American Journal of Biomedical Science and Engineering
2018; 4(2): 17-23
http://www.aascit.org/journal/ajbse
ISSN: 2381-103X (Print); ISSN: 2381-1048 (Online)

AASCIT American Association for Science and Technology

Polyfactorial Etiology on Demography of Parasitic Allocreodoidean Trematodes in the Gangetic Ecosystem

Sushil Kumar Upadhyay*, Raj Singh

Department of Biotechnology, Maharishi Markandeshwar (Deemed to be University), Mullana- Ambala (Haryana), India

Email address

upadhyay.k.sushil@gmail.com (S. K. Upadhyay)

*Corresponding author

Citation

Sushil Kumar Upadhyay, Raj Singh. Polyfactorial Etiology on Demography of Parasitic Allocreodoidean Trematodes in the Gangetic Ecosystem. *American Journal of Biomedical Science and Engineering.* Vol. 4, No. 2, 2018, pp. 17-23.

Received: February 23, 2018; **Accepted**: March 21, 2018; **Published**: June 1, 2018

Abstract: One decade (2007-2017) successive investigations were conducted for environmental influence on the population dynamics of parasitic helminthes in pisces of the Gangetic plains. The fresh water crow fish of the Gangetic riverine ecosystem were found to be infected by allocreodoidean trematodes in gastro-intestinal region. The impacts of seasonality, hydrobiological and climatic factors *vs.* helminthes bio-ecology were reflected during investigation. The peak infection appeared to be in month of May and June. Size, weight and sex biased population dynamics of helminthes infections were well marked. Helminthes infections were found to be significantly influenced by dissolved oxygen, temperature and pollution parameters, substantiated and analyzed by the application of advanced numerical tool, SYSTAT 11. Therefore, the evidence of polyfactorial etiology is available. Thus no single factor could be segregated for typical peaks of infections during investigation. The present study will provide a new dimension to fish farmers for management of fish farming in wild and artificial conditions. The weakness of the current investigation is that authors did not work out impact of artificial environmental factors *in vitro*.

Keywords: Demography, Polyfactorial Etiology, Allocreodoidean Trematodes, Fresh Water Fish

1. Introduction

Parasitic helminthes in aquatic vertebrates are frequent and natural incident. Helminthes be able to supply information about host bioecology. These communities can be applied to discriminate separate populations of the equivalent fish species co-inhabiting a region. Compassionate the aspects of parasite ecology, in their own interest, can illuminate parasite-avoidance strategies in a job by hosts. Utilization of resources and diet should have a major pressure on host revelation to parasitic worms [1, 2]. Fishes consumed invertebrates as prey within aquatic ecosystem, may dole out as secondary host for trophically transmitted parasites (especially trematodesand namtodes), predicting increased diversity of complex life-cycle [3, 4]. The vigorous conscription or transmission of endo-parasitic larvae or their passive transmissions via ingestion are crucial to determine variability in transmission dynamics. As a consequence, therefore, the structure of ecto and endo-parasitic communities in an aquatic environment is the function of the influence of host characteristics such as body size, diet, abundance, swimming behavior and host phylogeny. The shared inheritance between different groups of hosts that established their phylogenetical closeness usually has similar compositions of parasite communities [3, 5]. The divergence of host species due to diversified influence of ecological variations has a marked impact on the numerical descriptors of parasitic species *viz.* the abundance of species or richness might vary significantly even in closely related hosts, particularly if the biogeographic distribution of hosts are different, with differences in their habitats, diet and body size [4].

All the parasites or their developmental stages, which succeed in reaching into the human system through flesh as food, do not achieve success in establishment of its larval stages within the human host. However, a fewer successful

ones, whose infective stages occur frequently in the flesh of fish in riverine ecosystems can be ingested alive by human beings, causing, for example, anisakidosis as a zoonotic disease [6]. Therefore, the history of zoonoses encompassed the culture of preparation methods of traditional fish dishes, being prepared in society for centuries, particularly with the tradition of consumption of raw, uncooked meat dishes that in fact, are instrumental in transmission of food-borne pathogens from fish to human beings. The animals that use a larger home range and travel a greater distance per day should encounter more helminthes species through contact with the environment and other individuals. The information on day range length and home range size has been used as measures of individual ranging patterns. The relative importance of different host characteristics will also depend on the biology of parasites themselves. Therefore, earlier investigators have conducted [7, 8] repeated analyses, for two different functional groups of parasites, *viz.*, those transmitted largely by close or non-close contact, and those characterized by complex life cycles and transmission via intermediate hosts. Such hypotheses are not mutually exclusive, and independent variables affecting parasite species richness are likely to co-vary.

2. Method

The investigations were conducted for two consecutive years, 2007-2017, on fresh water fish of Gangetic plains of India to work out transmission dynamics and environmental influence on helminthes parasites. The collections of fishes were made from River Yamuna, Allahabad, Uttar Pradesh, India (81°49'06.28"E (Lon), (25°24'53.24"N (Lat), 74m (Alt)). The parasitological investigations were conducted on 3579 fishes, *Xenentodon cancila* (crow fish). The collected hosts were separated sex-wise, freshly weighed, their total and standard length measured. Viscera of hosts were teased by dissecting needle and examined microscopically for developing stages of parasitic helminthes, while intestine was carefully examined for adults. The collected worms were further processed, fixed and mounted for taxonomic identification [1]. The weekly/fortnightly qualitative estimation of Dissolved Oxygen (DO) in water was done by modified Winkler's method at the sites of investigation after American Public Health Association [9]. Water samples were collected in plastic samplers (Torson's sampling bottle). The fluctuation in hydrobiological parameters was analyzed by titrimetric/ volumetric analysis [10]. The correlations of infection prevalence and mean intensity [1] with extrinsic factors and intrinsic factors (sex, size and weight) were worked out, during different months and seasons. Various biostatistical parameters such as Linear regression, Analysis of variance [11] Multivariate analysis, Principal component analysis, Student 't' test and Poisson distribution [12] were applied to substantiate and evaluate the impact by application of advanced software SYSTAT11 during investigations.

3. Result

3.1. Season and Sex of Fish

The period of highest infection prevalence appeared to be late summer (female, 71.3% and male, 69.23%). On contrary, season of highest mean intensity were the period of maximum change in water temperature, *i.e.* autumn (female, 20.33), as well as winter (female, 19.37; male, 18.26). Monthwise population dynamics of flukes in fresh water fish showed significantly different sexwise distribution pattern (Figure 1).

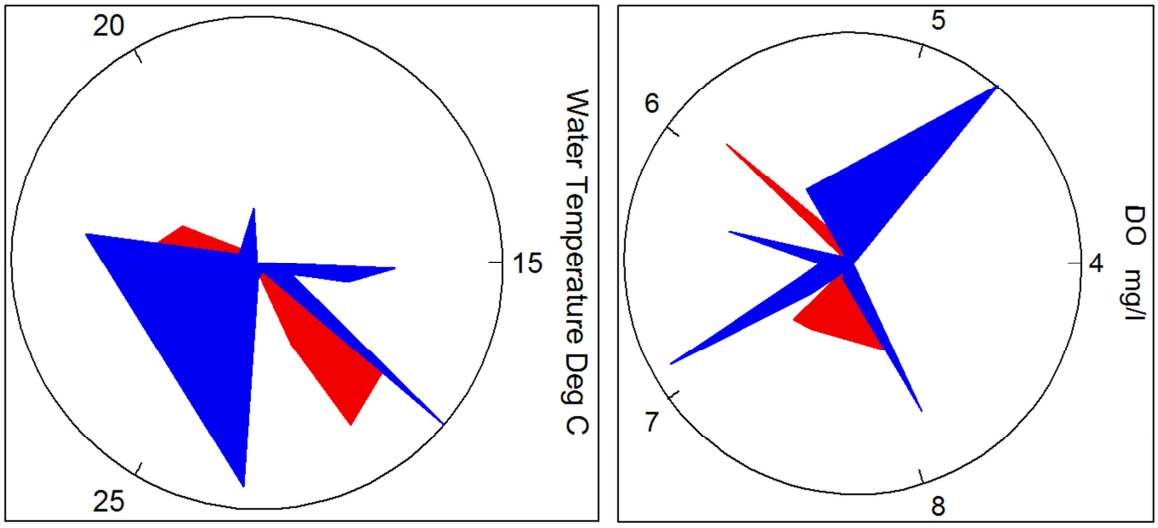

Figure 1. *Polar area curve depicting sex and monthwise association of infection prevalence vs. water temperature and dissolved oxygen by allocreodoidean trematodes in X. cancila.*

3.2. HydrobiologicalParameters

Monthwise association of combined influence of hydrobiological factors on infection prevalence and mean intensity by allocreodoideantrematodes in*X. cancila* was strongest in May- June and during November substantiated by cluster tree. The linear regression trends depicting varied

influence of hydrobiological parameters on infection prevalence and mean intensity by allocreodoidean flukes in both sexes of fish (Figure 2).

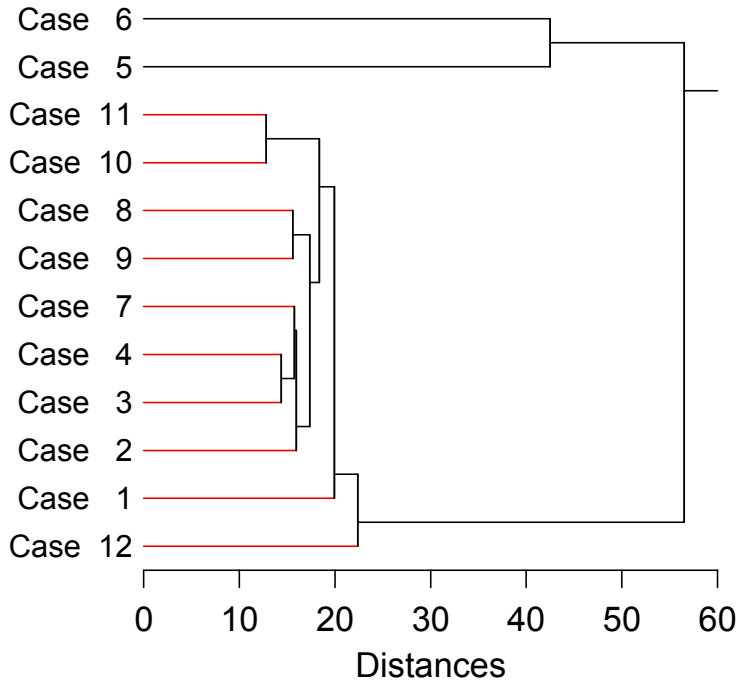

Figure 2. *Monthwise association of combined influence of hydrobiological factors on allocreodoidean trematodes infection in X. cancila.*

3.3. Mann-Whitney's Test

The findings of the Non-Parametric Mann-Whitney's test were found significant for dissolved oxygen on infection prevalence in male (Test statistic =7.872, p= 0.55 with 9 df) and magnesium on mean intensity of male and female fish (Test statistic =9.611, p= 0.50 with 10 df).

3.4. Multivariate Analysis

The interrelationships of multiple hydrobiological parameters reacting together in the same aquatic body during ten years of observations were described by multivariate analysis depicted below:

IPMALE-r=0.791

$$Y = 45.340 + {}^{\circ}C\ 0.560X_1 - DO\ 2.871X_2 - Hardness\ 0.148X_3 + Alk\ 0.056X_4 - Acidity\ 0.762X_5 + Cl\ 0.358X_6 + Ca\ 0.045X_7 - Mg^{*}\ 0.688X_8$$

IPFEMALE-r=0.943

$$Y = 170.859 - {}^{\circ}C\ 2.058X_1 - DO\ 11.263X_2 + Hardness\ 0.367X_3 + Alk\ 0.141X_4 - Acidity\ 1.286X_5 - Cl\ 0.657X_6 - Ca\ 0.723X_7 - Mg\ 0.534X_8$$

MIMALE-r=0.777

$$Y = 3.359 - {}^{\circ}C\ 0.601X_1 + DO\ 9.154X_2 + Hardness\ 0.224X_3 - Alk\ 0.032X_4 - Acidity\ 0.757X_5 - Cl\ 0.605X_6 + Ca\ 0.253X_7 - Mg\ 0.738X_8$$

MIFEMALE-r=0.897

$$Y = 38.539 - {}^{\circ}C\ 0.730X_1 - DO\ 1.462X_2 - Hardness\ 0.093X_3 + Alk\ 0.027X_4 + Acidity\ 0.225X_5 - Cl\ 0.179X_6 + Ca\ 0.113X_7 + Mg\ 0.344X_8$$

*°C, Water temperature; DO, Dissolved Oxygen; Alk, Alkalinity; Cl, Chloride; Ca, Calcium; Mg, Magnesium.

3.5. Principal Component Analysis

The biostatistical evaluation, particularly of Pearson's coefficient matrix affirmed DO as dominant Ist component (PC1^{P}) form Principal component analysis of infection data during investigation by allocreodoideantrematodes in *X. cancila*. The predominance of the Ist component was also reflected in the Scree plot and factor loadings plot of Eigenvalues as depicted in Figure 3.

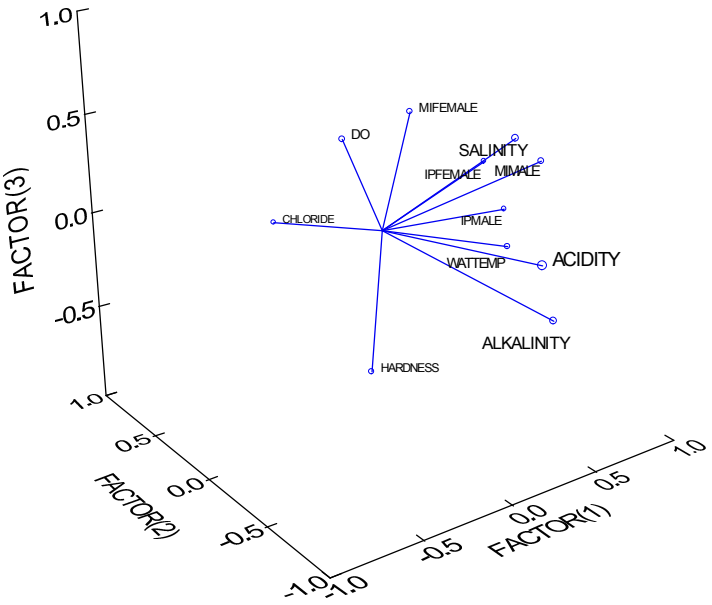

Figure 3. *The factor loadings plot of infection parameters by allocreodoidean flukes in X. cancila.*

3.6. Size of Fish

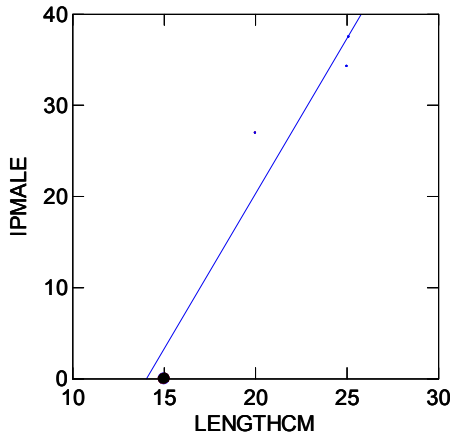

Figure 4. *Correlation of infection prevalence by allocreodoidean trematodes in male X. cancila with body size (cm).*

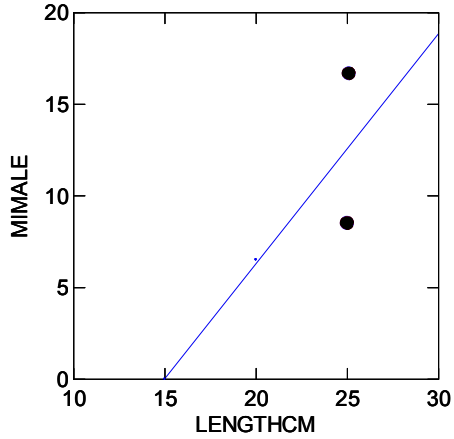

Figure 5. *Correlation of mean intensity by allocreodoidean trematodesin male X. cancila with body size (cm).*

The consistent findings of the ten year's studies summarily reflected positive change of events in the correlation of infection data corresponding to the augmented size of fish (Figures 4, 5). The highest infection prevalence (44.0%) and highest mean intensity (16.33) was estimated in the largest groups (>25.1cm). The findings explained that the larger fish (>20.1cm) had greater infection than the smaller ones (<15.0-20.0cm).

3.7. Weight of Fish

The consistent findings of the ten year's investigations for change of events in the correlation of infection data corresponding to the weight of fish were illustrated in Figures 6-8. The investigations represented the highest infection prevalence in medium weight class of fish. However peak mean intensity, 20.67 were encountered in the heavier fish that weighed more than 75.1g. The functional linear regression curves showed that the mean intensity was higher in heavier fish of both the sexes (Figures 6, 7). However, dispersal of infection (infection prevalence) was lower in heavier female (Figure 8).

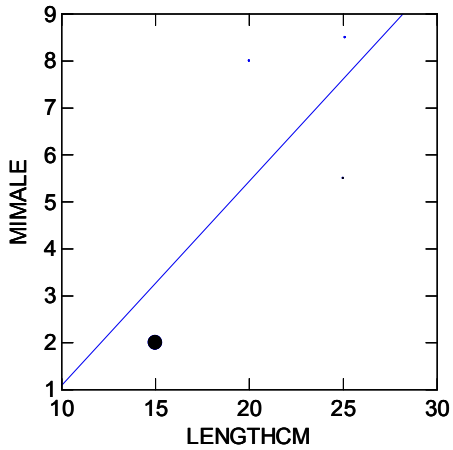

Figure 6. *Correlation of mean intensity by trematodes in male X. cancila with body size (cm).*

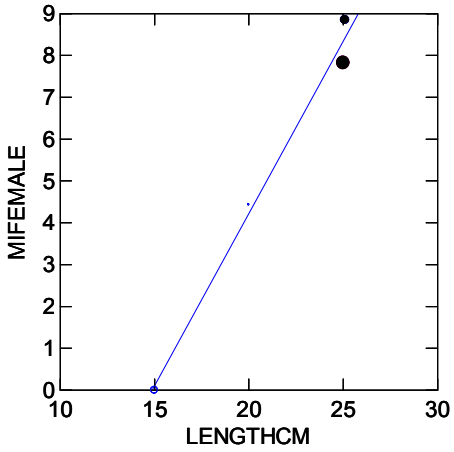

Figure 7. *Correlation of mean intensity by flukes in female X. cancila with body size (cm).*

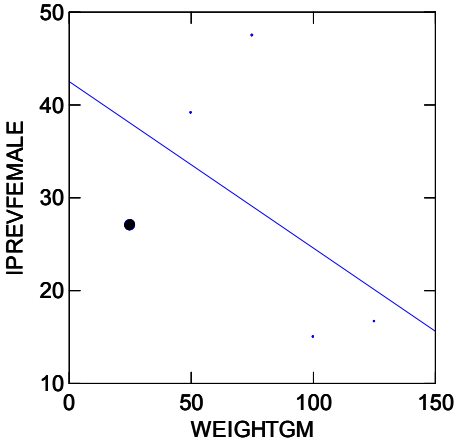

Figure 8. *Correlation of infection prevalence by allocreodoidean trematodes in female X. cancila with body weight (g).*

4. Discussion

The findings of this study were closest to those of [13] on allocreodoidean trematodes in fish, to show highest infection prevalence in summer period and highest mean intensity during winter period. It was illustrated by earlier workers [14] that the number of parasite species significantly increased in summer for the two habitats (upstream and downstream). It was also emphasized that in addition to effect of weirs, parasite diversity of gudgeon was influenced by season, with parasite diversity being higher during summer. This result was explained by these authors by changes in water temperature along the seasonal gradient. In view of [15] the parasite assemblages could also be affected by seasonal host movements (spawning movements), increasing the degree of social interactions of host, and consequently, the probability of parasite transmission.

The temperature optimum 23-27°C was concluded in the investigations conducted on edible fish in the wild. There was a spurt in the mean intensity in male fish at increased temperatures during study. The trematode recruitment was effectively under influence of spatial and temporal variations. The influence of temporal factors on community dynamics of trematodes in snails have vastly been worked out in temperate climates. The regular cyclic fluctuations in prevalence and intensity of infections by trematodes under influence of temperature changes in water bodies have been well documented [16, 17]. The temperature optimum in this study, 23-27°C was closely related to 26-27°C as reported by [18] for parasites of fishes in Meinhart and Manginia dam in Pakistan. The association of larval stages of trematodes with summer season in Pakistan fishes indicated that high water temperature revealed suitable conditions for their reproduction. Therefore, it was concluded that DO, temperature and Magnesium play a key role in the dynamins of allocreodoidean trematodes, that verified by the multivariate analysis, but the other extrinsic individual environmental factors such as hardness and alkalinity, enhanced due to the man made alterations in the natural water also play a significant impact on the establishment and abundance of the parasitic helminthes in freshwater aquatic fauna [19]. The high level of significance depicted by Principal component analysis, Mann-Whitney's test for effect of dissolved oxygen and magnesium on infection prevalence in fish, further strengthened viewpoint that the physico-chemical factors did not operate in isolation [20-24].

A positive correlation of infection by allocreodoidean trematodes with the size of *X. cancila* during study has been illustrated in the freshwater ecosystem. Larger fish had greater infection than in smaller ones during the investigations, due to the physiological, dietary habit variations and because of being greater in contact with the helminthes parasites [25-28]. There was a positive correlation between the body weight of *X. cancila* with flukes establishment during the parasitological investigations. The functional linear regression equations illustrated that the mean intensity was higher in heavier fish; however, infection prevalence was lower in heavier female fish [29-31].

5. Conclusion

The evidence therefore, is available in this study to indicate that the association of infection prevalence and mean intensity was not completely dependent on fluctuations in DO of water, particularly because of the continuous availability of infective larvae of nematodes in the area of study that lead ultimately two separated waves of infection in summer and winter periods. The impact of intrinsic and extrinsic factors, inter-ionic interaction among various hydro-parameters on allocreodoidean trematodes demography was reflected and well documented by advanced numerical tools. Therefore, the evidence of multifactorial etiology is available. Thus no single factor could be segregated for typical peaks of infections during investigation. The present study will provide a new dimension to fish farmers for management of fish farming in wild and artificial conditions.

Acknowledgements

Authors are very grateful to the Director, Maharishi

Markandeshwar Engineering College and Dr. Anil K. Sharma Professor and Head, Department of Biotechnology, Maharishi Markandeshwar (Deemed to be University), Mullana-Ambala, Haryana, India for continuous encouragement and laboratory facility for conduction of research.

References

[1] Upadhyay, S. K. 2012. Transmission dynamics and environmental influence on food borne parasitic helminthes of the Gangetic plains and central west coast of India. *Unpubl. D. Phil. Thesis*, University of Allahabad. 400p.

[2] Upadhyay, S. K., Jaiswal, N., Malhotra, A. and Malhotra, S. K. 2013. Ecological morphotaxometry of trematodes of garfish (Teleostomi: Belonidae) from Gangetic riverine ecosystem in India. II. Correlation of seasonality and host biology with distribution pattern of *Cephalogonimus yamunii* n.sp. *J. Parasit. Dis.,* 37 (2): 211-217.

[3] Upadhyay, S. K., Yadav, D. and Pathak, R. K. 2015. The impact of water quality on the population distribution pattern of cephalogonimid trematodes *Cephalogonimus yamunii* in fresh water fish *Heteropneustes fossilis* at Allahabad, Uttar Pradesh. *J. Kalash Sci.,* 3 (2): 11-17.

[4] Upadhyay, S. K. 2017. Environmental impact on helminth parasites of fresh water garfish from river Yamuna at Allahabad, Uttar Pradesh, India. *Proc. Zool. Soc. India,* 16 (02): 63-75.

[5] Jaiswal, N., Upadhyay, S. K., Malhotra, A. and Malhotra, S. K. 2014. Ecological morphotaxometry of trematodes of garfish (Teleostomi: Belonidae) from Gangetic riverine ecosystem in India. III. Principal Component Analysis for hydrobiological correlates to dynamics of infections by *Cephalogonimus yamunii* (Upadhyay, Jaiswal, Malhotra and Malhotra, 2012). *J. Parasit. Dis.,* 38 (2): 153-162.

[6] Audicana, M. T., Pozo, M. D. Del, Iglesias, R. and Ubeira, F. M. 2003. *Anisakis simplex* and *Pseudoterranova decipiens*. *In: International handbook of foodborne pathogens* (eds. R. Learmonth and M. D. Milliotis) 1st ed. Marcel Dekker, NY. 613-636.

[7] Nunn, C. L., Altizer, S., Jones, K. E. and Sechrest, W. 2003. Comparative tests of parasite species richness in primates. *Amer. Nat.* 162: 597-614.

[8] Lamkova., K., Simkova, A., Polycova, M., Jurajda, P. and Lojeck, A. 2007. Seasonal changes of immunocompetence and parasitism in chum (*Leuciscus cephalus*), a fresh water cyprinid fish. *Parasitol. Res.* 1755-1757.

[9] APHA (Amer. Pub. Hlth. Asso.) 1981. *Standard method for the examination of water and waste water*. 15th ed. *Amer. Wat. Works. Asso. Wat. Poll. Cont. Fed. Wash. D. C.* 134p.

[10] APHA (Amer. Pub. Hlth. Asso.) 1998. *Standard method for the examination of water and waste water*. 20th ed. *Amer. Wat. Works. Asso. Wat. Poll. Cont. Fed. Wash. D. C.* 1085p.

[11] Zeller, R. A. and Carmine, E. G. 1978. *Statistical analysis of social data*. *Rand. Mc. Nally. Coll. Publ. Co.* Chicago. 398p.

[12] Poission, S. D. 1837. *Recherchessur la probability des judgments*. Paris.

[13] Dhole, J., Jawale, S., Waghmare, S. and Chavan, R. 2010. Survey of helminth parasites in freshwater fishes from Marathwada region, MS, India. *J. Fish. Aquacult*. 1: 01-07.

[14] Loot, G., Reyjol, Y., Poulet, N., Simkova, A., Blanchet, S. and Lek, S. 2007. Effects of small weirs on fish parasite communities. *Parasitol. Res*. 101: 1265-1276.

[15] Karvonen, A., Cheng, G. H. and Valtonen, E. T. 2005. Within–lake dynamics in the similarity of parasite assemblages of perch (*Percafluviatilis*). *Parasitol*. 131: 817-823.

[16] Al-Kandari, W. Y., Abdul-Salam, J. and Meakins, R. 2000. Temporal variations in the infection of a population of *Cerithidea cingulata* by larval trematodes in Kuwait bay. *J. Helminthol*. 74: 17-22.

[17] Ernst, I., Whittington, I. D., Corneillie, S. and Talbot, C. 2005. Effects of temperature, salinity, dessication, hatchery and chemical treatment on egg embryonation and hatchery success of *Benedenia sericola* (Monogenea: Capsalidae, a parasite of formal *Sericola* sp.). *J. Fish. Dis.* 28: 157-164.

[18] Khan, M. N., Aziz, F., Afzal. M. Rab, A. Sahar, l. Ali, R. and Naqvi, M. 2003. Parasitic infection in different freshwater fishes of mini dames of Patohor region, Pakistan. *Pak. J. Biol. Sci*. 6: 1092-1095.

[19] Krasnov, B. R., Stanko, M., Miklisova, D. and Morand, S. 2006. Habitat variation in species composition of flea assemblages on small mammals in central Europe. *Ecol. Res.* 21: 460-469.

[20] Combes, C. 2001. *Parasitism. The ecology and evolution of intimate interactions*. University of Chicago Press, USA.

[21] Fenton, A. 2007. Worms and germs: the population dynamics consequences of microparasite-macroparasite coinfection. *Parasitol*. 135: 1545-1560.

[22] Poulin, R. 2007. *Evolutionary ecology of parasites* (2nd edn). Princeton, Princeton University Press, USA and Oxford, UK.

[23] Barrett, J. 2009. Forty years of helminth biochemistry. *Parasitol*. 136: 1633-1642.

[24] Kennedy, C. R. 2009. The ecology of parasites of freshwater fishes: the search for patterns. *Parasitol.* 136: 1653-1662.

[25] Morand, S., Cribb, T. H., Kulbicki, M., Rigby, M. C., Chauvet, C., Dufour, V., Falix, E., Galzin, R., Lo, C. M., Lo Zet, A., Pichelin, S. and Sasal, P. 2000. Endoparasite species richness of new Caledonain butterfly fishes: host density and diet matter. *Parasitol.* 121: 65-72.

[26] Simkova, A., Morand, S., Matejusova, I., Jurajda, P. and Gelnar, M. 2001. Local and regional influences on patterns of parasite species richness of central European fishes. *Biodiv. Conserv*. 10: 511-525.

[27] Chaurasia, G. 2002. Investigations to identify Biodiversity determinants in Ichthyoparasitology. *Unpubl. D. Phil. Thesis*. University of Allahabad. 129p.

[28] Ryce, E. K. N., Zale, A. V., Mac Connell, E. and Nelson, M. 2005. Effects of fish age versus size on the development of whirling disease in rainbow trout. *Dis. Aquat. Org.* 63: 69-76.

[29] Morand, S. and Guegan J. F. 2000. Distribution and abundance of parasite nematode: ecological specialisation, phylogenetic constraint or simply epidemiology? *Oikos.* 88: 563-573.

[30] Olurin, K. B. and Somorin, C. A. 2006. Intestinal helminthes of the fishes of Owa stream, South-West Nigeria. *Res. J. Fish. Hydrobiol*. 1: 6-9.

[31] Lindenfros, P., Nunn, C. L., Jones, K. E., Cunningham, A. A., Sechrest, W. and Gittleman, J. L. 2007. Parasite species richness in carnivores: effects of host body mass, latitude, geographical range and population density. *Global. Ecol. Biogeo*. 1-14.