Pakistan J. Zool., vol. 44 (3), pp. 823-828, 2012.

Prevalence of Paramphistomosis in Relation to Meteorological Factors

Umbreen Javed Khan[1] and Azhar Maqbool [2]*
[1]*Department of Zoology, University of the Punjab, Lahore*
[2]*Department of Parasitology, University of Veterinary and Animal Sciences, Lahore, Pakistan*

Abstract.- Role of meteorological factors on the prevalence of paramphistomosis has been studied. Temperature plays very important role in the causation of disease, which affects the metabolic processes of both the snail (host) and the parasite, thus interfering with parasite reproduction within the snail, snail growth and snail survival rate. The parasite develops optimally at 22-25°C and humidity of 55-70%. Rainfall is very important for the completion of life cycle of paramphistome and also it helps in the spread of cercariae from one place to other place.

Keywords: Paramphistomosis, buffaloes, cattle, snails, meteorological factors.

INTRODUCTION

Meteorological factors play very important role in the disease prevalence and severity of infection. Recent evidence indicates that climate change can alter the geographical distribution of parasitic diseases with potentially drastic consequences for their hosts. The warmer conditions could promote the transmission of parasites and raise their local abundance (Diaz *et al.*, 2007; Khan *et al*., 2008). The effect of climatic factors on host parasite population dynamics is particularly evident in northern latitudes where the occurence and transmission of parasite are strongly regulated by seasonality driven changes in envrionemental temperatures. Shortened winter periods would increase growth potential in many parasite populations (Hakalahti *et al.*, 2006).

The life cycle of paramphistome and prevalence of paramphistomosis is dependent on climate. This has led to development of forecasting system, based on meteorological data, which estimate the likely timing and severity of disease. In most of the countries these forecasts are used as basis for animal control programme.

Many health outcomes on diseases are sensitive to climate, particularly to those transmitted indirectly via water or by roadent vectors. Yet changing landscape can significantly affect local weather more acutely than long-term climate change. Land cover change can influence micro climatic conditions, including temperature, evapotranspiration and surface run off, that are key determinants in the emergence of many infectious diseases (Patz and Olson, 2006; Liu *et al*., 2010).

Temperature has been pointed out as the most important factor (Appleton, 1978) besides other factors such as rainfall, water velocity, geomorphology and habitat stability (Appleton, 1978; Diaz *et al*., 2007).

Temperature plays very important role in the causation of disease. It affects the metabolic processes of both the snail host and the parasite, thus interferring the parasites reproduction within the snails, snail growth and snail survival rate (Appleton, 1978; Khan *et al*., 2006, 2008). Thieltges and Rick (2006) reported that trematode matacercariae appeared with rising water temperature in April and highest infection rate during August when the water temperature reached 20°C.

Keeping in view the importance of meteorological factors on the occurrence of disease, the present study was designed to see the effects of meteorological factors *i.e.* temperature, humidity and rainfall in the occurrence of disease and severity.

MATERIALS AND METHODS

Prevalence of paramphistomosis

For recording monthly prevalence, a total of 9600 buffaloes and 9600 cattle were surveyed *i.e.* 200 faecal samples per month from November 2002 to October 2003 and November 2003 to October

* Corresponding author: azhar2007m@yahoo.com
0030-9923/2012/0003-0823 $ 8.00/0

2004 respectively in different districts of Punjab Province. Infection in faecal material was determined by direct smear, sedimentation technique and Floatation technique.Eggs were identified on the basis of morphology as described by Soulsby (1986). Prevalence in relation to season, age and sex was also noted. For recording seasonal prevalence, the year was apportioned into four seasons *viz.*, winter (Nov-Feb), spring (March-April), summer (May-August) and Autumn (Sep-Oct). The prevalence of disease was recorded according to Thrusfield (1995).

Meteorological data

The meteorological data *i.e.* temperature, humidity and rainfall was obtained from the meteorological stations of Gujranwala and Lahore, and related with the prevalence of disease.

Prevalence of snail infection

A total of 10341 snails were collected from June 2003-May 2004 from various water bodies of Gujranwala, Sheikhupura, Lahore and Kasur districts. Infection percentage was recorded on month, season and district wise.

Statistical analysis

The data was analysed statistically by using Analysis of Variance (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

Table I shows month wise temperature, humidity, rainfall and pan evaporation at Gujranwala and Lahore district.

The peak paramphistome infection was recorded during the month of August in buffaloes and cattle with an infection rate of 52% and 43.55% respectively whereas in buffaloes the lowest incidence was recorded during the month of February (16%) followed by March and December (16.5%). The lowest prevalence in cattle was 1.5% during the month of February (Table II). From the data it was noted that the highest month wise prevalence of trematodal infection in snails was reported during August *i.e.,* 24.26% and 20% in Gujranwala and Lahore districts, whereas the lowest (4.4% and 2.79%) was recorded during January.

A positive correlation of disease incidence to maximum and minimum temperature, humidity, rainfall and pan evaporation was observed. From the results it is indicated that at Gujranwala district, rice is grown in abundance, constant water logging helps in breeding and reproduction of snails and also for the cercariae and metacercriae of the paramphistomes.

From the data highly significant correlation between disease incidence to temperature, humidity and rainfall was observed, whereas disease incidences to other meteorological factors were found non-significant. It was evident from that during summer and autumn optimum temperature, relative humidity and rainfall play an important role for rapid propagation of the parasitic life cycle.

When the data on monthly and seasonal incidence of paramphistome infection in buffaloes and cattle was analyzed, it was observed that higher incidence of paramphistomosis occurred in the month of August. Two most important factors influencing the incidence of paramphistomosis are adequate temperature and moisture in the environment, which helped the hatching of fluke ova, the viability of encysting cercariae and population of snails. There are at least 3 seasonal periods in which the temperature and moisture are favourable for the rapid propagation of the parametric life cycle and snails are infected with paramphistomum species during rainy season.

When analysis of Varience was applied it was noted that season wise highly significant difference ($p<0.001$) was observed during autumn and significant ($p<0.05$) during summer. District wise prevalence was highly significant ($p<0.001$) at Gujranwala district as compared to other districts.

Temperature seems to exert a powerful dispersal effect on snail population. The growth rate of snail and development of paramphistome from egg to cercariae was directly related to temperature (Thieltges and Rick, 2006; Diaz *et al*., 2007; Khan *et al*., 2008; Arindam and Santra, 2009).

It was noted that in Punjab summer season followed by autumn season provided optimum temperature required for breeding and reproduction of snails and parasites. The present study carried out in 4 districts of the Punjab province. It was noted that snails and parasites were found maximum

Table I.- Mean month wise temperature (°C), humidity (%), rainfall (mm) and pan evaporation (mm) at Gujranwala and Lahore districts during November 2002 – October 2004.

Time (Month)	Temperature (°C)		Relative humidity (%)		Rainfall (mm)	Pan evaporation (mm)
	Minimum	Maximum	Morning	Evening		
Gujranwala district						
November	10.75	25.55	90.5	55.5	21.15	2
December	6.85	20.55	92	60	12.35	35
January	5.75	15.45	96	71.5	62.85	1.1
February	8.45	21.55	89.5	49	90.7	1.4
March	13.65	27.85	78	41	36.1	3.65
April	18.9	34.35	57.5	31	28.05	6.05
May	22.05	38.35	44	21.5	20.75	8.75
June	25.2	38.75	56	35.5	88.3	8.1
July	25.15	35.05	78.5	60.5	458.6	7.15
August	25.2	33.45	83.5	66.5	326.45	4.45
September	23.7	33.55	84.5	59.5	71.35	5.45
October	16.65	30.1	85.5	52	34.9	3.15
Average	16.85	29.54	77.95	50.2	104.29	4.46
Lahore district						
November	14.25	26.8	74.5	44.5	8	2
December	10.5	21.75	79.5	54.5	7.9	1.5
January	8.1	16.65	90	67	19.35	1.1
February	11.7	22.25	77	49	58.35	2.3
March	17.55	28.9	64	37	1	3.65
April	22.75	35.55	44.5	25	7.05	6.05
May	25.45	38.45	38.5	20	30.1	8.75
June	27.9	38.4	54	34	57.3	8.25
July	27.5	35.9	73.5	56	198.45	7.15
August	27.65	34.5	78	64	126	4.45
September	26.2	34.85	72	50.5	13.8	5.45
October	19.65	31	69.5	43	2.9	3.15
Average	19.88	30.41	65.91	45.33	46.55	4.465

Table II.- Showing (%) of infection in Buffaloes and Cattle from Nov. 2002 to Oct. 2004 at four districts of Punjab province.

Months	(%) infection in Buffaloes from Nov 2002-Oct 2003	(%) infection in Cattle from Nov 2003-Oct 2004
November	30	6.5
December	16.5	5
January	27	5.5
February	16	1.5
March	16.5	6
April	17.5	10
May	19.5	6
June	17.5	2.5
July	40.5	9.5
August	52	43.5
September	45.5	33.5
October	41.5	18.5

Table III.- Showing month wise prevalence (%) infection of various Snails from June 2003 to May 2004 at Gujranwala and Lahore districts.

Months	(%) infection in Gujranwala	(%) infection in Lahore
June 2003	9.09	5.57
July	20.69	15
August	24.26	20
September	19.93	14.28
October	15.46	9.21
November	11.06	7.73
December	13.88	6.70
January 2004	4.41	2.79
February	7.06	6.98
March	13.49	6.56
April	9.45	5.42
May	6.06	4.35

during summer and autumn. These results are in agreement with Diaz *et al.* (2007) and Khan *et al*. (2008). They found that the temperature 25°C was maximum where ideal growth of snail and parasite occurs. These results differ with those of Thieltges and Rick (2006). They reported that the emergence of cercariae peak at 20°C and was considerably lower at 10°C, 15°C and 25°C. Stables and Chappell (1986) reported that growth and reproduction activities of snail and parasite were greatest in spring while mortality was recorded in summer.

Temperature and humidity are important factors for the survival of snails and flukes (Arindam and Santra, 2009). Maqbool *et al*. (2003), Joao and Fernand (2006) and Dreyfuss *et al.* (2007) reported that there was no development and hatching of fluke, no development of parasite in snail, nor even emergence of cercaries from snail at temperature below 10°C take place. Hence the development of parasite outside the host in Pakistan is restricted from November to January (Tanveer and Khan, 1989). They also noted that the animals depending upon grazing in the pastures throughout the year showed continuous output of fluke eggs and their hatching under this temperature regime occurs mainly from June to October. Snails infected up to early July produce cercariae in late summer and early autumn giving rise to disease in livestock in autumn and early winter. In the present study, minimum temperature was noted during December and January which range between 4.7-6.6°C is not suitable for the survival of snails. This is why in the present study snails were not found in the ponds during December and January 2003-2004. Temperature under 10°C is dangerous for snail and paramphistome production. It was also noted infection rate decreases with decrease in temperature (Maqbool *et al.*, 2003; Morley *et al.*, 2007). Findings of the present study are in agreement with the observations of the above mentioned workers.

There is a basic relationship between climate and life cycle of paramphistome. The limiting effect of temperature on the development of parasite in winter is seen throughout the areas under study. Whereas inspite of presence of intermediate (snail) host and the importation of infected cattle and buffaloes, disease doesn't occur. This is simply due to the fact that temperature during December and January is insufficient to allow the completion of the life cycle of paramphistome (Dreyfuss *et al*., 2007; Khan *et al*., 2008).

In the present study various snail species show different degree of tolerance towards the extreme temperature is as low as 6.8°C and as high as 40.3°C. Similar results have been reported by Tanveer and Khan (1989). They reported that extreme temperature is as low as 3.5°C and as high as 46°C with an average temperature range of 15-30°C.

The climatic conditions of Pakistan are favourable for the development and growth of fresh water snails. These snails are found in abundance in water streams and ponds almost throughout the year with the exception of a small period of dormancy in winter and spring. Summer is generally dry so development of flukes outside the final host takes place from autumn to early winter. The distribution and the population density of snails and percentage of infection are determined largely by moisture condition so moisture factor is important in producing disease. Temperature and moisture are antagonistic. Irrigation may play an important role in the spread of snail but intensity of disease mostly depends on temperature and moisture. During the study period *i.e*. from 2003 -2004, rains started in the Punjab province during June-July that changed the humidity and helped the emergence of cercariae form snails and after transformation into metacercariae and its ingestion, produced paramphistomosis in animals. This assumption appears to be the reason for the high incidence of paramphistomosis in July and August. Persistance of rain throughout the month of June to August provide favourable period for the liberation of cercariae. Although rains were recorded during January, February but due to lower temperature, no liberation of cercariae from the snails takes place. These observations were also supported by Pfukenyi *et al*. (2005), Mavenyengwa *et al*. (2006) and Phiri *et al.* (2007).

Role of rainfall in the breeding, reproduction of snail and larval stages of paramphistome was studied by various workers of the world (Maqbool *et al*., 1998). In the present study maximum rainfall take place during July, August and minimum during

November, October, January and March. The high incidence of disease during rainy season is supported by Phiri *et al.* (2006) and Khan *et al*. (2006, 2008).

Relative humidity is another factor which plays an important role in the hibernation and aestivation phenomenon.In the present study, it was reported that minimum relative humidity was noted during May at 8:00a.m and maximum relative humidity was reported during August 2003 and Jan 2004 at 5:00 p.m whereas the percentage of infection was found maximum during August and minimum during February. Similar findings were supported by (Musthaq, 1983).

In the present study maximum number of snails were found during July, August whereas relative humidity ranged from 60-70% and their minimum number was recorded during December, January when the relative humidity ranged from 70-80%. Any changes in the rainfall disturb and affect the snail population. During the period of study i.e., from June 2003- May 2004, due to erratic rains in July and August, the snail population was high (Khan *et al*., 2006; Hudson *et al*., 2006; Thieltges and Rick, 2006). In the present study this moisture range persisted during July. Mushtaq (1983) also reported similar findings.

It was concluded that an extreme climatic events that act across population appear important in synchronizing transmission and disease outbreaks, so it is speculated that climatic disruption will lead to increased intenstity of infection outbreaks in parsite populations not regulated by acquired immunity.It was noted that animals should not allowed to graze especially during rainy season.

REFERENCES

APPLETON, C.C., 1978. Review of literature on abiotic factors influencing the distribution and life cycles of bilharziasis intermediate host snails. *Malacol. Rev.*, **11**: 1-25.

ARINDAM, S. AND SANTRA, P.K., 2009. Prevalence of gastrointestinal helminths in hot and humid zone of West Bengal. *J. Vet. Parasit.,* **23**:73-76.

DREYFUSS, G., NOVOBILSKY, A., VIGNOLES, P., BELLET, V., KOUDELA, V. AND RONDELAUD, D., 2007. Prevalence and intensity of infections in the lymnaeid Snail *Omphiscola glabra* experimentally infected with *Fasciola hepatica, Fascioloides magna and paramphistomum daubneyi. J. Helminthol.,* **81**: 7-12.

HAKALAHTI, T., KARVONEN, A. AND VALTONEN, E.T., 2006. Climate warming and disease risks in temperate regions *Argulus coregoni* and *Diplostomum spathaceum* as case studies. *J. Helminthol*., **80**: 93-98.

HUDSON, P.J, CATTADORI, I.M, BOAG, B. AND DOBSON, A.P., 2006. Climate disruption and parasite host dynamics: patterns and processes associated with warming and the frequency of extreme climatic events. *J. Helminthol.,* **80**: 175-82.

JOAO, R.C. AND FERNANDO, S.M.B., 2006. The effects of temperature changes on the infection rate of *Biomphalaria qlabrta* with *Schistosoma mansoni. Mem. Inst., Oswaldo Crus.,* **101**: 223-224.

KHAN, U.J., TANVEER, A., AZHAR, M. AND AWAIS, A., 2006. Epidemiology of paramphistomosis in buffaloes under different management conditions at four districts of Punjab province, Pakistan. *Iranian J. Vet. Res. Univ. Shiraz*, **7**: 68-72.

KHAN, U.J., TANVEER, A., AZHAR, M. AND MASOOD, S., 2008. Epidemiological studies of paramphistomosis in cattle. *Vet. Archiv*., **78**: 243-251.

LIU**,** L., MONDAL, M.M.H., IDRIS, M.A., LOKMAN, H.S., RAJAPAKSE, P.R.V.J., SATRIJA, F., DIAZ, J.L., UPATHAM, E.S. AND ATTWOOD, S.W., 2010. The phylogeography of *Indoplanorbis exustus* (Gastropoda: Planorbidae) in Asia. *Parasites and Vector,* 3:57 doi:10-1186/1756-3305.

MAQBOOL, A., HAYAT, C.S., TANVEER, A. AND AHMAD, I., 2003. Prevalence and ecology of *Lymnaea* snails in Punjab. *Iranian Vet. Res. Univ. Shiraz*, **4**: Ser.8, 132.

MAQBOOL, A., HAYAT, C.S., TANVEER, A., ANJUM, A.D. AND HAYAT, B., 1998. Prevalence and ecology of fresh water snails in Punjab. *Malays. appl. Biol*., **27:** 69-72

MAVENYENGWA, M., MUKARATIRWA, S., OBWOLO, M. AND MONRAD, J., 2006. Observations on mass production of *Calcicophoron microbothrium* metacercariae from experimentally and naturally infected *Bulinus tropicus. Onderstepoot J. Vet. Res.,* **73**: 95-100.

MORLEY, N.J., ADMA, M.E. AND LEWIS, J.W., 2007. The effects of temperature on the distribution and establishment of *Echinoparyphium recurevatum metacercariae* in *Lymnaea peregra. J. Helminthol*., **81**: 311-315.

MUSHTAQ, S., 1983. *Ecological and biochemical studies on the sinals Lymnaeidae*. M.Sc. thesis, Department of Zoology, University of the Punjab Lahore. Page 9,17,34.

PATZ, J.A. AND OLSON, S.H., 2006. Climate change and health: global to local[286] influences on disease risk. *Ann. trop. Med. Parasitol*., **100**: 535-549.

PFUKENI, D.M., MUKARATIRWA, S., WILLINGHAM, A.L. AND MONRAD, J., 2005. Epidemiological studies of amphistorne infection in cattle in the highveld and lowveld communal grazing areas of Zimbabwe. *Onderstepoort J. Vet. Res.*, **72**: 67-86.

PHIRI, A.M., PHIRI, I.K. AND MONRAD, J., 2006a. Prevalence of amphistomiasis and its association with *Fasciola gigantica* infections in Zambian cattle from communal grazing areas. *J. Helminthol.*, **80**: 65-68.

PHIRI, A.M., PHIRI, I.K., CHOTA, A. AND MONRAD, J., 2007. Trematode infections in freshwater snails and cattle from the Kafue wet lands of Zambia during a period of highest cattle - water contract. *J. Helminthol.*, **81**: 85-92.

SOULSBY, E.J.L., 1986. *Helminths, arthropods and protozoa of domesticated animals*. The English Language book society. Bailliere Tindal, London.

STABLES, J.N. AND CHAPEL, L.H., 1986. The epideminology of diplostomiasis in farmed rainbow trout from North East Scotland. *Parasitol.*, **92**: 699-710

STEEL, R.G.D. AND TORRIE, J.H., 1980. *Principle and procedures* of *staictics*. 2nd Ed. McGraw Hill Book Company Inc., New York.

TANVEER, A. AND KHAN, D., 1989b. Seasonal variations in the environmental factors and snail population in four different habitats around Lahore. *Punjab Univ. J. Zool.*, **4**: 31-69.

THIELTGES, D.W. AND RICK, J., 2006. Effect of temperature on emergence, survival and infecting cercarial of the marine trematode *Renicola rescovita* (Digenea: Renicolidae). *Dis. Aquatc. Organ.*, **73**: 63-68.

THRUSFIELD, M., I995. *Veterinary epidemiology*. Longman Scientific Technology, U.K.

(Received 29 April 2011, revised 25 October 2011)