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EPIDEMIOLOGY OF FASCIOLIASIS IN THE KOSHI HILLS OF NEPAL

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SUMMARY

Lymnaea auricularia *race* rufescens *and* Lymnaea luteola *were shown to transmit* F. gigantica *in the Koshi hills of Nepal. The ecology of the snails was studied at nine different habitats in Hattikharka panchayat, the highest numbers occurring immediately after the end of the monsoon. Mature* F. gigantica *infections in the snails were detected from May to August and again in November. The prevalence of the infection in cattle was highest during the summer monsoon and in January and February. A control programme for fascioliasis based on these findings is suggested which requires that cattle be treated in February and possibly again in late August.*

INTRODUCTION

Bommeli, Eichenberger, Singh and Basnyet (1973) reported that liver fluke infestation causes losses of 200 million Nepalese rupees per annum ($ US 19·7 million). They recorded infestation rates of 50 to 90% in areas below 1,830 m. The Central Veterinary Laboratory, Tripureswor (1978) recorded a prevalence of 60% in cattle and buffalo. The Tinau Watershed Project (1983) found that 67·1% of untreated cattle and buffalo were affected with liver fluke in Madam Pokhara and from November 1981 to June 1982 the levels rose from 33·8% to 62·2%. In Humin during the same period the rate rose from 34·1% to 42·3%. Lowcock (1982) reporting on a survey conducted in the Pokhara valley found that 79% of adult buffalo, 66% of adult cattle and 37% of adult goats were positive for liver fluke on faecal examination. In 1973 Bommeli *et al.* collected snails from different regions of Nepal and found *Lymnaea viridis* and *L. auricularia* race *rufescens* to be widespread. Lohani and Jaeckle (1982) identified *Fasciola gigantica, F. hepatica* and intermediate forms in water buffalo and goats slaughtered in Tansen, Palpa.

The epidemiology of fascioliasis in cattle in the Koshi Hills has not been described so it was decided to carry out a survey concentrating on Hattikharka panchayat (altitude 610 to 1,830 m) adjacent to Pakhribas Agricultural Centre, Dhankuta District. The climatic conditions and altitude range in this panchayat are comparable with much of the rest of the Koshi Hills. The prevalence of fascioliasis in cattle was investigated in 1981 and 1982 and the epidemiology of the disease in the intermediate host was studied in 1984.

MATERIALS AND METHODS

The meteorological data for Hattikharka panchayat is similar to that of Pakhribas panchayat which is situated about 2 km away and for which full records exist; therefore the temperature and rainfall figures from the meteorological station at Pakhribas Agricultural Centre are quoted; this station is sited at 1,667 m, latitude 27°2′, longitude 87°7′.

In 1981 and 1982 12 permanent watering sources were selected at altitudes of 671 m (low), 1,068 m (mid) and 1,678 m (high). Monthly faecal samples were

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collected from five cattle at each water source. The faecal samples were examined by a differential flotation technique (Sewell and Hammond, 1972).

In 1984 the epidemiology of the disease in the intermediate host was studied, snails being collected monthly, except in February and July, from nine of the 12 watering sources previously identified. All the live snails, were counted at each water source using a 0·1 m quadrant and 10 random throws. Some of the snails were preserved in 10% formalin and sent to Dr C. B. Ollerenshaw, Central Veterinary Laboratory, Weybridge, UK or to Dr D. S. Brown at the British Museum, London for identification and dissection. In the same year faecal samples were obtained at monthly intervals from 20 calves born in September 1983 and examined for *Fasciola* eggs.

RESULTS

Definitive host

The prevalence of chronic fascioliasis as detected by faecal egg output and the average monthly temperature and rainfall records for 1981 and 1982 are given in Figs 1 and 2 respectively. There was a high prevalence rate in January which declined as the dry season advanced, rose again during the monsoon and again fell early in the following dry season.

Liver fluke eggs were first detected in faeces from calves born in the autumn of 1983 during September of the following year after they had been grazing with the herd for between six and nine months. The liver fluke eggs measured $163{\cdot}8 \pm 14{\cdot}1\,\mu m$ by $95{\cdot}5 \pm 10{\cdot}0\,\mu m$ which is within the normal range for *F. gigantica*. Adult flukes collected at post-mortem have also been identified as *F. gigantica*.

Intermediate host

In 1984 the climatic data was similar to that in the earlier years (Figs 1 and 2). The habitats studied were spring-fed ponds or paddy fields and were flooded with running water during the monsoon (June to September). Most sites were north to west facing, sunlit, permanent water sources. All were used as drinking places by

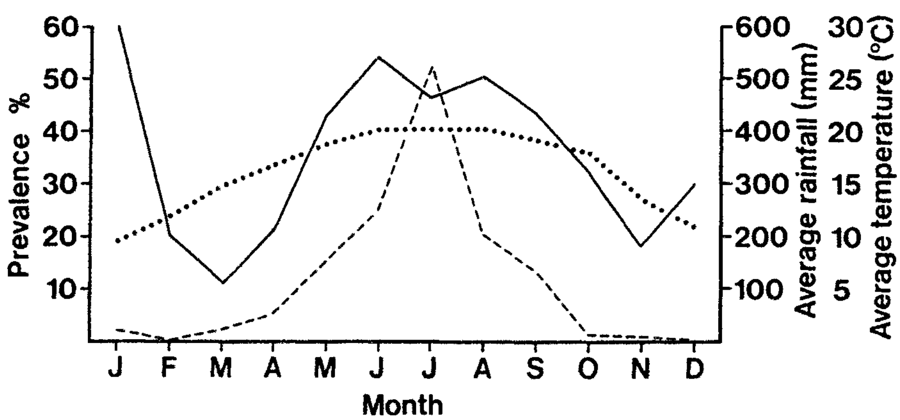

FIG. 1. Average monthly liver fluke prevalence, rainfall and temperature (1981).

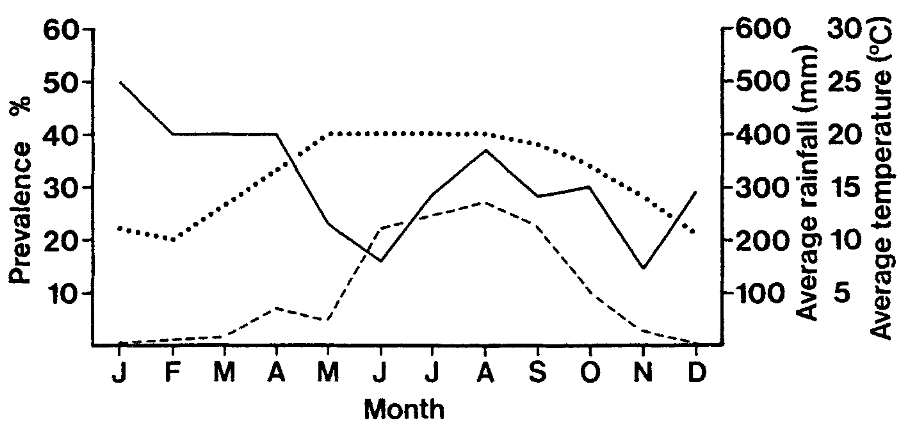

FIG. 2. Average monthly liver fluke prevalence, rainfall and temperature (1982).

livestock and were contaminated with dung. *Nasturtium officinale* (watercress) and unspeciated grasses grew in the water and *Eupatorium adenophorus, N. officinale,* bamboos and trees grew around the water's edge.

The snails were found just below the surface of the water attached to the watercress and grasses or lying on the mud at the edge of the water. The snail data recorded each month are given in Table I.

At all altitudes the highest concentration of snails was found at the beginning of the dry season but the proportion of snails that were infected with *F. gigantica* was much lower at high altitude than at low or mid altitudes. At high altitude only snails with a similar gross morphology to *L. auricularia* race *rufescens* were found. The shell of *L. auricularia* race *rufescens* varied from light to dark brown with a non-operculate aperture extending two-thirds the length of the shell which was blunt ended. Parasitism with xiphidiocercaria was detected in these snails but only two cases of parasitism with *F. gigantica* were noted.

L. luteola species were commonly present at low and mid altitudes but no *L. auricularia* species were found. *L. luteola* were similar in colour to *L. auricularia* but the non-operculate aperture was only half the length of the shell which was pointed. Although the internal anatomy of the snails was investigated doubt still exists as to whether snails classified as *L. luteola* might not be examples of *L.*

TABLE I

Numbers of living snails and the percentage infected with Fasciola gigantica *at three altitudes in Nepal in* 1984

Altitude	Snails	Jan.	Mar.	Apr.	May	Jun.	Aug.	Sep.	Oct.	Nov.	Dec.
High	Population/m^2	6	13	24	27	0	22	36	49	69	103
	Infected (%)	0	0	0	0	0	4	0	0	0	0
Mid	Population/m^2	16	27	39	43	46	48	39	70	86	81
	Infected (%)	2	0	4	22	6	0	0	5	0	1
Low	Population/m^2	19	26	44	31	48	44	47	66	86	72
	Infected (%)	0	0	1	13	5	0	0	0	4	0

viridis. Parasitism with *F. gigantica* and xiphidiocercaria occurred in snails collected at both altitudes. Bithyniid snails were common at low altitudes and *Chaetogaster* occurred in lymnaeid snails at mid altitude. A few snails resembling *L. truncatula* were found at low altitudes in December but these have not been positively identified. No instance of parasitism with *F. hepatica* was recorded.

One immature infection in January and another in December were the only evidence of over-wintering infection in the snails. Mature infections were most prominent in the snails in May and June and the numbers that were infected had declined by August. There appeared to be a resurgence of infection at mid altitude in October but no mature infections were found at this time.

DISCUSSION

Only a few of the small numbers of *L. auricularia* race *rufescens* found at high altitude were parasitised by *F. gigantica*. At low and mid altitudes *L. luteola* (or possibly *L. viridis*) is probably the main intermediate host of *F. gigantica*. No bithyniid snails were infected with *F. gigantica* nor was any instance of parasitism with *F. hepatica* recorded. These findings are similar to those of Bommeli *et al.* (1973). The populations of *L. auricularia* race *rufescens* and *L. luteola* fluctuated widely during the year. The low numbers in January probably reflect the intensification of the drought, the increasing population pressure and the senility of the snails. The numbers of snails then rose slowly with increasing temperature until April. This may also be a reflection of higher concentrations of snails due to contraction of the water sources.

From the onset of the monsoon the snail populations again rose slowly, favourable climatic conditions being offset to some extent by flooding of the water sources, which will have dispersed the snails. The population figures at this time are almost certainly an underestimate as most of the snails were small and difficult to detect. Towards the end of the monsoon (September to October) the snail population increased dramatically as water movement slowed and allowed the growth of suitable vegetation.

The over-wintering infection in the snails was negligible since only one snail with an immature infection was found in January and one other in December. The new infections detected in April coincided with the pre-monsoon showers. The first mature infections in May were detected at low altitude possibly as a result of higher temperatures at this height. Mature and immature infections in June demonstrated continuing maturation of infection derived from eggs hatching in April together with further hatching in May. This pattern probably continued into July although no data was collected during that month. Relatively few infected snails were detected in August and September which suggests that the snails which had been infected in April and May were dying out and there had been little or no further infection of the snails in late June, July or August. This may have been due to the multiplicity of water sources available during these months with the consequent reduction in the number of stock grazing adjacent to the water sources under study, to the monsoon rains washing away *Fasciola* eggs coming from those animals still grazing these sites and to the limited practice of stall feeding during the maize and paddy season (June to August). A resurgence of infection was detected at mid altitude in October, probably from eggs hatching in September when the animals again had free access to these sites following the maize harvest. By then the dry season had started and in November there was a

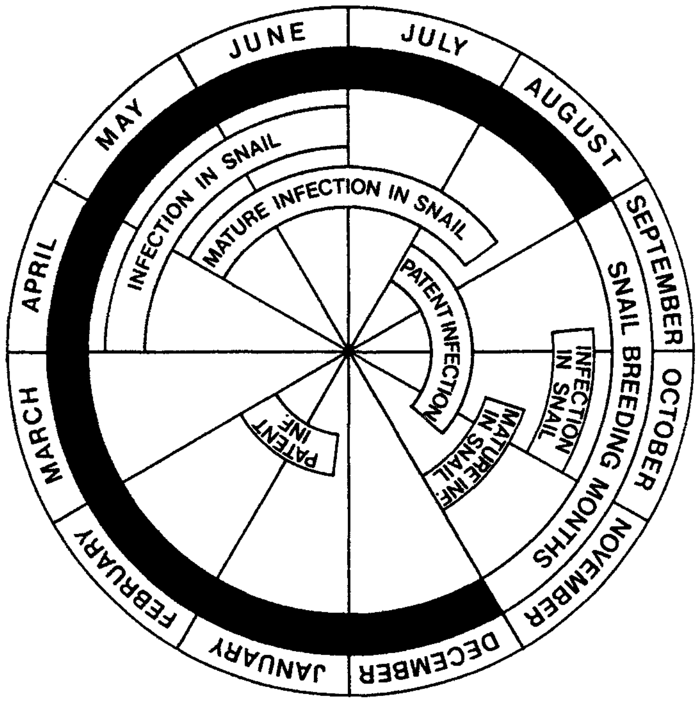

FIG. 3. Probable epidemiological cycle of *F. gigantica* in the Koshi hills of Nepal.

decline in the number of snails infected, only one mature infection being identified in that month.

Metacercaria ingested by cattle from May to July became patent from August to October. However, with the onset of the dry season few of the eggs deposited on the pasture survive and only the eggs dropped in March, April and May will give rise to miracidia and infect new generations of snails. If the epidemiological pattern varies little from year to year then the resurgence of infection in snails in October could account for the high prevalence of chronic fascioliasis in January and February. The investigations described in this paper thus give a picture of the epidemiological cycle of *F. gigantica* in the Koshi hills of Nepal (Fig. 3).

If further investigations confirm that the over-wintering infection is insignificant and that the bulk of the infection in snails is derived from fluke eggs deposited on the pasture in March and April and again in September there would be a good case for a single administration of anthelmintics in February with perhaps a further dose in late August to control the pasture contamination. However, this approach would only work if all the stock are treated with one of the more efficient anthelmintics. Although dosing the stock in the middle of the monsoon would not be a very effective control measure it may be justified on an individual animal basis. Attempting to control the snails using molluscicides during the dry season would be of doubtful value due to the large number of water sources, the great biotic potential of the snails and the recurrent labour and equipment costs.

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EPIDEMIOLOGIE DE LA FASCIOLOSE DANS LES COLLINES DE KOSHI AU NEPAL

Résumé—On a montré que *Lymnea auricularia* race *rufescens* et *Lymnea luteola* transmettent *F. gigantica* dans les collines de Koshi, au Népal. L'écologie des mollusques a été étudiée dans 9 habitats différents du panchayat d'Hatikharka; le plus grand nombre se rencontre immédiatement après la fin de la mousson. Des infections à *F. gigantica* matures ches les escargots ont été détectées de mai à août, et de nouveau en novembre. La prévalence de l'infestation chez le bétail est maximum pendant la mousson d'été, puis en janvier et février. Un programme de contrôle de la fasciolose est suggéré sur la base de ces découvertes; il requiert que le bétail soit traité en février et, si possible, de nouveau fin août.

EPIDEMIOLOGIA DE FASCIOLIASIS EN LAS COLINAS KOSHI DE NEPAL

Resumen—Se encontró que la *Lymnaea auricularia* raza *rufescens* y la *Lymnea luteola* transmiten *F. gigantica* en las colinas Koshi de Nepal. Se estudió la ecología de los caracoles en 9 habitats diferentes en Hattikharka panchayat, ocurriendo el mayor número inmediatamente despues de los monsones. Las infecciones de las caracolas con fases maduras de *F. gigantica*, se detectaron desde mayo hasta agosto y otra vez en noviembre. La prevalencia de la infección en bovinos fue más alta durante los monsones veraneros, y posteriormente en enero y febrero. Se sugiere el tratamiento del ganado en febrero y agosto para controlar la fascioliasis.