INTERNATIONAL JOURNAL OF APPLIED BIOLOGY AND PHARMACEUTICAL TECHNOLOGY

www.ijabpt.com ISSN : 0976-4550

Volume-7, Issue-2, April-June-2016 Coden IJABFP-CAS-USA Copyrights@2016

Received: 16th Jan-2016 *Revised: 10h Feb -2016* *Accepted: 11th Feb 2016*

Research article

DISTRIBUTION OF PULMONATE SNAIL *INDOPLANORBIS EXUSTUS* IN RELATION TO VARIANT ABIOTIC FACTORS IN AND AROUND WATER BODIES OF DOON VALLEY, UTTARAKHAND

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ABSTRACT: The present communication deals with the distribution and population fluctuation of *Indoplanorbis exustus* under the impact of variant abiotic factors in Doon Valley, Uttarakhand. Further the study also revealed the effects of some physico-chemical parameters, like pH, water temperature, dissolved oxygen, free carbon dioxide on the occurrence and abundance of snail *Indoplanorbis exustus* in the vicinity of Doon Valley. The study involved sampling for a year from water bodies of various localities of Doon valley. Analysis of the data revealed that the physico-chemistry of the stream exercised profound effect on the distribution and population fluctuation of the fresh water snails. Significant changes in freshwater snail assemblages were primarily due to changes in the water quality from locality to locality. Coefficient of correlation (r) between population and physico-chemical parameters revealed significant relationship with population of the snail *Indoplanorbis exustus*. The study also revealed the existence of seasonal variation in the incidence of the species surveyed in different localities. The highest incidence of the snail have been found in monsoon season followed by post monsoon and winter seasons, while least incidence was reported in summer season indicated its thermophobic nature. The species was also found positive for different types of cercarial infection in selected localities.

Key words: Mollusca, Gastropoda, *Indoplanorbis exustus*, Cercaria, Physico-chemical

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INTRODUCTION

Fresh water snails belong to a large and highly diverse group of invertebrate known as the phylum – Mollusca and class - Gastropoda, which are extremely important communities of many ecological communities. Freshwater snails are considered as common components of the benthic communities, understanding their role in the aquatic ecosystems and their contribution to biomass production is deficient (Supian and Ikhwanuddin, 2002). They occur across a variety of habitats, reflecting the wide ranging biology of many different aquatic species. Marshes and swamps, permanent or temporary ponds, natural and manmade freshwater lakes, seasonal or permanent or slow flowing river streams, irrigated canals, rice fields and all other types of standing, slow flowing or impounded water are potential snail breeding sites. Being molluscs they have been important to humans throughout history as a source of food, jewellery, tools and even pets. The ecology of fresh water snails is considered to be affected by environmental abiotic factors like physico-chemical parameters (Ricker 1952; Shrivastava 1956; Vasisht and Bhandal 1979; OKland and Okland 1980; Pip, 1985; Dhar et al., 1985; Bisht et al., 1989; Habib 1997; Singh and Panwar, 1998; El-kady et al., 2000; Gupta and Khajuria 2004; Malik and Bharti 2005; Biswas et al., 2008; Garg et al., 2009; Devi et al., 2009). They are also influenced by other factors like availability of food, competition, predator-prey interactions (Williams, 1970; Harman, 1972; McMahon et al., 1974; Lassen, 1975; Ofoezie, 1999).

The detail studies on the diversity, occurrence and abundance of freshwater snails with special reference to effects of various abiotic factors on population dynamics have been studied in different parts of the world (Michael, 1968; Dutta and Malhotra 1986; Gupta et al., 1987; Amanullah and Hameed 1996; Khatri and Sharma 1996; Malhotra et al., 1996; Dey and Mitra 2000; Martins-Silva and Barros 2001; Strzelec and Królczyk 2004; Sharma et al., 2005; Gambhir et al., 2007; Surya Rao et al., 2008). In the year 2014 Gautam and Kakulte undertook studies on trematode cercariae of Gangapur project in Godavari River and reported six species of snails including *I. exustus* infected with cercraiae. Further, Ramitha and Vasandakumar (2015) made a survey of fresh water snails in Malabar, Kerala and observed that *Indoplanorbis exustus* dominated the collections of fresh water snails inhabited in stagnant waters and were found to thrive well in them.

Besides these, freshwater snails are also recognized as vector of different type of trematode parasites, causing various diseases *viz.*, shistosomiasis, fasciolopsis, amphistosomiasis etc. to the human beings and their livestock. They play significant role in public and veterinary health (Sharatkumar and Mohilal 2006; Kumar et al., 2007; Choubisa 2008; Devkota et al., 2011). Some species of aquatic snails play an important role in spreading these types of diseases because they harbor infected stages as intermediate host of the parasite (Abd El-Malek, 1958; Dazo et al., 1966; Barbosa and Barbosa, 1994; Brown, 1994; Karimi et al., 2004; Cañete et al., 2004; Kazibwe et al., 2006; Mostafa, 2009). India is well known for the abundance of these parasites (Mukherjee, 1980). Therefore it is necessary to know the name and proper identification of the snails before going into the details of larval trematodes present in snails. In India, *Indoplanorbis exustus* is also recognized as one of the most common and widely distributed pulmonate freshwater snail inhabits a variety of aquatic habitats. The snails also have medical importance, since the species have the potentialities to act as an intermediate host of helminthic parasites larvae and also have the abilities to transmit diseases to livestock and human beings. As far as the study regarding distribution of freshwater snails in Doon Valley is concerned, there were few publications, Srivatava and Jauhari (1990 a, b), Pokhriyal (1997, 1998 a, b), Rai and Jauhari (2009, 2010, 2012). The occurrence of the pulmonate snail is reported throughout the country, however, there is lack of systematic and detail study on the distribution of pulmonate snail *Indoplanorbis exustus* in Doon Valley.

MATERIAL AND METHODS

A survey of freshwater snails has been done at different localities *viz.*, Badowala (L-1), Nepalifarm (L-2), Dudhlee (L-3) and Gularghati (L-4). Freshwater snails have been collected from various aquatic habitats like riverbeds, irrigated canals, rice fields, others aquatic habitats etc. In other habitats ditches, streams were included. After collection these were brought to laboratory in polythene bags with water and vegetation of study areas providing natural situation to these snails. Further the collected snails were identified using standard keys and catalogues (Subba Rao 1989 and Ramakrishana & Dey, 2007).

During the study period a number specimens of *I. exustus* were collected form different localities of Doon valley. Snails were collected with the aid of forceps for the prevention of any cercarial infection. The snails were sorted, counted, grouped under different categories according to their diameter of the shell *i.e.* 0-5 mm, 5-10 mm and 10-15 mm. and data was processed. Beside these, water temperature was also determined using thermometer while water samples were collected from the same site. The samples were analyzed for pH, dissolved oxygen and free carbon dioxide as per standard methods (Golterman et al., 1978).

After collection on the next day snails were also exposed to sunlight or under table lamp for the emergence of cercariae. After emergence the cercariae were collected with the aid of fine dropper and kept on the slide and further investigation was done under the simple microscope. Slide of cercariae were prepared according to the method adopted by Mukherjee (1980) and Pokhriyal et al. (1998, a).

RESULTS

The population fluctuation trend of snail *I. exustus* was found to be different from locality to locality. During the study period habitat wise, size wise distribution and seasonal prevalence of snail *I. exustus* have been studied in all selected localities. The study revealed the occurrence of snails *Indoplanorbis exustus* throughout the year in all selected localities *viz.*, Badowala (L-1), Nepalifarm (L-2), Dudhlee (L-3) and Gularghati (L-4) (Fig. 1, 2[A-D]). Further, habitat wise distribution pattern of snail *I. exustus* have also been studied in all the four selected localities, which revealed that the high incidence of the snails in irrigated canals and paddy fields followed by riverbeds and other aquatic habitats, respectively in localities Badowala (L-1) and Nepalifarm (L-2). While in localities Dudhlee (L-3) and Gularghati (L-4), maximum specimens of snails *I. exustus* was found in irrigated canals followed by riverbeds, paddy fields and others in succession (Fig. 3 [A-D]).

During the study period size wise distribution of snails have also been studied. The collected snails were grouped in three categories – 0-5 mm, 5-10 mm and 10-15 mm in diameter. Size wise distribution of snails *I. exustus* in all selected localities revealed that snails ranged between 0-5 mm and 5-10 mm in diameter was found abundant in comparison to snail ranged between 10-15 mm in diameter (Fig. 4). The effects of seasons on population fluctuation of snail *I. exustus* have also been observed in selected localities. The observation showed clear existence of seasonal variation of the snails in different seasons. On the basis of seasonality maximum occurrence of snails was recorded in monsoon season followed by postmonsoon and winter seasons respectively, while least occurrence was observed during summer season in all selected localities (Fig. 5). The minimum number of snails reported in summer season would be due to the thermo phobic nature of the snails. The cercariometry of the snail was also found positive in all selected localities. The snails *I. exustus* was found infected with cercarial infection in all localities shedding two types of cercraiae *viz*., monostome and amphistome cercariae.

During study period various associated and supported environmental variables have also been recorded along with snail's population sites in selected localities. Various parameters like temperature, pH, dissolved oxygen (DO) and free carbon dioxide (CO_2) of snail's breeding habitats were analyzed. During the study period it was observed that at locality Badowala (L-1) water temperature was ranged between 12.4-26.1° C, pH of the water was also found slightly acidic with maximum value were recorded as 8.07, the range of DO and free CO_2 were also recoded as 3.15-5.03mg/l and 4.25-5.62 mg/l respectively. The minimum and maximum values of water temperature was found between 14.2-26.1° C at locality Nepalifarm (L-2), the pH of water valued between 6.92-7.70 during study period. The range of DO and free CO_2 were found between 4.12-5.32 mg/l and 3.95-5.75 mg/l respectively. Further in concern of all selected environmental variables more or less similar trend was found at locality Dudhlee (L-3) as compared to locality Nepalifarm (L-2). At locality Gularghati (L-4) pH of water was found alkaline with maximum value recorded as 8.94; the range of water temperature was observed between 13.7-27.5° C. The minimum and maximum range of DO and free CO_2 were found between 4.04-5.23 mg/l and 4.31-5.52 mg/l respectively at locality Gularghati (L-4) (Table.1).

Fig.1: Snail *Indoplanorbis exustus*, collected from water bodies of selected localities.

A correlation coefficient of physico-chemical factors of snail's breeding site with abundance of snail *I. exustus* was studied. At localities Badowala (L-1) and Nepalifarm (L-2), temperature has been found related to abundance of snails. At Localities Dudhlee (L-3) and Gularghati (L-4) there was a fluctuation in both the abundance of snails and water temperature. The following three parameters *viz*., pH, DO and free CO_2 have been found to alter the snail abundance month to month in all selected localities. At localities Badowala (L-1) and Dudhlee (L-3) pH concentration of water influenced the snail's population. Conclusively, It is gathered that pH, temperature and dissolved oxygen exhibited a positive correlation at P=0.05, while free CO_2 showed a negative correlation with the abundance of snail *I. exustus* in most of the selected localities (Table .2).

Table 1: Showing the minimum and maximum range of physico-chemical parameters of snail's habitat at different localities (L-1 to L-4) during study period.

Localities	Environmental Parameters			
	Temperature (°C)	pH	Dissolved Oxygen (mg/l)	Free CO_2 (mg/l)
Badowala (L-1)	12.4-26.1	6.9-8.07	3.15-5.03	4.25-5.62
Nepalifarm (L-2)	14.2-26.1	6.92-7.70	4.12-5.32	3.95-5.75
Dudhlee (L-3)	14.1-26.8	7.01-7.72	4.21-5.22	4.05-5.54
Gularghati (L-4)	13.7-27.5	7.05-8.94	4.04-5.23	4.31-5.52

Table 2: showing correlation coefficients of physico-chemical factors of snail's breeding sites (L-1 to L-4) with the abundance of snail *I. exustus* during study period.

Environmental factors	Localities							
	Badowala (L-1)		Nepalifarm (L-2)		Dudhlee (L-3)		Gularghati (L-4)	
	r	P	r	P	r	p	r	P
Temperature (°C)	0.73	P>0.05	0.69	P>0.05	0.49	P<0.05	0.45	P<0.05
pH	0.49	P<0.05	0.78	P>0.05	-0.01	-	0.01	P<0.05
Dissolved Oxygen (mg/l)	0.02	P<0.05	-0.22	-	0.45	P<0.05	-0.13	-
Free CO_2 (mg/l)	0.66	P>0.05	-0.23	-	-0.63	-	-0.07	-

Fig. 2 (A) Badowla (L-1)

Fig. 2 (B) Nepalifarm (L-2)

Fig. 2 (C) Dudhlee (L-3)

Fig. 2 (D) Gularghati (L-4)

Fig. 2 [A-D]: Different selected localities [L-1, L-2, L-3 & L-4] for the collection of snail *Indoplanorbis exustus*.

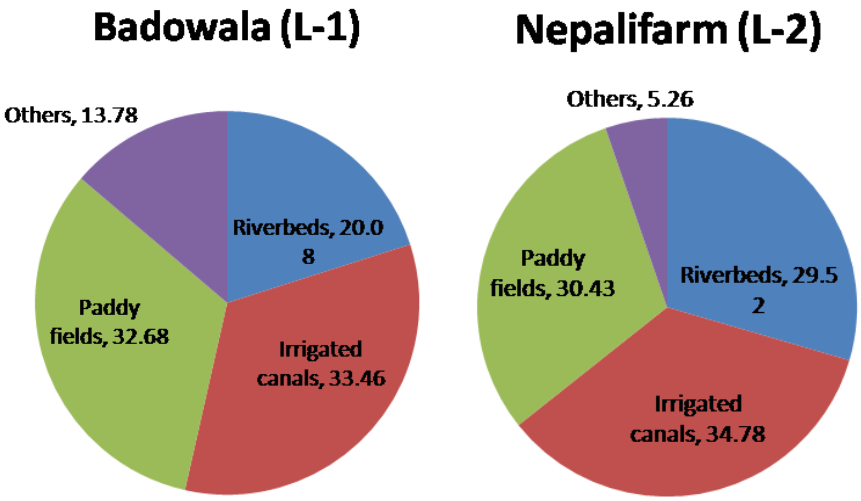

Fig. 3 A **Fig. 3 B**

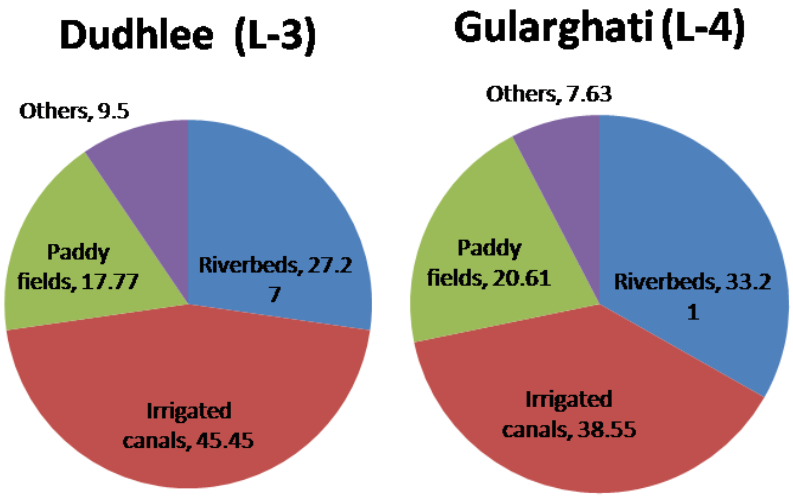

Fig. 3 C **Fig. 3 D**

Fig.3 [A-D]: Habitat wise distribution (%) of the snail *Indoplanorbis exustus* in selected localities [L-1, L-2, L-3 & L-4] during study period.

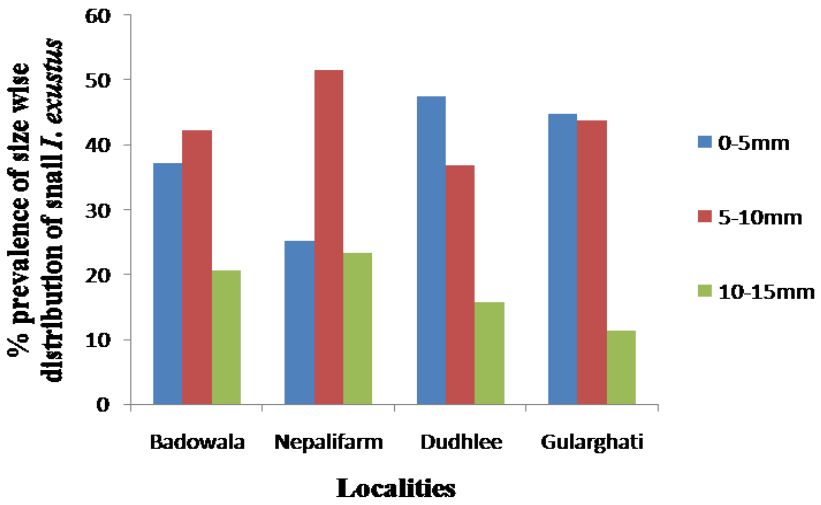

Fig. 4: Size wise distribution (%) of the snail *Indoplanorbis exustus* in selected localities [L-1, L-2, L-3 & L-4] during study period.

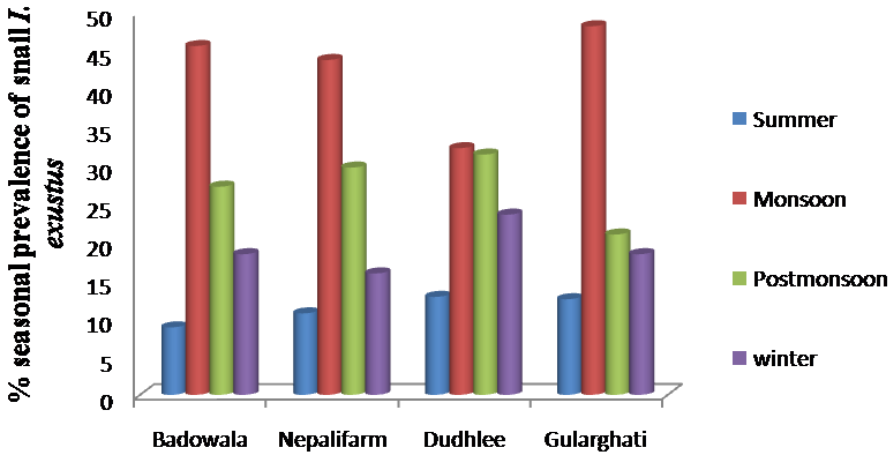

Fig. 5: Seasonal prevalence (%) of the snail *Indoplanorbis exustus* in selected localities [L-1, L-2, L-3 & L-4] during study period.

DISCUSSION

The distribution of snail *I. exustus* has been found different in different localities. The present communication revealed the occurrence of snail *I. exustus* throughout the year in selected localities of Doon Valley, however, the fluctuation in population trend of the snail was found in all localities. The present findings are close to Khatri and Sharma (1996), Singh and Panwar (1998), Dey and Mitra (2000), Sharma et al., (2005), Gambhir et al., (2007), Surya Rao et al., (2008) in the view of occurrence and abundance of freshwater snails with special reference to effects of various abiotic factors on population dynamics. The present results also support the observation made by Pokhriyal et al., (1997) who observed the occurrence of another species of pulmonate snail *Lymnaea (P.) acuminata* throughout the year in Doon Valley. Further Pokhriyal et al (1998 a) also made a study on the malaco faunal diversity of Asan river in Doon valley with special reference to vector of trematode parasites and collected 13 species of gastropods under 5 families. In the same year (1998 b) Pokhriyal et al., continued their studies on occurrence of recognized helminthic vector snails in different habitats in Dehradun valley and reported seven species of freshwater snails including snail *I. exustus*. The results of present findings are in accordance with Pohkriyal et al., (1998 a, b) in respect of occurrence of common forms of freshwater snail species in Doon Valley. The present findings also showed clear existence of seasonal variation of the snail *I. exustus* in different seasons. Further Pokhriyal et al. (1998 a) studied the seasonal variation on the basis of families of gastropods, while our study was made on the particular snail species, which clearly showed its variation in different season. Amanullah and Hameed (1996) did not give any information regarding the types of cercarial larvae collected from five species of gastropods, while the present findings also examined cercarial infection in snail *I. exustus* and found different types of cercariae *viz*., monostome and amphistome.

The present results are also related with findings of Gupta et al., (1987) who studied the bionomics of aquatic snails *Lymnaea luteola, L. acuminata* and *Gyaraulus convexiusculus* in Harayana state and also observed variation in population of snail species from locality to locality. Srivastava and Jauhari (1990, b) also pointed out clues on the population fluctuation of other species of freshwater snail *Thiara (Melanoides) tuberculata* in relation to their certain abiotic factors. The present findings are also in close with results made by Singh and Panwar (1998) who emphasized the bionomics of some aquatic snails of Merrut and found a clear cut seasonal variation among the different species of snails. El-kady et al., (2000) also made a survey of freshwater snails and studied the population dynamics in newly settled areas of Sinai Penninsula and they observed clear cut variation in the occurrence of freshwater snails in different months and habitats, which favors the findings of the present study.

The results of present study have been found more or less similar to the results made by Biswas et al., (2008) who emphasized their studied on the abundance and seasonal variation of benthic macro invertebrate in an Ox-bow lake in West Bengal. They collected 11 species of snails and observed that highest incidence of snails was found in monsoon and post monsoon seasons in comparison to pre monsoon.

The present findings revealed the influence of various abiotic environmental factors on snail's population and abundance in selected localities. Michael (1968), Dutta and Malhotra (1986) and Malhotra et al. (1996) also recorded a positive correlation between molluscs and temperature, while a negative correlation between temperature and molluscs was noticed by Ricker (1952), Shrivastava (1956) and Vasisht and Bhandal (1979).

OKland and Okland (1980) also found that most gastropods do not occur below the pH 6.0 and with only a few species being able to tolerate values as low as below 5.2.

The view of OKland and Okland (1980) differ with results made by Pip (1985) who observed that the snails were able to tolerate pH in range of 7.20-9.25 and below or above of this there was a decrease in number of snails. However in the present findings it was observed that slightly alkaline water was found much favorable for the snail's population and abundance.

The present findings are also in accordance with Dhar et al., (1985) who studied the aquatic snails of Kashmir valley and stated that snail abundance was found in alkaline medium of water ranged 7.12-9.04. According to Habib (1997) the presence of temperature was found essential to maintain the higher forms of biological life in water. The present findings is more or less similar the results made by Bisht et al., (1989) who carried out studied on hydrobiology of Song river in eastern Doon and stated that either very high or low dissolved oxygen exert a negative effects on the production of planktons.

The findings of Martins-Silva and Barros (2001) revealed that acidic pH was found unfavorable to the occurrence of molluscs. Strzelec and Królczyk (2004) indicated that many gastropod species are tolerant to most physico-chemical parameters and their occurrence is affected by the quality of bottom sediments and abundance of vegetation and reported that the most suitable substrate for snails in rivers is a sandy bottom covered with thin layer of organic silt. According to Cañete et al., (2004) temperature would play an important role in abundance of *Lymnaea* species. Gupta and Khajuria (2004) also undertook studies on the ecology of freshwater snails in lake Mansard, Jammu and mentioned that there was a variation in correlation coefficient between physico-chemical parameters and gastropods species in littoral, sublittoral and profaundal zones of lake. In this regard the findings of the present study are in agreement with Gupta and Khajuria (2004).

The present results are in agreement with the results made by Malik and Bharti (2005) who made a study on planktonic population fluctuation of Shastrdhara hill stream at Dehradun and pointed out a variation in physico-chemical parameters of the ecosystem that influenced the number and distribution of planktonic population in aquatic ecosystem. The fresh water snails were found to exhibit a negative correlation with free CO_2. Similar relationship between mollusks and free CO_2 was recorded by Garg et al. (2009) for the molluscs of Ramsagar Reservior (M.P). However, a very weak and insignificant negative correlation between molluscs and pH recorded by Garg et al. (2009) suggests that molluscs were found to be independent of fluctuations with respect to pH value, which did not favor our findings. Devi et al., (2009) also studied the ecology and biology of aquatic snails in Deepor Bel wetland of Assam and developed a correlation between physico-chemical parameters *viz*., pH, temperature and free CO_2 with snail population and found variation in values of selected parameters.

During the study period the cercariometry of the snail *I. exustus* was also found positive in all selected localities. The present study supports the views made by Sharatkumar and Mohilal (2006) who studied the trematode larvae and their seasonal variation in fresh water snails of Manipur and found different types of cercariae, recovered from different species of snail *viz*., *I. exuxstus, G. convexiusculus, L. luteloa, M. tuberculata* and *V. bengalensis*. Kumar et al., (2007) also made a study on the incidence of aquatic snails with regard to cercarial infection in Jharkhand and observed that snail species *Indoplanorbis exustus* and *Gyraulus convexiusculus* were commonly found to act as source of larval trematodes infecting livestock in some part of Jharkhand. The findings of the present study exhibited similarities with the results made by Kumar et al., (2007) in respect of cercarial infection and host specificity in fresh water snails. The findings of the present study are also accordance with the results made by Choubisa (2008) who studied the pathogenic trematode cercariae infecting fresh water snail species viz., *M. tuberculata, I. exutus, L. acuminata, L. luteola* and *V. bengalensis* in tribal region of Southern Rajasthan. Further the present study also supports the observations made by Choubisa (2008) who stated that rain water enhances the snail population of most of the fresh water snails species breed in rainy season, which would be one of the important reason for the maximum abundance of the snails in monsoon and postmonsoon seasons. Devkota et al. (2011) undertook studies on trematode caerariae infections in fresh water snails of Chitwan district, Central Nepal and observed that *I. exustus* had the highest prevalence of trematode infection, and harbored different types cercariae *viz*., amphistomes, brevifurcate-apharyngeate (likely mammalian schistosomes), clinostome, longifurcate-pharyngeate and xiphidiocercaria except gymnocephalus (likely fasciolid). The present findings also resembles with Devkota et al. (2011) in the concern of cercarial infection in snail *I. exustus*. According to Ramitha and Vasandakumar (2015) *I. exustus* proved to be the most preferred host of trematode parasites as maximum infection and trematode species diversity was observed in this snail. The present findings favored the results made by Ramitha and Vasandakumar (2015) in the concern of occurrence of the snail and also in the host specificity of trematode cercarial infection in snail *I. exustus*.

CONCLUSION

The present study give information on the ecology of *I. exustus* inhabits various types of aquatic habitats *viz*., riverbeds, irrigated canals, streams ditches etc. The study indicated clear cut variation in the occurrence of the snails in different seasons. The findings of the present study indicated that the distribution of the pulmonate snail *I. exustus* influentially correlated with the physico-chemical regime of the selected localities.

Besides these the snails harbored infected stage of different types of trematode larvae. Thus it would be interesting to undertake detail study on the seasonality and dynamics of cercarial infection in snail *I. exustus*. Findings of the present work would be utilized by researchers and ecologists as valuable information in public and veterinary health sciences and for water quality assessment studies.

ACKNOWLEDGEMENT

The authors are thankful to Uttarakhand State Council of Science and Technology for providing financial assistance.

REFERENCES

Abd El-Malek E. (1958). Factors conditioning the habitat of Bilharziasis intermediate hosts of the family Planorbidae. Bull. Org. mond. Santé. Bull. World Health. Organ: Vol.18, 785-818.

Amanullah B. and Sahul Hameed P. (1996). Studies on molluscan diversity in Kaveri river system (Tiruchirappalli, India) with special reference to vector snails of trematode parasites. Currenr Science: Vol. 71, 6, 437-475.

Barbosa F.S, and Barbosa C.S. (1994). The bioecology of snail vector for Schistosomiasis in Brazil. Cad. Saùde Pùbl., Rio de Janeiro: Vol.10, 2, 200-209.

Bisht S., Grover S.P. and Bhatt A.M (1989). Hydrobiology of the river Song in Eastern Doon. Uttar Pradesh J. Zool.: Vol. 9, 1, 121-123.

Biswas B.K., Hassan M.A. and Mukherjee A. (2008). Abundance and seasonal variation of benthic macro-invertebrates in an Ox-bow lake in West Bengal, India. Environment & Ecology: Vol., 26, 4B, 2112-2115.

Brown D.S. (1994). Freshwater Snails of Africa and their Medical Importance, 2nd Ed. Taylor & Francis, London, ISBN: ISBN 0-7484-0026-5, pp: 609.

Cañete R., Yong M., Sánchez J., Wong L. and Gutiérrez A. (2004). Population dynamics of intermediate snail hosts of *Fasciola hepatica* and some environmental factors in San Juan Martinez Municipality, Cuba. Mem. Inst. Oswaldo Cruz, Rio de Janeiro: Vol. 99, 3, 257-262.

Choubisa S.L. (2008). Focus on pathogenic trematode cercariae infecting freshwater snails (Mollusca: Gastropoda) of tribal region of southern Rajasthan. India. J. Parasitic Dis.: Vol. 32, 1, 47-55.

Dazo B.C., Hairston N.G. and Dawood I.K. (1966). The ecology of *Bulinus truncatus* and *Biomphalaria alexandrina* and its implications for the control of Bilharziasis in the Egypt- 49 Project Area. Bull. Org. mond. Santé Bull. World Health Organ: Vol. 35, 339-356.

Devi P., Islam S. and Das M. (2009). Ecology and biology of aquatic snails and their control: V. Ecology of snails in Deepor Beel wetland, Assam. J. vet Parasitol.: Vol. 23, 1, 17-22.

Devkota R, Budha P.B, and Gupat R. (2011). Trematode cercarial infections in fresh water snails of Chitwan district, Central Nepal. Himalayan Journal of Sciences: Vol. 7, 9, 8-14.

Dey A. and Mitra S.C. (2000). Molluscs of the Himalaya. Rec. Zool. Surv. India: Vol. 98, Part-2, 5-50.

Dhar D.N., Bansal G.C. and Sharma R.L (1985). Studies on the aquatic snails of Kashmir valley with particular reference to *Lymnaea auricularia sensu stricto*. Indian J. Parasitol.: Vol 9, 2, 241-244.

Dutta S.P.S. and Malhotra Y.R. (1986). Seasonal variations in the macrobenthic fauna of Gadigarh stream (Miran Sahib), Jammu. Indian J. Ecol.: Vol. 13, 138-145.

El-Kady G.A., Shoukry A., Reda L.A. and El-Badri Y.S (2000). Survey and population dynamics of freshwater snails in newly settled areas of the Sinai Peninsula. Egyptian J. Biol.: Vol. 2, 42-48.

Gambhir R.K., Chongtham I. Tranita Th., Gyaneswori I. and Chinglenkhomba A. (2007). A new species of echinostome cercaria from the snail, *Lymaea acuminata* of Manipur, India. Flora & Fauna: Vol. 13, 2, 427-428.

Garg R.K, Rao R.J. and Saksena D.N. (2009). Correlation of molluscan diversity with physicochemical characteristics of water of Ramsagar reservoir. India. Int. J. Biodivers. Conserv.: Vol. 6, 202-207.

Gautam A.D. and Kakulte (2014). Studies on larval tramatodes of Gangapur Project- Godavari river: Distome cercariae. International Journal of Life Science & Pharma Research: Vol. 4, 3, 57-67.

Goltermaan H.L., Clymo R.S. and Ohnstad M.A.M. (1978). Methods for physical and chemical analysis of fresh waters.Ed. II, Blackwell Scientific publ., pp.: 213.

Gupat K. and Khajuria A. (2004). Ecology of freshwater snails (gastropoda: Molluscs) in lake Mansar, Jammu. Advances in fish aand Wildlife Ecology and Biology: Vol.3, 258-264.

Gupta R.P., Yadav C.L., and Ruprah N.S. (1987). Studies on bionomics of some aquatic snails and their cercarial fauna of Harayana State. Indian vet. Med. J.: Vol. 11, 2, 77-83.

Habib I. (1997). Hydrobiological studies on river deorania at Bareilly. Rec. Adv. Biosc. Ocean: 169-190.

Harman W.N. (1972). Benthic substrates: their effect on water Mollusca. Ecology: Vol. 53, 271.

Karimi G.R., Derakhshanfar M. and Paykari H. (2004). Population density, trematodal infection and ecology of *Lymnaea* snails in Shadegan, Iran. Arch. Razi Inc.:Vol. 58,125-129.

Kazibwe F., Makanga B., Rubaire-Akiiki C., Ouma J., Kariuki C., Kabatereine N.B., Booth M., Vennervald B.J., Sturrock R.F. and Stothard J.R. (2006). Ecology of *Biomphalaria* (Gastropoda: Planorbidae) in Lake Albert, Western Uganda: snail distribution, infection with schistosomes and temporal associations with environmental dynamics. Hydrobiologia: Vol. 568, 433-444.

Khatri A. and Sharma P.N. (1996). Seasonal variation among snails of Udaipur region. J. Parasit Appl Anim Bio.: Vol. 5, 1, 21-24.

Kumar R.R., Prasad K.D. and Kumar A. (2007). Incidence of aquatic snail and cercariae of the commonly infecting trematodal parasite of livestock in Jharkhand. Indian J. Anim. Hlth.: Vol. 46, 2, 121-122.

Lassen H.H. (1975). The diversity of freshwater snails in view of the equilibrium theory of island biogeography. Oecologia: Vol. 19, 1-8.

Malhotra Y.R., Sharma K.K. and Thakial M.R. (1996). Ecology of macro invertebrates from a fish pond. Proc. Natl. Acad. Sci. India: Vol. 66, 53-59.

Malik D.S. and Bharti P.K. (2005). Fluctuation in planktonic population of Sahastradhara hill-stream at Dehradun, Uttaranchal. Aquacult: Vol. 6, 2, 213-220.

Martins-Siva M.J. and Barros M. (2001). Occurrence and Distribution of Fresh-Water Molluscs in the Riacho Fundo Creek Basin, Brasilia, Brazil. Rev. Biol. Trop.: Vol. 49, 3-4.

McMahon R.F., Hunter R.D. and Russell-Hunter W.D. (1974). Variation in aufwuchs at six freshwater habitats in terms of carbon biomass and carbon: nitrogen ratio. Hydrobiologia: Vol. 145, 391-404.

Michael R.G. (1968). Studies on bottom fauna in a tropical freshwater pond. Hydrobiology:Vol. 31, 203-230.

Mostafa O.M.S. (2009). Effect of salinity and drought on the survival of *Biomphalaria arabica*, the intermediate host of *Schistosoma mansoni* in Saudi Arabia. Egyptian Acad. J. Biol. Sci.: Vol. 1, 1, 1-6.

Mukherjee R.P. (1980). Collection and study of larval trematodes (Platyhelminthes). Proc. Workshop Tech. Parasitol. Zool. Surv. India: 23-26.

Ofoezie I.E. (1999). Distribution of freshwater snails in the man-made Oyan Reservoir, Ogun State, Nigeria. Hydrobiology: Vol.416, 181-191.

Okland, J. and Okland, K.A (1980). Acidification threatens trout diet. Res in Norway: 21-27.

Pip E. (1985). The ecology of fresh water gastropods on the southwestern edge of Precambrian shield. Can. Field Nat.: Vol. 99, 1, 76-85.

Pokhriyal B.P., Mahesh R.K. and Jauhari R.K. (1997). Prevalence of trematode cercarial infection in the snail *Lymnaea (Pseudosuccinea) acuminata* Lamarck, 1822 in different localities of Dehradun Valley. Bioved: Vol. 8, 1-2, 15-19.

Pokhriyal B.P., Mahesh R.K. and Jauhari R.K. (1998 a). Studies on the molluscan diversity of Asan river system in Doon Valley with special reference to vectors of trematode parasites. Indian J. Forestry: Vol. 21, 2, 167-170

Pokhriyal B.P., Mahesh R.K. and Jauhari R.K. (1998 b). Occurrence of recognized helminthic vector snails in different habitats in Dehradun Valley. Him. J. Env. Zool.: Vol. 12, 167-172.

Rai R. and Jauhari R.K. (2009). New record of a pulmonate snail, *Physa acuta* Draparnaud, 1805 (Gastropoda: Physidae) from Doon-Valley (Uttarakhand). Ann. For.: Vol. 17, 2, 293-297.

Rai R. and Jauhari R.K. (2010). Malaco faunal diversity in water bodies of Doon Valley. Uttar Pradesh J. Zool.: Vol. 30, 1, 101-106.

Rai, R. and Jauhari, R.K. (2012). Bioecology of a pulmonate snail, *Physa acuta* Draparnaud (Mollusca: Gastropoda) in Doon-Valley (Uttarakhand). 1st Ed. Macmillan Publishers India Ltd. ISBN: 978-935-059-119-2, pp: 176-180.

Ramakrishana and Dey A. (2007). Handbook on Indian freshwater molluscs. Ed. 1st Zoological Survey of India, Kolkata. ISBN: 978-81-8171-146-5, pp:1-399.

Ramitha U.C. and Vasandakumar M.V. (2015). Survey of freshwater snails in Malabar, kerala and an account on the prevalence of infection by digenean (Platyhelminth) parasites. J. Chem. Bio. Phy. Sci.: Vol. 5, 4, 4065-4070.

Ricker W.E. (1952). The benthos of Cultus lake. J. Fish. Res. Bd. Canada: Vol. 9, 204-212.

Sharatkumar S. and Mohilal N. (2006). Larval trematodes and their seasonal variation in snails of Manipur. Uttar Pradesh J. Zool.: Vol. 25, 3, 307-310.

Sharma B., Sharma N. and Kumar, D. (2005). Biodiversity of fresh water snail fauna of Western Uttar Pradesh. Uttar Pradesh J. Zool.: Vol. 25, 3, 303-306.

Shrivastava V.K. (1956). Studies on the freshwater bottom fauna of North India. Quantitative fluctuations and qualitative composition of benthic fauna in lake in Lucknow. Proc. Nat. Acad. Sci.: Vol. 25, 406-416.

Singh H.S. and Panwar N. (1998): Bionomics of some aquatic snails of Merrut. Uttar Pradesh J. Zool.: Vol 18, 1, 77-79.

Srivastava N. and Jauhari R.K. (1990 a). Influences of certain abiotic factors on the occurrence of larval trematodes in *Lymnaea acuminata* (Lamarck) in Doon Valley. Riv. di Parassit.: Vol. 51, 3, 341-355.

Srivastava N. and Jauhari R.K. (1990 b). Population fluctuation of fresh water snails, *Thiara* (*Melanoides*) *tuberculata* in Doon Valley in relation to certain abiotic factors. J. Zool. Soc. India.: Vol. 41, 1&2, 63-67.

Strzelec M. and Królczyk A. (2004). Factors affecting snail (Gastropoda) community structure in the upper course of the Warta river (Poland). Biologia Bratislava: Vol. 59, 2, 159-163.

Subba Rao, N.V. **(**1989). Handbook Fresh water molluscs of India. Ed. 1st Zoological Survey of India, Calcutta, XXIII + 1-289.

Supian, Z. and Ikhwanuddin, A. M. (2002). Population dynamics of freshwater molluscs (Gastropod: *Melanoides tuberculata*) in Crocker Range Park, Sabah. ASEAN Rev. Biodiv. Environ. Conserv. (ARBEC): pp. 1-9.

Surya Rao K.V., Mitra S.C. and Manna R.N. (2008). Land and fresh water Molluscs of Pondicherry. Rec. Zool. Surv. India: Vol. 108, Part-2, 1-15.

Vasisht H.S. and Bhandal R.S. (1979). Seasonal variations of benthic fauna of some North Indian lakes and ponds. Ind. J. Ecol.: Vol. 6, 77-83.

Williams, N. V. (1970). Studies on aquatic pulmonate snails in Central Africa. I: Field distribution in relation to water chemistry. Malacologia: Vol. 10, 153-164.

ISSN : 0976-4550

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