaeopodidae). J.Fish.Res. Bd. Can. 34 : 191-202.

Kasim, M.H; and Z.I.F. Rahemo. 1981. Influence of seasons and sex on the intensity of Pseudolamproglena annulata Bozshall, 1976, (Lernaeidae) infection in Cyprinion macrostomus, a freshwater teleost from the river Tigris. Rivi. Parasit. 42 : (3) : 455-460.

Kazakov, B.E. 1982. An ecological analysis of monogeneans of the roach and perch in lakes of the Lithuanian national park. Trudy.gel.mint. Lab. 31 : 11-22.

Kelly, H.D; and R. Allison. 1962. Observations on the infestations of a fresh water fish population by a marine copepod. (Ergasilus lizae, Kroyer 1863). Proceedings of the sixteenth Annual conference, Southeastern Association of Game and Fish Commissioners. October 14-17, 1962. 236-239.

Kennedy, C.R. 1968. Population biology of the cestode Caryophyllaeus laticeps (Pallas, 1781) in dace, Leuciscus leuciscus.L. of the river Aron. J.parasit. 54 : 538-543.

Kennedy, C.R. 1969. Seasonal incidence and development of the cestode Caryophyllaeus laticeps (pallas) in the river Avon. Parasitology. 59 : 783-794.

Kennedy, C.R. 1970. The population biology of helminths of British, freshwater fishes. p. 145-159 in A.E.R. Taylor and R. Muller (eds). Aspects of Fish parasitology. Blackwell Sci. Pub; Oxford and Edinburg.

Kennedy, C.R. 1972. The effect of temperature and other factors upon the establishment and survival of Pomphorhynchus laevis (Acanthocephala) in gold fish Carassius auratus. Parasitology. 65 : 283-294.

Kennedy, C.R. 1975. Distribution and zoogeographical characteristics of the parasite fauna of char Salvelinus alphinus in Arctic Norway, including spitsbergen and Jan Mayen Islands. Astarte 10 : 1: 49-55.

Kennedy, C.R. 1981a. Longterm studies on the population biology of two species of eyefluke, Diplostomum gasterostei and Tylodelphys clavata (Digenea : Diplostomatidae),concurrently infecting eyes of perch, Perca fluviatilis. J. Fish. Biol. 19 : (2) 221-236.

Kennedy, C.R. 1981b. The establishment of population biology of the eye fluke Tylodelphys podicipina (Digenea : Diplostomatidae) in perch. Parasitology 82 : (2) : 245-255.

Kennedy, C.R. 1984. The dynamics of declining population of the acanthocephalan Acanthocephalus clavula in eels Anguilla anguilla in a small river. J. Fish.Biol. 25 : 665-677.

Kennedy, C.R. 1985. Site segregation by species of Acanthocephala in fish, with special reference to eels, Anguilla anguilla Parasitology. 90 : 375-390.

Kennedy, C.R; P.F. Broughton; and P.M. Hine. 1978. The status of brown and rainbow trout, Salmo trutta and S. gairdneri as hosts of the acanthocephalan Phomphorhynchus laevis J.Fish.Biol. 13 : 265-275.

Kennedy, C.R; and P.M. Hine. 1969. Population biology of the cestode Proteocephalus torulosus (Batsch) in dace Leuciscus leuciscus (L) of the river Avon. J. Fish. Biol. 1 : 209-219.

Kennedy, C.R; and D. Lord. 1982. Habitat specificity of the Acanthocephalan Acanthocephalus clavula (Dujardin, 1845) in eels Anguila anguila (L). J. Helminth. 56 : (2): 121-129.

Kennedy, C.R; and A. Rumpus. 1977. Long-term changes in the size of the _Pomphorhynchus_ _laevis_ (Acanthocephala) population in river Avon. J.Fish.Biol. 10 : 35-42.

Kennedy, C.R; and P.J. Walker. 1969. Evidence for an immune response by dace _Leuciscus_ _leuciscus_ to infections by the cestode _Caryophyllaeus_ _laticeps_. J.Parasit. 55 : 579-582.

Kenzie, M.K; A.H.M. Vicar; and I.F. Waddell. 1976. Some parasites of plaice _Pleuronectus_ _platessa_ L. in three different farm environments. Scottish. Fish.Res.resp. 4 : 1-14.

Khalil, L.F. 1969. Larval nematodes in the herring (_Clupea_ _harengus_) from British coastal waters and adjacent territories. J.Mar.Biol.Ass.U.K. 49 : 641-659.

Kinne, O. 1980. Diseases of marine animals. Ed. Otto Kinne. John Wiley & Sons, Chichester, New York, Brisbone, Toronto.

Kirby, J.M. 1981. Seasonal occurrence of the ectoparasite _Gyrodactylus_ _atratuli_ on spotfin shiners. Trans. Am.Fish.Soc. 110 : (3) : 462-464.

Ko, R.C; B. Morton; and P.S. Wong. 1975. Prevalence and histopathology of _Echinocephalus_ _sinensis_ (Nematoda : Gnathostomatidae) in natural and experimental hosts. Can.J.Zool. 53 : 550-559.

* Kollatsch, D. 1959. Untersuchungen über die Biologie and Okologie der Kerpfenlaus (_Argulus_ _foliaceus_ L.) Zool. Beitr. 5 : 1-36.

Koya, M.S; and A. Mohandas. 1982. Helminth parasites of marine fishes of Cochin. Indian. J. Parasit. 6 : (1) : 103-105.

Kupryanova, R.A. 1954. Contributions to the biology of the fish nematode *Camallanus lacustris* and *C. truncatus*). Dokl. Akad.Nauk. SSSR. 97 : 337-376.

Kurup, B.M; and C.T. Samuel. 1987. Ecology and fish distribution pattern of a tropical estuary. In: Abstracts- National Seminar on eusturine management.No. EB. 13. 2 pp.

Lamberta, A; and R. Romand. 1984. The monogenea, dactylogyridae used as biological tags for cyprinidae. Cybium(3E SER). 8 : (1) : 9-14.

Lawler, G.H. 1969. Aspects of the biology of *Triaenophorus nodulosus* in yellow perch, *Perca flavescens*, in Heming Lake, Manitoba. J.Fish. Res.Bd. Can. 26 : 821-831.

Lawrence, J.L. 1970. Effects of season, host age and sex on endohelminths of *Catostomus commersoni*. J. Parasit. 56 : 567-571.

*Layman, E.M. 1957. Disease of fishes (In Russian) pishchepromizdat, Moscow, 259 pp.

*Lechler, H. 1935. Die wirkung von Kiemnparasiten auf das wachstum von Reinanken. Fisch. ztg. 38 : 39-40.

Lee, R.L.G. 1981. Ecology of *Acanthocephalus lucii* (Muller, 1776) in Perch *Perca fluviatilis*, in the serpentine, London. U.K. J. Helminth. 55 : (2) : 149-154.

Leong, T.S. 1986. Seasonal occurrence of metazoan parasites of *Puntius binotatus* in an irrigation canal, Pulau pinag, Malayasia. J.Fish. Biol. 28 : 9-16.

Lester, R.L.G. 1972. Attachment of *Gyrodactylus* to *Gasterosteus* and host response. J. Parasit. 58 : 717-722.

Lester, R.L.G. 1977. An estimate of the mortality in a population of *Perca flavescens* owing to the trematode *Diplostomum adamsi*. Can.J.Zool. 55 : 288-292.

Lester, R.L.G. 1984. A review of methods for estimating mortality due to parasites in wild fish populations. Helgolander. Meeresunters. 37 : 53-64.

Lester, R.L.G; and J.R. Adams. 1974a. *Gyrodactylus alexanderi* : reproduction, mortality and effects on its host *Gasterosteus aculeatus*. Can.J.Zool. 52 : 827-833.

Lester, R.L.G; and J.R. Adams. 1974b. A simple model of *Gyrodactylus* population. Int. J. Parasit. 4 : 497-506.

Lester, R.L.G; and H.W. Huizinga. 1977. *Diplostomum adamsi* sp.n. description, life cycle and pathogenesis in the retina of *Perca flavescens*. Can.J.Zool. 55 : 64-73.

Li, S.Y; and S.F. Hsu. 1951. On the frequency distribution of helminths in their naturally infected hosts. J. parasit. 37 : 32-41.

Llewellyn, J. 1956. The host specificity, microecology, adhesive attitudes and comparative morphology of some trematode gill parasites. J.Mar.Biol.Assoc.U.K. 35 : 113-127.

Llewellyn, J. 1962. The life histories and population dynamics of monogenean gill parasites of Trachurus trachurus.(L) J. Mar.Biol. Ass. U.K. 42 : 587-600.

Mackenzie, K; and S. Mehi. 1984. The cestode parasite Grillotia angeli as a biological tag for mackeral in the eastern north Atlantic. Proceedings of council meeting, 1984, of the International Council of the Exploration of the Sea. pp 13.

Madhavi, R. 1979. Observations on the occurrence of Allocreadium fasciatusi in Aplocheilus melastigma. J. Fish. Biol. 14 : 47-58.

Madhavi, R. 1980. Comparison of the parasitic fauna of Aplocheilus panchax and A. melastigma J.Fish.Biol. 17 : 349-358.

Malhotra, S.K. 1982a. Log-normal distribution of nematode parasites in the Himalayan riverine ecosystems. Science-cult. 48 : (5) : 175-176.

Malhotra, S.K. 1982b. Nematode-weight to body weight relationships in Tor tor in the Himalayan riverine ecosystems. Current Sci. 51 : (8) : 423-424.

Malhotra, S.K; and R.S. Chauhan. 1980. Statistical analysis of cestode infection in relation to some ecological aspects of Hill stream fishes in Garhwal Himalayas, India, Indian J. Helminth. 32 : (1) : 43-52.

Malta, D.O; and J.C. Varella. 1983. The argulidae (crustacea : Brachiura) of the Brazillian Amazon. 3. Ecological aspects of Dolops striate Bouvier, 1899 and Dolops carvalhoi Castro.1949. Acta.Amazon. 13 :(2) : 299-306.

* Mann, H. 1953. Lernaeocera branchialis (Copepoda : parasitica) und seine schadwirkung by einingen Gadiden. Arch.Fisch. wirts. 7 : 153-155.

* Mann, H. 1960a. Schadwirkung des parasitischen copepoden Lernaeocera branchialis auf das wachstum von wittlingen. Inf.Fisch. wirts. 7 : 153-155.

* Mann, H. 1960b. Schadwirkung des befalls mit Ergasilus bei schleien. Inf. Fisch. wirts. 7 : 48-49.

* Mann, H. 1964. Vorkommen, verbreitung und schadwirkung von Lernaeocera minuta (T.scott) (copepoda parasitica) Ver.Inst.Meeresf. Bremerhaven. 9 : 79-83.

Mann, H. 1970. "Copepoda and isopoda as parasites of marine fishes". A symposium of diseases of fishes and shell fishes.ed. S.F. Snieszko. pp. 177-189.

Manter, H. 1934. Some digenetic trematodes from deep water fishes of Tortugas. Florida.Pap.Tort.Labor. XXVIII.

Margolis, L. 1970. Nematode diseases of marine fishes. A symposium on diseases of fishes and shellfishes. ed. S.F.Snieszko. pp. 190-208.

Margolis, L; G.W. Esch; J.C. Holmes; A.M. Kuris; and A.M. Schad.1982. The use of ecological terms in parasitology. (Report of an adhoc committee of the American Society of parasitologists. J.parasit. 68 : (1) : 131-133.

* Marochino, V. 1926. Die pathological-histologischen Veranderungen. Zool. Jahrb. Abt. Anat. 47 : 246-260.

May, R.M; and R.M.Anderson. 1979. Population biology of infectious diseases Part II. Nature. 280 : 455-461.

Maxwell, J.G.H. 1982. Infestation of the Jack mackeral, *Trachurus declivis* (Jenyns) with the cymothoid isopod, *Cerratothoa imbricatus* (Fabricus) in South eastern Australiaus waters. J.Fish. Biol. 20 : (3) : 341-349.

Mc Donough, J.M; and L.N. Gleason. 1981. Histopathology in the rainbow darter *Etheostoma caeruleum*, resulting from infections with the acanthocephalans, *Pomphorhynchus bulbocolli* and *Acanthocephalus dirus*. J. parasit. 67 : (3) : 403-409.

Meyer, F.P. 1975. The pathology of the major diseases of catfish. No. 9 : 275-286. In:(Ribelin. W.E; & Migaki. G. (Eds)). "The pathology of fishes". University of Wisconsin Press, U.S.A.

Millemann, R.E; and S.E. Knapp. 1970. Pathogenecity of the 'Salmon poisoning' trematode, *Nanophyetus salminicola*, to fish. A symposium on Diseases of fishes and shellfishes, ed. S.F. Snieszko, pp. 209-217.

Mohr, C.O. 1961. Relation of ectoparasite load to host size and standard range. J.parasit. 47 : 978-984.

Moller, H. 1975. Distribution of some parasites and diseases of fishes from the North sea in February, 1977. ICES Publs. CM 1977/E. 20 : 1-16.

Moller, H. 1976. Reduction of the intestinal parasite fauna of marine fishes in captivity. J.Mar. Biol.Ass.U.K.56 : 281-285.

Moller, H. 1978. The effects of salinity and temperature on the development and survival of fish parasites. J.Fish.Biol. 12 : 311-323.

Molnar, K. 1980. A histological study of ancylodiscoidosis in the sheath fish (Silurus glanis). Helminthologia. 17 : (2) : 117-126.

Molnar, K; G.L. Chan; and C.H. Fernando. 1982. Some remarks on the occurrence and development of philometrid nematodes infecting the white sucker, Catostomus commersoni, Lacepede (pisces : catastomidae) in Ontario. Can.J.Zool. 60 : (3) : 443-451.

*Monterosso, B. 1923. Contriboto allo studio di Peroderma cylindricum. Atti.Acad.Sci.Nat.Contania (5a), 13 : 1-9.

MPEDA. 1984. Statistics of marine products exports No. 16 Pub. Marine products export development authority, Cochin. India.

Muhammed Salih, K.Y. 1973. On the growth of the back water calm Meritrix casta (Chemnitz) in the calm beds off Cochin barmouth. J. Mar.Biol.Assoc.India. 15 : 345-353.

Muller, H. 1983. The effect of Lernaeocera infestation on cod (Gadus morhua). Bull.Eur.Assoc.Fish.Pathol. 3 : 21-22.

Munro, I.R.S. 1955. The marine and freshwater fishes of Ceylon.Dept. of external affairs, Canberra.

Murdy, D.R; and H.P. Arai. 1973. Population dynamics of Hunterella nodulosa (cestoidea : caryophyllidea) in Alberta. Can.J. Zool. 51 : 787-792.

*Musselius, V.A. 1967. Parasites and diseases of herbivorous fishes and their control measures. (In Russian) "Kolos", Moscow 83 pp.

Muzzal, P.M. 1980a. Population biology and Host-parasite relationships of Triganodistomum attenuatum (Trematoda : Lissorchiidae) infecting the white sucker, Catostomus commersoni (Lacepede). J.Parasit. 66 : (2) : 293-298.

Muzzal, P.M. 1980b. Seasonal distribution and ecology of three caryophyllaeid cestode species infecting white suckers in Hampshire. J.Parasitol. 66 : (3) : 542-550.

Muzzal, P.M. 1980c. Ecology and seasonal abundance of three Acanthocephalan species infecting white suckers in Se New Hampshire. J.Parasit. 66 : (1) : 127-133.

Muzzal, P.M; and W.L. Bullock. 1978. Seasonal occurrence and host parasite relationships of Neoechinorhynchus saginatus, Vancleave and Bangham 1949 in the fallfish, Semotilus corporalis (Mitchill) J.Parasit. 64 : 860-865.

Muzzal, P.M; and F.G. Rabalis. 1975. Studies on Acanthocephalus jacksoni Bullock,1962 (Acanthocephala, Echinorhynchidae) seasonal periodicity and new host records. Proc. Helminth. Soc.Wash. 42 : 31-34.

Nagasawa, K; S. Egusa; and K.Ishino.1982.Occurrence of Acanthocephalus minor (Acanthocephala) in two types of the goby Chaenogobius annularis. Japaneese J. Icthyol. 29 (2): 229-231.

Nair, G.A; H. Suryanarayanan; and N. Balakrishnan Nair. 1981. Host specificity and biochemical changes in fishes owing to the infestation of the isopod, Alitropus typus. M. Edwards (crustacea : Flabellifera : Aegidae). Proc . Indian. Acad.Sci.Anim.Sci. 90(4): 445-452.

Nair, N.B. 1975. Key note paper-Biological sciences. Souvenir, All Kerala University research scholars Association: Seminar on "Environment oriented research in the Universities" 1975 : 3-5.

Nair, S.R; and N.B. Nair. 1981a. Nature of Peniculisa wilsoni Radhakrishnan (copepoda : Lernaeoceridae) infestation of Didon hystrix Linnaeus (Pisces : Diodontidae) J. Anim.Morph.Physiol. 28 : (1-2) : 73-81.

Nair, S.R; and N.B. Nair. 1981b. Histopathology of the infestation of Didon hystrix L. by Peniculisa wilsoni Radhakrishnan (copepoda : Lernaeoceridae).J. Fish.Disease.4: 83-87.

Nair, S.R; and N.B. Nair. 1981c. Histopathology of the infection of Trichurus savala cuvier by Caligus uruguayensis Thompson (copepoda). Contributions to fish toxicology and parasitology. 147-152.

Nair, S.R; and N.B. Nair. 1981d. Nature of infestation of fishes by Lernanthropus gibbosus Pillai and L. koenigii stp and Lutk (copepoda : Anthosomatidae) along the south west (Trivandrum) coast of India. Proc.Indian.Acad.Sci. Anim.Sci, 90 : (1) : 209-223.

Nair, S.R; and N.B. Nair. 1981e. On Nybelinia sp. plerocercoid (cestoda : Tentacularidae) infection of the oesophagus

Acad. Sci. 90 : (3) : 251-289.

Nair, S.R; N.B. Nair; and N.K. Balasubramaniam. 1983. Nature of infection of Trichiurus lepturus Linnaeus (Pisces : Trichiuridae) by Scolex pleuronectis Muller (cestoda: Tetraphyllidae). Arch.Hydrobiol. 99 : (2) : 254-267.

Najib, M.A. 1983. Linear distribution pattern of Acanthosensis oligospinus Anantaraman 1980 in the alimentary canal of Mystus gulio. Indian J.Parasit. 7 :(2) : 223-224.

Nammaiwar, P. 1980. A note on parasitised ovaries in the perch Pomadasys hasta (Bloch) (Pomadasyidae). Indian. J.Fish. 24 : (1-2) : 271-272.

Nascimento, M.A; J.G. Carvajal; and H.C. Alcaino. 1983. Occurrence of Anisakis sp. larvae in the chilean jack mackeral (Trachyrus murphyi) Nichols - 1920. Rev. Chil. Hist. Nat. 56 : (1) : 31-37.

Nascimento, F.M; and R.L. Vergar. 1982. Relationships between some inherent host factors and the size of infrapopulations of Proleptus acutus Dujardin, 1845 (Nematoda) within the stomach of its definitive host, Schroederichthys chilensis. (Guichenot, 1848) (Chondrichthyes : Saylior-hinidae). J. Parasit. 68 : (6) : 1170-1172.

Natarajan, P; and P.S.B.R. James. 1977. A bibliography of parasites and diseases of marine and freshwater fishes of India. J. Fish.Biol. 10 : 347-369.

Natarajan, P; and N.B. Nair. 1978. On the incidence and infestation of copepode parasites of marine fishes. Aquatic. Biol. 3 : 1-13.

*Neuhaus. E. 1929. Untersuchungen uber die lebensweise von Ergasilus sieboldi. seitschr. Fisch. XXVII, 3.

*Neveu, A; and M. Thiabault. 1977. Comportement alimentaire d'une population sauvage de truites fario (Salmo trutta). dans un ruisseau des pyrenees atlantique le Lissauraga. Ann. Hydrobiol. 8 : 111-128.

Nigrelli, R.F. 1935. On the effects of fish mucus on Epibdella mellani a monogenetic trematode of marine fishes. J. Parasit. 21 : 438.

Nigreli, R.F; and F.F. Firth. 1939. On Sphyrion lumpi (kroyer) a copepod parasite on the red fish Sebastes marinus (Linnaeus) with special reference to the host parasite relationship. Zoologica. 23 : 1-10.

Noble, E.R. 1957. Seasonal variations in host-parasite relations between fish and their protozoa. J.Mar.Biol.Assoc.U.K. 36 : 143-155.

Noble, E.R; R.E. King; and B.L. Jacobes. 1963. Ecology of the gill parasites of Gillichthys mirabilis cooper. Ecology. 44 : (2) : 295-305.

Noga, E.J. 1986. The importance of Lernaea cruciata (Lesueur) in the initiation of skin desions in large mouth bass, Micropterus salmoides (Lacepede) in the chowan river, North Carolina, U.S.A. J. Fish.Disease. 9 : 295-302.

Ocvirk, J; N. Snoj; and J. Brglez. 1980. Discovery of Cystidicola farionis Fischer in wild brown trout and the Patho-antomical changes caused by them. Ichthyologia.12:27-31.

Olson, R.C. 1978. Parasitology of the English sole, Parophrys vetulus Girard in Oregon, U.S.A. J.Fish.Biol. 13 : 237-248.

Olson, R.C; and I. Pratt. 1973. Parasites as indicators of English sole (Parophrys vetulus) in Nursery grounds. Trans. Amer.Fish.Society. 102 : (2) : 405-411.

Orr, T.S.C. 1966. Spawning behaviour of rudd, Scardinius erythrophthalmus infested with Plerocercoids of Ligula intestinalis. Nature.Lond. 212 :736.

Otto, F; and W. Korting. 1973. Report on postmorterm finding in an outbreak of endoparasitism in rainbow trout. Vet. Med. Rev. 2 : 99-106.

Pal, R.I. 1975. Role of fish pathology in Aquaculture. J. Inland. Fish. Soc. India. 7 : 131-136.

Pal, R.N. 1963. Observations of fluctuations in parasitisation of the Indian shad Hilsa ilisha (Hamilton) of the Hooghly estuary. Indian.J.Helminth. 15 : 119-126.

Palling, I.E. 1965. The population dynamics of the monogenean gill parasite Discocotyle sagittata on windermere trout Salmo trutta.L. Parasitology 55 : 667-694.

Pandey, P.K; A.K. Haal; K.L. Shah; and N.K. Dubey. 1982. Philometra abdominalis, infestation in a freshwater fish Glossogobius giuris (Ham). Biol.Bull.India.4:199-200.

Pannikar. N.K; and N.G. Sproston. 1941. Osmotic relations of some metazoan parasites (Lernaeocera, Bopyrus). Parasitology. 33 : 214-223.

Paperna, I. 1974. Hosts, distribution and pathology of infections with larvae of Eustronglylides (Dioctophymidae,Nematoda) in fishes from East African lakes. J.Fish.Biol. 6 : 67-76.

Paperna, I. 1975. Parasites and diseases of the Grey mullet (Mugilidae) with special reference to the seas of the near east. Aquaculture. 5 : 65-80.

Paperna, I; and R.M. Overstreet. 1981. Parasites and diseases of mullets. (Mugilidae). International Biol. Progm. 26 : 411-493.

Paperna. I; and D.E. Zwerner. 1976a. Parasites and diseases of striped bass, Morone saxatilis (Walbaum), from the lower chesapeake bay. J.Fish.Biol. 9 : 267-287.

Paperna. I; and D.E.Zwerner. 1976b. Studies of Ergasilus labracis Kroyer (cyclopidea : Ergasilidae) parasite on striped bass, Morone saxatilis from the lower Chesapeake Bay. I. Distribution life-cycle and seasonal abundance. Can. J.Zool. 54 : 449-462.

Paperna, I; and D.E. Zwerner. 1982. Host parasite relationship of Ergasilus labracis Kroyer (cyclopidea, Ergasilidae) and the striped bass Morone saxatilis (Walbaum) from the lower chesapeake bay. Annales. Parasit. Hum. Comp. 57 : (4) : 361-364.

Parukhin, A.M; and A.K. Zajtsev. 1984. The investigation of helminths of grey Notothenia (Notothenia squamifros) of different age from the sub antartic sector of the Indian Ocean. Biol. Naukl. 10 : 34-37.

Pennycuick, L. 1971a. Seasonal variations in the parasite infection in a population of three-spined stickle backs. Gasterosteus aculeatus L. Parasitology.63 : 373-388.

Pennycuick, L. 1971b. Differences in the parasite infections in three spined stickle back (Gasterosteus aculeatus L.) of different sex, age and size. Parasitology.63: 407-418.

Pennycuick, L. 1971c. Freequency distribution of parasites in a population of three spined sticklebacks, Gasterosteus aculeatus L. with particular reference to the negative binomial distribution. Parasitology. 63 : 389-406.

Pennycuick, L. 1971d. Quantitative effects of three species of parasites on a population of three spined stickle backs, Gasterosteus aculeatus. J.Zool.Lond. 165 : 143-162.

Petrushevski, G.K; and S.S. Shulman. 1961. The parasitic diseases of fishes in the natural waters of U.S.S.R. In "Parasitology of fishes" ed. V.A.Dogiel, G.K.Petrushevski and Y.Z. Polyamski. English Translation by Z. Kabata (1970) pp. 299-319.

Pickering, A.D; and P. Christie. 1980. Sexual differences in the incidence and severity of ectoparasitic infestation of the brown trout, Salmo trutta. J. .Fish.Biol. 16 : (6) : 669.

Pipy, J.H.C. 1969. Pomphorhyndrus laevis (Zoega) Muller, 1776 (Acanthocephala) in Atlantic Salmon (Salmo salar) and its use as a biological tag. J.Fish. Res.Bd. Can. 26 : 909-919.

Polyanski, Yu. I. 1958. Ecology of parasites of marine fishes. In. "Parasitology of fishes." ed. V.A. Dogiel, G.K. Petrushevski and Yu. I. Polyanski. Tran. by. Z. Kabata. (1979).

Polyanski, Yu. 1984. Ecological and parasitological studies of northern seas. Publ. by Kol skij Filialan S.S.S.R, APATITY U.S.S.R) 103 pp.

Pomales, A.D; and .EH. Williams. 1980. Yearly parasite variation in the temperate Centrárchid, Micropterus salmonides (Lacipede), Large mouth bass, Twenty eight years, after introduction into a tropical environment. J. Parasit. 66 : (1) : 81.

Praksh, A; and J.R. Adams. 1960. A histopathological study of the intestinal lesions induced by Echinorhynchus lageniformis in the starry flounder. Can.J.Zool. 38 : 895-897.

Price, P.W; and K.M. Clancy. 1983. Patterns in number of helminth parasites species in fresh water fishes. J. Parasit. 69 : 449-454.

Rai, P. 1969a. Notes on the histopathology of Opisthorchid, Plagiorchid and Isoparochid metacercarial invasion of some Indian freshwater fishes. Indian. J. Anim. Sci. 39 : (2) : 177-188.

Rai, P. 1969b. On the morphology and pathogenic significance of the strigeoid metacercariae in some Indian freshwater fishes. Indian.J.Anim.Sci.39 : (4) : 360-364.

Rai, P. 1970. On the clinostomatid metacercaria in some of our edible fishes and remarks on the pathological significance. Indian.J. Amin.Sci. 40 : (2) : 189-198.

Ramachandran, P. 1975. Philometra cephalus sp. n. infecting the gonads of the striped mullet, Mugil cephalus. L. from the Arabian coast of Kerala, India, with a note on its pathology. Zool • Anz. 194 : (1-2) : 140-144.

Ramamritham, C.P; and R. Jayaraman. 1963. Some aspects of the hydro-biographical conditions of the back waters around Willingdon Island. (Cochin). J. Mar.Biol. Ass. India. 7 : 150-168.

Rand, T. 1981. Comparison of the parasite fauna and diets of two species of Bermuda mongroove fishes. Part I parasite burdens. Monthly.Bull.Bermuda Dep. Agric. Fish. 52: (10) : 76-78.

Rand, T. 1983. Diseases of Bermuda fishes. Monthly. Bull.Bermuda. Dep. Agric.Fish. 54 : (6) : 45-47.

Rand, T.G. 1986. The histopathology of infestation of Paranthias furcifer (L) (osteichthyes : serranidea) by Nerocila acuminata (schioedte and Meinert) (crustacea: Isopoda: cymathoidae). J.Fish.Disease. 9 : 143-146.

Rao, S.B.V. 1981. Incidence of a cymathoan parasite on white sardine. Geobios, Jodhpur. 8 : (5) : 228-229.

Rapa, 1985. Agriculture in Asian Pacific region - A pictorial profile. Rapa Monogr. 133 pp.

Rawson, M.V. 1976. Population biology of parasites of striped mullet, Mugil cephalus L. I. Monogenea. J. Fish. Biol. 9 : 185-194.

Rawson, M.V. 1977. Population biology of parasites of striped mullet, Mugil cephalus I. crustacea. J.Fish.Biol.10:

Rawson, M.V; and W.A. Rogers. 1972. Seasonal abundance of Ancyrocephalinaen (Monogenea) parasites of blue gill Lepomis macrochirus. J. Wild life Dis. 8 : 255-260.

Rawson, M.V; and W.A. Rogers. 1973. Seasonal of Gyrodactylus macrochiri Hoffman and Putz, 1964 on blue gill and large mouth bass. J.Wild life Dis. 9 : 174-177.

Reichenbachklinke,R.W; F. Braun; H. Held; and S. Riedmuller. 1968. Vorlaufige Ergebnisse vergleichender physiologischer untersuchunger an coregonen verschiedener oberbayerischer seen, (Fettgehalt, Blutbild, Fermentspiegel, Parasitisierung). Arch.Fishchereiwiss. 19 : 114-130.

Reimchem, T.E. 1982. Incidence and intensity of Cyathocephalus truncatus and Schistocephalus solidus infection in Gasterosteus acculeatus. Can.J.Zool.60:(5): 1091-1095.

Remley. 1936. Morphology and life history studies of Microcotyle spinicirrus Mac Callum, 1918, a Monogenetic trematode from the gills of Aplodinotus grunniens J.Parasit.22: 535.

Reshetinikova, A.V. 1955. Contribution to the parasite fauna of Sarda sarda Bloch in the Black sea. Tr: Karadagsk biol. St. XIII.

Rizvi, S.S.H. 1969. Studies on the structure of the sucker and seasonal incidence of Argulus foliaceus (L. 1758) on some freshwater fishes. Crustaceana. 17:(2): 200-206.

Rogers, W.A. 1968. The biology and control of the anchor worm, Lernaea cyprinacea. FAO Fisheries Report. 44: 393-398.

Rogers, W.A. 1969. Ergasilus cyprinaceus sp.n. (copepoda : cyclopoida) from cyprinid fishes of Alabama, with notes on its biology and pathology. J.parasit. 55 : 443-446.

Rogers, W.A; and J.P. Hawke. 1978. The parasitic copepod Ergasilus from the skin of the Gizzard shad Dorosoma cepedianum. Trans. Amer.Micros.Soc. 97 : (2) : 244.

Rohde, K. 1976a. Monogenean gill parasites of Scomberomorus commersoni Lacepede and other Mackerel on the Australian east coast. Z.parasitenk. 51 : 49-69.

Rohde, K. 1976b. Marine parasitology in Australia. Search. 7: 11-12 .

Rohde, K. 1978. Latitudinal differences in host specificity of Marine Monogenea and Digenea. Marine Biology. 47 : 125-134.

Rohde, K. 1979. A critical evaluation of intrinsic and extrinsic factors responsible for niche restriction in parasites. Am. Nat. 114 : 648-671.

Rohde, K. 1980. Comparative studies on microhabitat utilization by ectoparasites of some marine fishes from the North sea and papua new guinea. Zool. Anz. 204: 27-64.

Rohde, K. 1981. Niche width of parasites in species rich and species poor communities. Experimentia. 37 : 359-361.

Rohde, K. 1982. "Ecology of Marine parasites" University of Queensland press, St. Lucia, Queensland. 1982. pp. 245.

Rohde, K. 1984. Ecology of marine parasites. Helgolander Meeresunters. 37 : 5-33.

Rosenthal, H. 1967. Parasites in larvae of the herring (Clupea harengus L.) fed with wild plankton. Mar.Biol.1:392-395.

Rumpus, A.E. 1975. The helminth parasites of the bull head Cottus gobio (L) and the stone loach Noemacheilus barbatulus(L) from the river Avon, Hampshire. J.Fish.Biol.7:469-483.

Sachlan. 1952. Notes on parasites of freshwater fishes in Indonasia. Contrib. Inl.Fish.Res.stat. 2 : 1-60.

Sadowsky, V; and P. Soaresmoreira. 1981. Occurrence of Squalus cubensis in the western south Atlantic ocean, and incidence of its parasitic isopod Lironeca splendida sp.n. Studies neotrop.Fauna. Environ. 16:(3): 137-150.

Sastry, J.S; and R.S. D'souza. 1972. Upwelling and upward mixing in the Arabian sea. Indian.J.Mar.Sci. 2 : 17-27.

Sathyanarayana, M.C. 1982. Incidence of trematode parasite, Paraplerurus sauridae, in relation to season, sex and length of the marine fish, Saurida undosquamis. Indian. J.Mar. Sci. 11 : 188-189.

Satpute, L.R; and S.M. Agarwal. 1974. Seasonal infection of Clarius batrachus (Bloch) by Lytocestus indicus Moghe and parasitic effects on its haematology and histopathology. Indian. J. Experimental Biol. 12 : 584-586.

Satput, L.R; and S.M. Agarwal. 1980. Studies on seasonal infection of Clarias batrachus (Lim) by Lytocestus indicus Moghe, 1925. Indian. J.Helminth. 32 : (1) : 9-17.

Schad, G.A. 1963. Niche diversification in a parasitic species. Nature. 198 : 404-407.

* Scheer, D. 1934. Die Jugendform des acanthocephalaen Echinorhynchus truttae schr. und ihr Vorkommen in Gammarus pulex zeitschr. Parasitenk. 7 : 4.

Scott, A. 1929. The copepod parasites of Irish sea fishes. Proc. L Pool. Biol. Soc. 43 : 81-119.

Scott, J.S. 1969. Trematode populations in the Atlantic Argentina, Argentina silus, and their use as Biological indicators. J. Fish.Res.Bd. Can. 26 : 879-891.

Scott, M.E; and D.J. Nokes. 1984. Temperature dependent reproduction and survival of Gyrodactylus bullatarudis (Monogenea) on guppies (Poecillia reticulata) Parasitology. 89: (2) : 221-227.

Shariff, M. 1980. The histopathology of acute and chronic infections of rainbow trout Salmo gairdeneri Richardson with eye flukes, Diplostomum spp. J. Fish Dis. 3 : 455-465.

Shariff, M. 1981. The histopathology of the eye of big head carp, Aristichthys noblis (Richardson), infested with Lernaea piscinae Harding 1950. J.Fish.Dis. 4 : 161-168.

Shariff, M; Z. Kabata; and C. Sommer Ville. 1986. Host susceptibility to Lernaea cyprinacea L. and its treatment in a large aquarium system. J. Fish.Dis. 9 : 393-401.

Sharma, G.S; R. Narendran Nair; and Basil Mathew. 1982. Current structure in the intertropical Indian ocean during the northeast monsoon. Indian. J. Mar.Sci. 11 : 7-14.

Shey, H.J. 1966. Three species of Formosan copepoda parasitic on fishes. Crustaceana. 11 : 163-177.

Shields, J.R; and Goode. 1978. Host rejection of Lernaea cyprinacea L. (copepoda) Crustaceana. 35 : 301-307.

Shields, J.R; and R.G. Sperber. 1974. Osmotic relations of Lernaea cyprinacea (L) copepoda. Crustaceana. 26 : 157-171.

Shiino. 1956. Copepoda parasitic on Japaneese fishes. 17. Lernaeidae. Rep. Fac.Fish.prefect. Univ.Mie. 3 : 75-100.

Shimura, S. 1983. Seasonal occurrence, sex ratio and site preference of Argulus coregoni Thorell (crustacea : Brachiura) Parasitic on cultural freshwater Salmonids in Japan. Parasitology. 86 : 537-552.

Shimura, S; K.Inoue; K.Kassai; and H.Saito.1983. Haematological changes of Onchorhynchus masou (Salmonidae) caused by the infection of Argulus coregoni (crustacea Brachiura) Fish.Pathol.Tokyo. 18 : (3) : 157-162.

Shore, B.C. 1940. An investigation of the common fish louse, Argulus foliaceus. Parasitology. 32 : 361-367.

*Shulman, S.S. 1950. Parasites of fishes in the aquatories of the catvian republic. (abstract of thesis) Trud.gelmint. Lab. IV.

Shulman, R.E. 1979. Dependance of seasonal dynamics of fish parasites on some environmental factors. Ekologicheskaya eksper. parasit. Leningr.gos.Univ. 2 : 117-136.

Siegel, V. 1980. Quantitative investigations on parasites of Antartic channichthyed and nototheniid fishes. Meeresforschung. Rep.Mar.Res. 28 : (2-3) : 146-156.

Sinderman, C.J. 1954. Diseases of fishes on the western north Atlantic.1.Diseses of the sea herring (Clupea harengus). Res. Bull. 18 : 3-22.

Sinderman, C.J. 1963. Disease in marine populations. Transactions of the twenty-eighth North American wild life and Natural resources conference, March 4,5 and 6: 336-356.

Sinderman, C.J. 1966. Diseases of marine fishes. Adv, Mar. Biol. 4 : 1-89.

Sinderman, C.J. 1970. Principal disease of marine fish and shell fish. 359 pp. Academic press, Newyork and London.

Sinderman, C.J. 1984. Disease in marine aquaculture. Helgolander Meeresunters; 37 : 505-532.

Sinderman, C.J; and A. Rosenfield. 1954. Disease of fishes of the western north Atlantic. 3. Mortalities of sea herring (Clupea harengus) caused by larval trematode invasion. Marine Dept. sea shore fish.Res.Bull. 19 : 1-40.

Skorping, A. 1980. Population biology of the nematode Camallanus lacustris in Perch, Perca fluviatilis. L. from an oligetrophic lake in Norway. J. Fish. Biol. 16 : (5): 483-492.

Skorping, A. 1981. Seasonal dynamics of abundance, development and pattern of infection of Bunodera luciopercae (Muller) in perch Perca fluviatilis L. from an oligotrophic lake in Norway. J.Fish.Biol. 18 : 401-410.

Smith, H.D. 1973. Observations on the cestode Eubothrium salvelini in juvenile Sockey salmon (Onchorhynchus nerka) at Basine lake, British columbia. J. Fish. Res. Bd.Can. 30 : 947-964.

Solonchenko, A.I; and L.P. Tkachuk. 1985. Helminth infestation in mullets from the Azov and Black seas. Ehkol. Morya. 20 : 39-43.

Sproston, N.G; and P.H. Hartley. 1941. The ecology of some parasitic copepods of gadoids and other fishes. J.Mar.Biol. Ass. U.K. 21 : 361-392.

Stolyarov, V.P. 1936. Observations on the life cycle of Lernaea cyprinacea and its pathogenetic influence on the skin of fishes. Trav.Soc.Nat.Leningr., LXV : 2.

Strelkov, Yu.A. 1956. Endoparasitic helminths of marine fishes in eastern kamchatka report. Zool.Inst.Acad.Sci. U.S.S.R.

Stromberg, P.C; and J.L. Crites. 1974. Triaenophoriasis in Lake Erie white bass Morone chrysops. J.Wildl.Dis.10:352-358.

Stromberg, P.C; and J.L.Crites. 1975. Population biology of Camallanus oxycephalus ward and Magath 1916, (Nematoda : Camnallanidae) in white bass in western lake Erie. J. Parasit. 61 : (1) : 123-132.

Szalai, A.J; and T.D. Dick. 1987. Intestinal pathology and site specificity of the acanthocephalan Neoechinorhynchus carpiodi Dechtiar, 1968, in quill back, Carpiodes cyprinus (Lesueur) J.Parasit. 73 : (3) : 467-475.

Tedla, S; and C.H. Fernando. 1969. Observations on the seasonal changes of the parasite fauna of yellow perch (Perca flavescens) from the Bay of Quinte, Lake Ontario. J.Fish. Res.Bd. Can. 26 : 833-843.

Templeman, W; and H.J. Squires. 1960. Incidence and distribution of infestation by Sphyrion lumpi (Kroyer) on the red fish, Sebastes marinus (L) of the western North Atlantic J. Fish.Res.Bd. Can. 17 : (1) : 9-31.

Thomas, J.D. 1964a. Studies on the growth of trout Salmo trutta from contrasting habitats. Proc. Zool. Soc. Lond.142: 459-509.

Thomas, J.D. 1964b. A comparison between helminths burdens of male and female brown trout, Salmo trutta L. from a natural population in the river Teify, west wales. Parasitology. 54 : 263-272.

Thune, R.L; and W.A. Rogers. 1981. Gill lesions in bluegill Lepomis macrochirus Rafinsque, infested with Cleidodiscus robustus Muller, 1934. (Monogenea; Dactlylogyridae). I. Fish. Dis. 4 : 277-280.

Timmons, T; and W.G. Hemstreet. 1980. Prevalence rate of Lernaea cyprinacea L. (copepoda : Lernaeidae) on young of the year large mouth bass, Micropterus salmoides (Lacepede) in west point reservoir, Alabama Georgia, U.S.A. J. Fish. Dis. 3 : 529-530.

Tkachuk, L.P. 1985. On the parasite infestation of commercial fishes from the south west Indian Ocean. Ehkol.Morya. 20 : 29-35.

Turner, W.R; and R.B. Roe. 1967. Occurrence of parasitic isopod Olencira praegustator (Latrobe) in the yellowfin menhaden, Brevoorita smithi. Trans. Am. Fisheries.Soc. 96 : 357-359.

Underwood, H.T. 1981. Ecological studies on the endohelminth fauna of fishes from the upper san Marcon river. Dissertation Abstr.Int. (B) 42 : (3) : 882.

Uspenskaya, A.V. 1953. The life cycles of the nematodes belonging to the genus Ascarophis Van Beneden. (Nematode, Spirurata) Zool.Zh., 32 : 5.

Valtonen, E.T. 1980a. Metechinorhynchus salmonis (Muller, 1780) (Acanthocephala) as a parasite of the white fish in the Bothnian Bay. 1-seasonal reltionships between infection and fish size. Acta. Parasit. Pol. 27 : (34): 293-300.

Voltonen, E.T. 1980b. Metechinorhynchus salmonis (Muller. 1780) (Acanthocephala) as a parasite of the white fish in the Bothnian Bay. 2. Sex ratio, body length and embryo development in relation to season and site in intestine. Acat.Parasit. Pol. 27 : (35) : 301-307.

Valtonen, E.T. 1983a. Relationship between Corynosoma semerone and C. strumosure (Acanthocephala) and their parathenic fish hosts in the Bothnian Bay, Baltic Sea. Acta.Univ. Oulu (Ser.Biol.) 155 : 1-32.

Valtonen, E.T. 1983b. On the ecology of Echynorhynchus salmonis and two Corynosoma species (Acanthocephala) in the fish and seals of the northern Gulf of Bothnia. Acta. Univ. Oulu. (Ser.biol.) 156 : 1-48.

Vandenbroek, W.L.F. 1978. The effects of Lernaeocera branchialis on the Merlangius merlangus population in the Medway estuary. J.Fish. Biol. 13 : 709-715.

Vandenbroek, W.L.F. 1979. Copepod ectoparasites of Merlangius merlangus and Platichthys flesus J.Fish. Biol. 14 : 371-180.

Varadachari, V.V.R; and G.S. Sharma. 1967. Circulation of the surface waters in the north Indian ocean. J. Indian. Geophys. Union. 4 : 61-73.

Vaughan, G.E; and D.W. Coble. 1975. Sub-lethal effects of three ectoparasites on fish. J.Fish.Biol. 7 : 283-294.

Venard, C.E; and J.H. Warfel. 1953. Some effects of two species of Acanthocephala on the alimentary canal of the large mouth bass. J.Parasit. 39 : 187-190.

Vijaya Batra. 1984. Prevalance of helminth parasites in three species of cichlids from a man-made lake in Zambia. Zool. J. Linnean society. 82 : 319-333.

Vilijoen, B.C.S. 1986. A seasonal investigation of the genus Lernaea (Crustacea-copepoda) on cyprinid fish in Doskp Dam, Transvaui, South Africa. S. African. J. Wild Res. 16 : (1) : 27-31.

Wakelin, D. 1976. "Host responses" IN: Kennedy, C.R. ed. Ecological aspects of parasitology. Amsterdam, Oxford : North-Holland Publ. Co. 116-141.

Wales, J. 1958. Two new blood fluke parasites of trout. Calif.Fish. Game,44 : 125-136.

Walkey, M. 1967. The ecology of Neoechinorhynchus rutili (Muller) J.Parasit. 53 : 795-804.

Wardle, and Mcleod. 1952. The zoology of tapeworms (University of Minnesota press, Minneapolis). 780 pp.

Wastern, R.A; and T.A. Dick. 1980. Metazoan parasites of pike Exos lucius. Limnaeus, from southern Indian lake, Manitoba, Can, J. Fish. Biol. 17 : 255-261.

Wierzbicki, K. 1960. Philometra of crucian carp. Acta.Parasitol. Pol. 8 : 181-194.

Williams, D.D. 1979a. Seasonal incidence of Isoglaridacris wisconsinensis (cestoda : Caryophyllaeidae) in its fish host. Iowa State J. Res. 53 : 305-310.

Williams, D.D. 1979b. Seasonal incidence of Glaridacris laruei and G. catostomi in red cedar river, Wisonsin, Catastomus commersoni.Iowa State J. Res. 53 : 311-316.

Williams, H.H. 1965. Observations on the occurrence of Discocotyle coeliaca and Calicotyle kroyeri (Trematoda-monogenea). Parasitology. 55 : 201-207.

Williams, H.H. 1967. Helminth diseases of fish. Helminth Abstr. 36 : 261-295.

Williams, L.B; and E.H. Williams. 1979. Isopods of the genus Anilocra, parasites of some west Indian fishes. Proc.Assoc. ISL Mar. Lab. Carrib. P : 15.

Zitnan, R; and V.Hanzelova. 1981. The seasonal dynamics of the invasion cycle of Dactylogyrus extensus Muller et Van Cleave, 1923 (Monogenea). Helminthologia. 18: 159-167.

* Not seen in original.

****