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INCIDENCE OF LARVAL TREMATODES INFECTION AND THEIR SEASONAL VARIATIONS IN THE FRESH WATER MOLLUSCS OF SOUTHERN-RAJASTHAN

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(With 3 Figures)

Introduction

Molluscs serve as intermediate hosts for many digenetic trematodes. Studies on the larval trematodes and their seasonal variations in the Indian aquatic molluscan are scanty.

Dubois (1929), Rees (1932), Wesenburg-Lund (1934), Rothschild (1941), Wikgren (1956), Deforest (1957), Khan (1960a, b), Radke *et al.* (1961), Larson (1961), Ewers (1964) and Basch (1966) have studied the larval trematodes infecting the different molluscan hosts. The seasonal variations of infection of larval trematodes in India have been studied by Soparkar (1921) Sewell (1922), Chatterji (1933), Ganpati and Hanumanth Rao (1959), Singh (1959), Probert (1966), Mukherjee (1966), Jain (1970, 1976), Mohandas (1974), Pandey and Agarwal (1978) and Choubisa and Sharma (1982). The present paper deals with the type of cercariae that infect the fresh water molluscs of Southern Rajasthan and their seasonal variations.

Material and Methods

During survey (from April, 1982 to March, 1983) of cercarial infection in fresh water snails of Southern-Rajasthan a rich collection of live specimens of more than 15,000 gastropods and 3,500 bivalves inhabiting the lentic and lotic habitats of five districts viz. Udaipur, Chittorgarh, Bhilwara, Dungarpur and Banswara was made in different seasons.

Molluscan species of lentic or lotic habitat, of bottom dwelling and surface-dwelling habits were maintained separately in laboratory aquaria. For examination the snails were exposed to light for cercarial infection and they were also dissected out for the presence of larval trematodes.

The larval trematodes were collected and examined according to the methods reported by Mukherjee (1980). Thus, the larvae were studied under light cover-slip pressure, both alive as well as in stained mounts. Neutral red and methylene blue were also employed for detailed study of penetration glands, gut and genital rudiments. Unstained live cercariae were studied specially for their Flame cell formulae. They were then identified following the key as given by Erasmus (1972).

Observations

All molluscan species of moderate size were usually found infected. *Vivipara bengalensis*, however, revealed gigantism due to helminthic

TABLE I. Habit and habitat of molluscs with their larval trematodes.

Class	Molluscs	Habit/ Habitat	Cercariae						Metacercariae				
			M	G	E	F	X	A	P	As	E	S	OP
Gastropoda	(A) *Hydrobidae*												
	(i) *Bithynia stenothyroides*	bd/o	—	—	—	+	—	—	—	—	—	—	—
	(B) *Viviparidae*												
	(i) *Vivipara bengalensis*	bd/e	—	—	+	+	+	—	+	—	+	—	—
	(ii) *Vivipara dissimilis*	bd/o	—	—	—	+	—	—	—	—	—	—	—
	(C) *Thiara (Melanoides)*												
	(i) *Melania tuberculata*	bd/e	+	+	—	+	+	—	—	+	—	—	—
	(ii) *Thiara (Thiori) scabra*	bd/o	—	—	—	—	+	—	—	—	—	—	—
	(iii) *Faunus ater*	bd/o	—	—	—	+	—	—	—	—	—	—	—
	(D) *Lymnaeidae*												
	(i) *Lymnaea acuminata*	sd/e	—	+	+	+	+	—	—	—	—	—	—
	(ii) *Lymnaea luteola*	sd/e	—	+	—	+	+	+	—	—	—	—	—
	(iii) *Lymnaea auricularia*	sd/e	—	+	+	+	+	—	—	—	—	+	—
	(iv) *Lymnaea pinguis*	sd/e	—	—	—	+	+	—	—	—	—	—	—
	(E) *Planorbidae*												
	(i) *Indoplanorbis exustus*	sd/e,o	—	—	+	+	+	+	—	—	—	—	+
	(ii) *Gyraulus convexiusculus*	sd/e	—	—	+	+	+	+	—	—	—	—	—
Pelecypoda	(A) *Unionidae*												
	(i) *Lamellidens marginalis*		—	—	—	—	—	—	—	—	—	—	—
	(ii) *Lamellidens* (species)		—	—	—	—	—	—	—	—	—	—	—
	(B) *Corbiculidae*												
	(i) *Corbicula regularis*		—	—	—	—	—	—	—	—	—	—	—
	(ii) *Corbicula stiatella*		—	—	—	—	—	—	—	—	—	—	—

Abbreviations used : + infected ; —noninfected ; bd, bottom dweller ; e, lentice (stagnent water) : o, lotic (running water) ; sd, surface dweller. A, amphistome ; As, aspidogaster ; E, echinostome ; F, furcocercous cercaria ; G, gymnocephalous ; M, monostome ; OP, opisthorchid ; P, plagiorchiid ; S, strigeid and X, xiphidiocercaria.

infection. Inspection of several hundred specimens of *V. bengalensis* revealed gigantism only in those individuals which were infected.

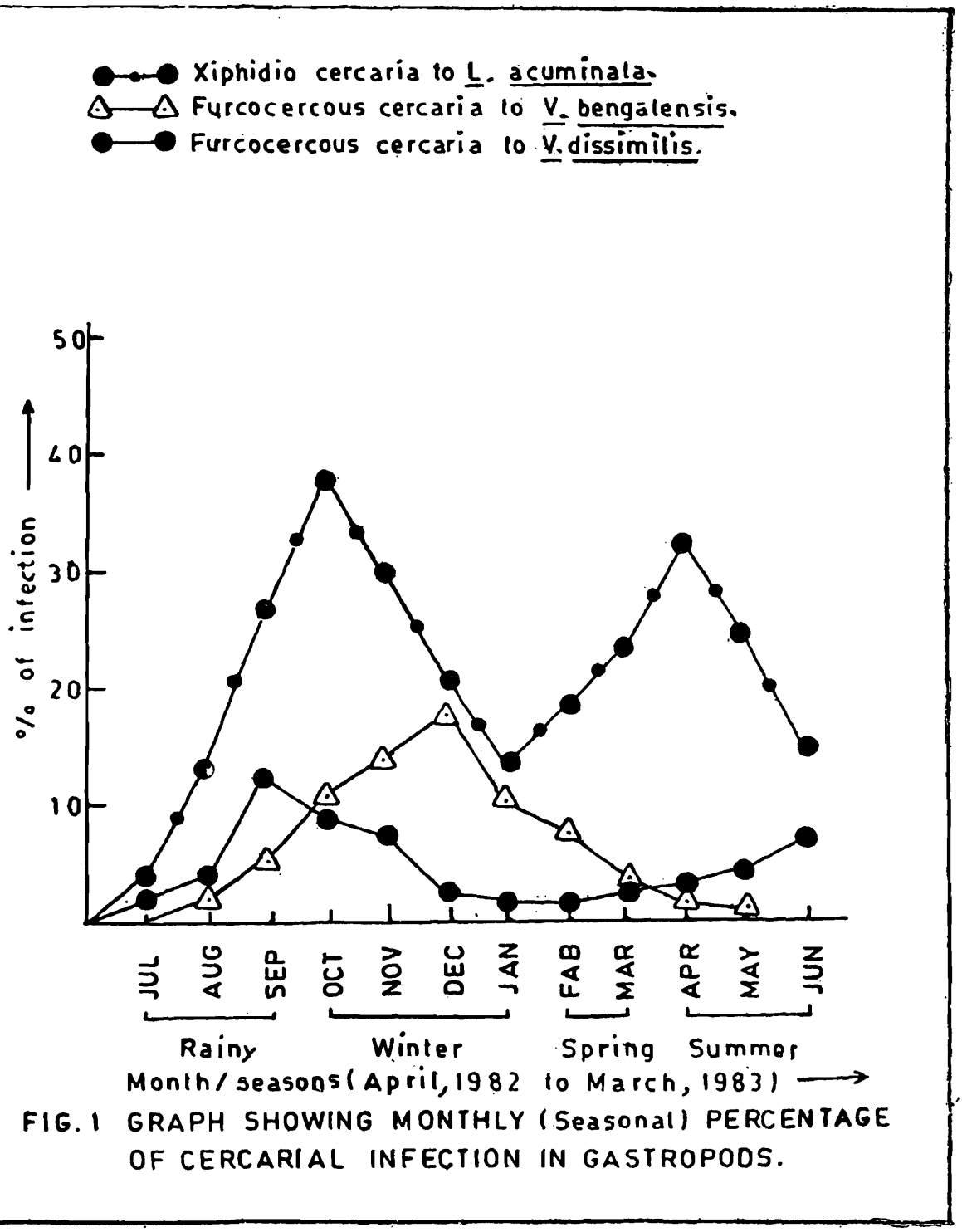

FIG. 1 GRAPH SHOWING MONTHLY (Seasonal) PERCENTAGE OF CERCARIAL INFECTION IN GASTROPODS.

Surface dwelling lentic gastropods *Lymnaea acuminata*, *L. auricularia*, *Indoplanorbis exustus* and *Gyraulus convexiusculus* revealed a fairly heavy infection of various types of cercariae. Bottom dwelling lentic molluscs *Vivipara bengalensis* and *Melania tuberculata* were found to be resistant to cercarial infection in comparison to other freshwater snails (Fig. 1). However, the incidence of infection within these molluscs in ponds was recorded slightly higher than those in lakes.

Molluscs of lotic water with bottom dwelling habit belonging to the families Hydrobidae, Viviparidae and Melaniidae showed a very low

incidence of infection of cercariae (Table I). Unionidae, Corbiculidae indicate no cercarial infection.

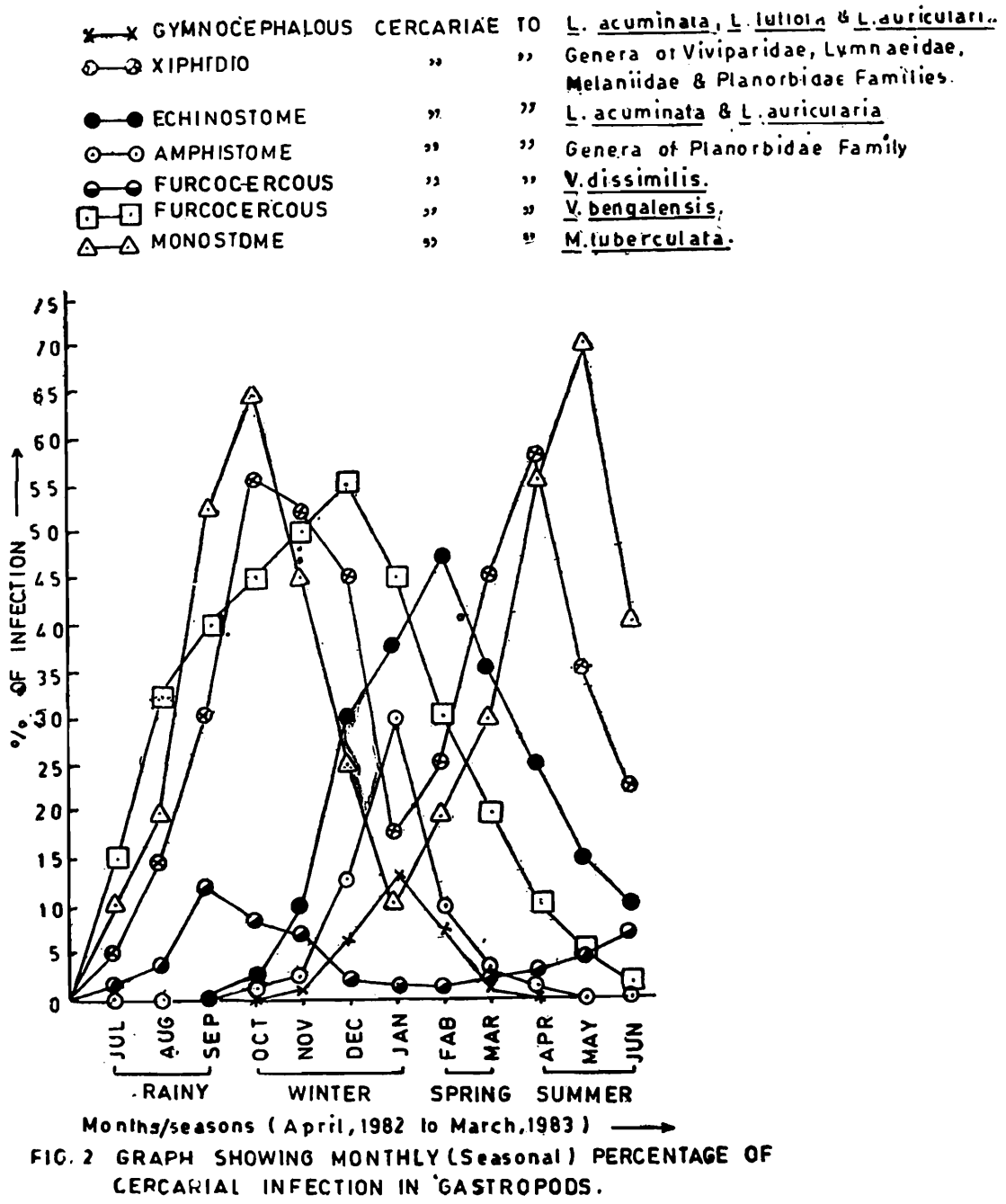

FIG. 2 GRAPH SHOWING MONTHLY (Seasonal) PERCENTAGE OF CERCARIAL INFECTION IN GASTROPODS.

Seasonal variations in the percentage of infections :

Gastropods infected with different larval parasites, cerariae and metacercariae, showed seasonal variations in the percentage of infections and indicated in the Figs. 2 and 3.

Xiphidio and monostome cercariae showed two peak periods of cercarial infection—one in the month of May and another in the month of October. Xiphidio cercariae were recorded from the genera belonging to families Viviparidae, Melaniidae, Lymnaeidae and Planorbidae and Monostome from *M. tuberculata* only as shown in Table II.

Viviparidae : The species belonging to this family that have been examined for cercarial infection are listed in Table I. *V. bengalensis* was found to be infected with furco and xiphidio-cercariae throughout the year. Echinostome cercariae were also recorded from this snail in the month of January but the percentage of infection was low (5%). Another fucocercous cercaria with two pigmented eyes spots, was shed by *V. dissimilis* in the month of September and incidence of infection was 12.5%.

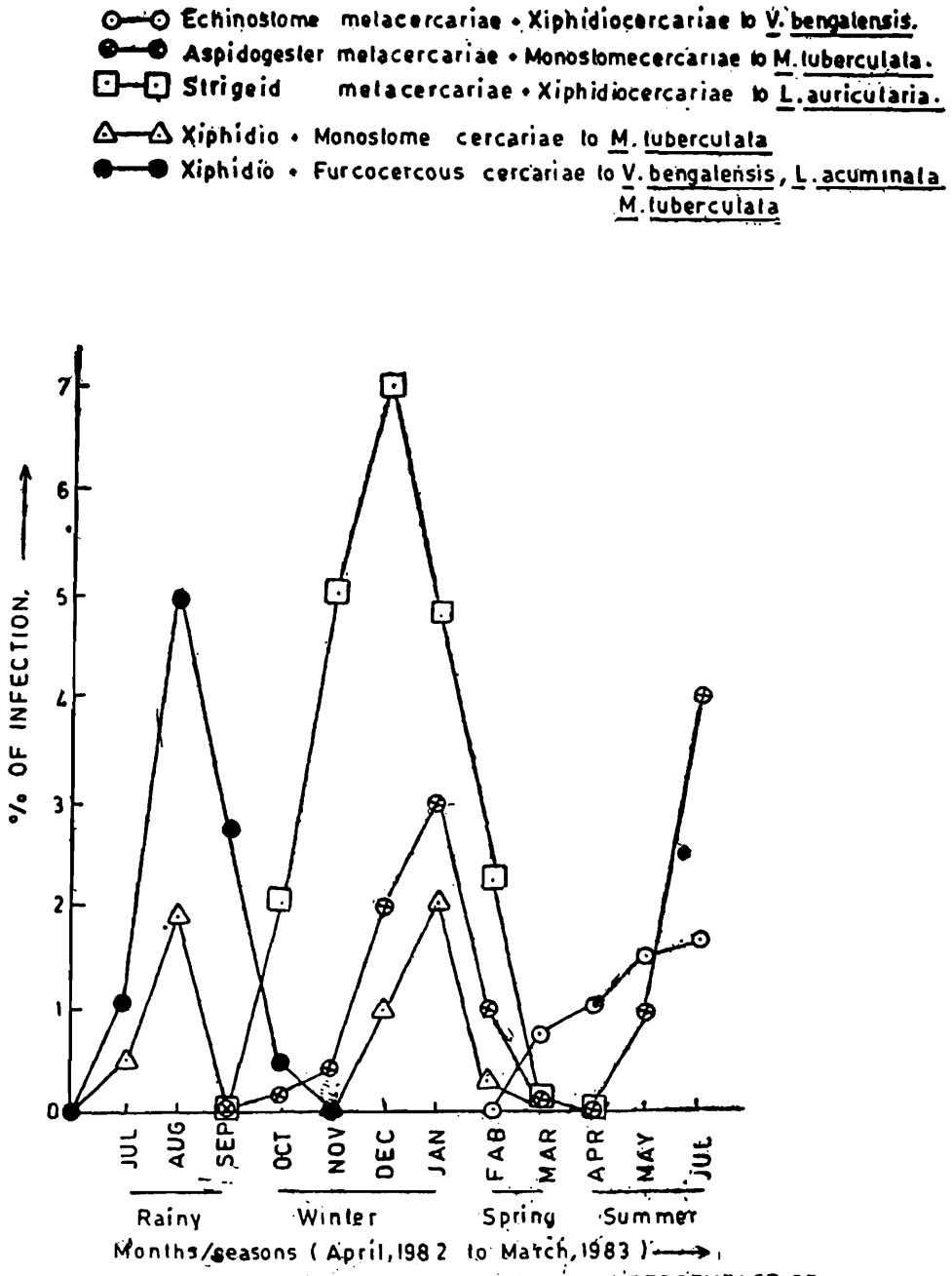

FIG. 3 GRAPH SHOWING MONTHLY (Seasonal) PERCENTAGE OF DOUBLE INFECTION IN GASTROPODS.

Besides the cercarial infection, the metacercariae of Plagiorchiid and Echinostome were also recovered from *V. bengalensis* in the summer season and the percentage of infections was 1.5% and 2% respectively.

Melaniidae : The monostome cercarial infection was found only in *M. tuberculata* and the infection was recorded throughout the year. Other cercariae like gymnocephalous, xiphidio and furcocercous cercariae were also shed by this snail in winter season. A rare species of furcocercous cercariae was found to infect the snail *F. ater* from the months of December to February and incidence of infection was about 0.08%.

TABLE II. Record of double infections in snail species.

Sl. No.	Snails	Cercarial infection
1.	*V. bengalensis*	(i) Xiphidio + Furcocercous cercaria
		(ii) Xiphidio + Plagiorchiid metacercaria
		(iii) Xiphidio + Echinostome metacercaria
2.	*L. auricularia*	(i) Xiphidio + Xiphidiocercaria
		(ii) Xiphidio + Strigeid metacercaria
3.	*L. acuminata*	(i) Xiphidio + Furcocercous cercaria
		(ii) Xiphidio + Echinostome cercaria
		(iii) Xiphidio + Gymnocephalous cercaria
4,	*M. tuberculata*	(i) Xiphidio + Monostome cercaria
		(ii) Xiphidio + Furcocercous cercaria
		(iii) Monostome + Monostome cercaria
		(iv) Monostome + Aspidogaster metacercaria
5.	*I. exustus*	(i) Amphistome + Xiphidiocercaria

The rarely occurings metacercariae of *Aspidogaster* in *M. tuberculata* varies in their indicence from 1% to 4% from the months of September to June (Fig. 3).

Lymnaeidae : Various species of snails of this family are found in abundance all over the Southern-Rajasthan after monsoon. The cercariae like gymnocephalous, furcocercous, xiphidio, echinostome and amphistome were shed by the different species of snails of this family. Three species of cercariae were found to infect *L. auricuiaria*, *L. luteola* and *L. acuminata*. The incidence and seasonal variation of cercarial infection in the various species of snails belonging to this family have been shown in Fig. 2.

The metacercariae of strigeid, *Tetracotyl lymnaei* (Pandey and Agrawal, 1978) were recovered from *L. auricularia* from the months of October to January and the peak of incidence (7%) of infection of this species was recorded in the month of December.

Planorbidae : *I. exustus* and *G. convexiusculus* are the two common species of snails of this family that are found in Southern-Rajasthan

and are generally infected with amphistome cercariae, pigmentata and diplocotylea groups of Sewell, 1922. They were found from September to late June. The maximum incidence of infection of 47.5% was recorded in these snails in the months of January and February. Other kind of cercariae like xiphidio, furcocercous and echinostome were also shed by these two species of snails.

I. exustus was also found to infect with metacercariae of Opisthorchiid in the months of July and August, but incidence of infection was only 3%.

Double infection : Usually a single snail is infected with one type of larval parasite but in some cases a snail may also shed two types of larvae. Such cases of double infections have been recorded from the snails *V. bengalensis*, *L. auricularia*, *L. acuminata*, *M. tuberculata* and *I. exustus*.

The pattern of double infection : One species of xiphidiocercariae either occurred with other xiphidio species or with furcocercous, exhinostome, monostome, gymnocephalous cercariae. Similarly in another combination, one monostome species occurred with another species of monostome cercariae (Table II).

The infection of cercariae and metacercariae have also been recorded from the snails like *V. bengalensis*, *L. auricularia* and *M. tuberculata*.

The indicence of double infection with two types of cercariae or with one type of carcaria and metacercaria have been shown in Fig. 3.

DISCUSSION

On the basis of present survey it was found that the larval digenean infection in surface dwelling snails in the lentic habitats, specially in the ponds, is higher than those of the bottom dwellers in the same habitat. Bottom dwellers of the lentic habitat show a greater cercarial infection as compared to their counter parts in the lotic habitat.

Since the chances of contact of free swimming miracidia to surface dwelling snails species such as, *L. acuminata*, *L. luteola*, *L. auricularia*, *L. pinguis*, *I. exustus* and *G. convexiusculus* were higher, therefore, the above lentic species were found to be infected maximally compared to bottom dwelling species such as snails of the families Hydrobidae, Viviparidae and Melaniidae as they had little chances of contact with various species of miracidia. Running water (Lotic habitat) diminishes the chance of contact of miracidia to snails and consiquently minimise the incidence of larval infections. Similar observations have also been made for cercarial infection in the snails of lotic waters (Radke *et al.*,

1961 ; Babikar *et al.*, 1984). These authors concluded that the infectivity was inversely proportional to water velocity. Further, Deforest (1957) also noted that seepage ponds and lakes (lentic habitats) had the highest percentage of infection and irrigation canals the lowest. Besides the habits and habitats, other factor such a s population density of miracidia and snails also appear to govern the intensity of infection as well as cercarial incidence.

Contrary to the high incidence of infection with monostome and furcocercous cercariae in large water bodies (lakes) Xiphidiocercariae had their highest infection in the snails of small water bodies (ponds and pools) whereas amphistome, echinostome and gymnocephalous cercariae had almost equal incidence of infection in the snails of lakes as well as ponds and pools surveyed. This difference in the incidence of various larval infection in lakes and ponds may be explained on the basis of (i) the final host inhabiting and frequently visiting these water bodies, (ii) the density of miracidia, (iii) physico-chemical conditions of water, (iv) the density of snail population and (v) water agitation.

While studying seasonal variations of larval infections among varioue fresh water snails, Mukherjee (1966) found two peaks of cercarial infection in *I. exustus* infected with *C. indicae* XXVI. He observed first peak in the months of August and September and second in December. Mukherjee also recorded three peaks of infection with cercariae of *Gigantocotyle explanatum* and *Ceylonocotyle scoliocoelium* in *Gyraulus convexiusculus*. Mohandas (1974) and Pandy and Agrawal (1978) on the other hand have observed only two peaks of cercarial infections in a year. Mohandas (1974) found first peak in summer and second in the rainy or early winter seasons whereas Pandey and Agrawal (1978) reported first peak in August and second in May. Further, Sewell (1922) has also found two peaks of infection in Indian snails. Three peaks of cercarial infection were never observed in the present survey. Two cercariae, xiphidio and monostome were found maximum in the months of Octobar (early winter) and in May (summer) in a year and this finding corroborates the observations of Mohandas (1974) and Pandey and Agrawal (1978) but differs from that of Mukherjee (1966).

Although like previous survey (Choubisa and Sharma, 1983) present survey has also exhibited a single peak of cercarial infection but for different cercariae and for different months viz. for furcocercous revealed the peak in the December ; amphistome and gymnocephalous cercariae in January and echinostome in February. Looking to the variability in

the cercarial infection from place to place and year to year, it is proposed that the peaks of cercarial infection with a particular snail species are not stable but vary due to change in the physicochemical factors of a particular niche.

It is interesting to note that the monostome cercariae exhibit strong host specificity as they were collected all these years only from *M. tuberculata*. No other species has shown such a stern host specificity. Further, out of 13 cases of double infection, 4 cases revealed the combination of cercariae with metacercariae (Table II). Emergence of two types of cercariae from a single suait host referred to as a case of double infection (Faust, 1917 ; Sewell, 1922 ; Porter, 1938 ; Mukherjee, 1966 ; Jain, 1977 ; Pandey and Agrawal, 1978). Sewell (1922) and Mukherjee (1966) did not consider the combinations of cercariae with metacercariae as double infection. The present authors, however, considered such infections as a cases of double infection.

SUMMARY

More than 15,000 gastropods and 3,500 bivalves were examined for cercarial infection. Habitat and dwelling behavior of molluscs determined their propensity for larval infection. In lentic water, the infection was maximum in the surface dwellers and minimum in the bottom dwellers. In lotic water, bottom-dwelling molluscs the cercarial infection was nominal. Double infection of various hosts is noteworthy.

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REFERENCES

BASCH, P. F. 1966. Patterns of transmission of the trematode *Eurytrema pancreaticum* in Malaysia. *Am. J. vet. Res.*, **27** : 234-40.

CHATTERJI, R. C. 1933. *Cercaria allahabadi* n. sp. *Allahabad Univ. Stud.*, **6** : 75-76.

CHOUBISA, S. L. AND SHARMA, P. N. 1982. Seasonal variation of cercarial infection in snails of Fateh Sagar Lake of Udaipur. *Indian J. Parasit.*, **7** (1) : 111-113.

DEFOREST, A. 1957. Larval trematodes of the Columbia Basin, Washinton. *J. Parasit.* **43** : Sect. 2, Suppl. 32.

DUBOIS, G. 1929. Les Cercaires de la region de Neuchatel. *Bull. Soc. neuchatel. Sci. nat.*, **53**, N. S. 2, year 1928, 3-177.

ERASMUS, D. A. 1972. *The Biology of Trematodes.* Printed in Great Britain at the University Press, Belfast.

EWERS, W. H. 1964. The influence of the density of snails on the incidence of larval trematodes. *Parasit*, **54** : 579-83.

FAUST, E. C. 1917. Life-history studies on Montana trematodes. *Illinois Biol. Monogr.*, **4** *No.* (1) : 1-121.

GANPATI, P. N. AND HANUMANTH RAO, K. 1959. Ecological and life history studies on strigeid metacercariae (Trematoda : Diplostomatidae) from freshwater fishes of Andhra Pradesh. *Parasit.*, **52** : 517-525.

JAIN, S. P. 1970. Double infection of larval trematodes in molluscs. *Agra Univ. J. Res. (Sci.).*, **21** : 47-48.

JAIN, S. P. 1976. Studies on amphistomes II. A survey of the incidence and nature of amphistome infection in aquatic snail. *Agra Univ. J. Res. (Sci.).*, **25** : 81-89.

KHAN, D. 1960a. Studies on larval trematodes infecting freshwater snails in London (U. K.) and some adjoining areas Part I. Echinostome cercariae. *J. Helminth.*, **34** : 227-304.

Khan, D. 1960b. Studies on larval trematodes infecting freshwater snails in London (U. K.) and some adjoining areas Part II. Gymnocephalous cercariae. *J. Helminth.*, **34** : 305-318.

LARSON, O. R. 1961. Larval trematodes of freshwater snails of lake Itasca, Minnesota. *Proc. Mines. Acad. Sci.*, **29** : 252-254.

MOHANDAS, A. 1974. Studies on the freshwater cercariae of Kerala. I. Incidence of infection and seasonal variation. *Folia Parasit.*, **21** : 311-317.

MUKHERJEE, R. P. 1966. Seasonal variations of cercarial infection in snails. *J. Zool. Soc. India*, **18** : 39-45.

MUKHERJEE, R. P. 1980. Collection and study of larval trematodes (Platyhelminthes). *Proc. Workshop. Tech. Parasit. zool. Surv. India.*, 23-26.

PANDEY, K. C. AND AGRAWAL, N. 1978a. A new Tetracotyle, larva, *T. lymnaei* n. sp. from a freshwater mollusc *Lymnaea auricularia*. *Indian J. Parasit.*, **2** (2) : 119-120.

PANDEY, K. C. AND AGRAWAL, N. 1978b. Larval trematodes and seasonal variations in snails of Kathauta Tal, Lucknow. *Indian J. Parasit.*, **2** (2) : 139-143.

PORTER, A. 1938. The larval trematodes found in certain South African mollusca. *Inst. Med. Res.*, **42** : 1-471.

PROBERT, A. J. 1966. Studies on the incidence of larval trematodes infecting the freshwater molluscs of Llangorse lake, South Wales. *J. Helminth.*, **49** : 115-30.

RADKE, M. G., RITCHIE, L. S. AND ROWAN, W. B. 1961. Effects of water velocities on worm burdens of animals exposed to *Schistosoma mansoni* cercaria released under laboratory and field conditions. *Expl. Parasit.*, **11** : 323-31.

REES, F. G. 1932. An investigation into the occurrence, structure and life-history of the trematode patasites of four species of Lymnaea (*L. truncatula* Mull.), *L. perger* (Mull.), *L. palustris* (Mull.) and *L. stangalis* (Linne) and *Hydrobia jenkinsi* (Smith) in Glamorgan and Monmouth. *Proc. zool. Soc. London.* **1** : 1-32.

ROTHSCHILD, M. 1941. Observations on the growth and trematode infections of *Peringia ulvae* (Pannant, 1777) in a pool in the Tamar Saltings, Plymouth. *Parasit.*, **33** : 406-15.

SEWELL, R. B. S. 1922. *Cercariae indicae. Indian J. Med. Res.*, **10** : 1-370.

SINGH, R. N. 1959. Seasonal infestation of *Indoplanorbis exustus* (Deshayes) with furcocercous cercariae. *Proc. Nat. Acad. Sci. India.*, **29** : 61-72.

SOPARKAR, M. B. 1921. The cercaria of *Schistosoma spindale* (Montgomery). *Indian J. Med. Res.*, **9** : 1-22.

WESENBERG-LUND, C. 1934. Development of the Trematoda Digenea Part II. (Biology of freshwater cercaria in Danish waters). *Mem. de Acad. Ray. Sci. et Lettres de Denemark, Sect. des. Sci.*, **3** : 1-223.

WIKGREN, BO-JUNGAR, 1956. Studies on Finnish larval flukes with a list of known Finnish adult flukes (Trematoda : Malacotylea). *Acta zool. fenn.*, **91** : 1-106.