References


Cattle, Worms and Zooprophylaxis

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**SUMMARY**

Epidemiological studies in North Cameroon indicate that a high population density of cattle in relation to man protects from severe oncho-....

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INTRODUCTION

In many traditional African societies, cattle are a sign of richness and welfare. There is also increasing evidence that cattle protect from some of the most dangerous parasitic diseases. Either by diverting the vectors coming to take a bloodmeal or by the transmission of bovine parasites to man which do not develop but stimulate the immune system. The reduction of the vectorial capacity of bloodfeeding vectors has been called “zooprophylaxis”, whilst the latter, i.e. resistance against the human parasite caused by cross-reactive immunity, was named the “Jennnerian principle of zooprophylaxis” (Nelson, 1987). In the following, the role of cattle will be examined with view to the epidemiology of human onchocerciasis, with a brief outlook on its influence on malaria and schistosomiasis, which are usually co-endemic in the same regions.

A MATHEMATICAL MODEL FOR ONCHOCERCIASIS

A stochastic model has been derived from the formulæ given in Dietz (1982). It allows to plot the average worm load in the human population (adult worms or microfilariae in the skin) in dependence from the size of the vector populations (m) and their biting rate on man (h, proportion of bloodmeals on the human host). In Figure 1, the effect of bloodfeeding on animals (zoophily) alone is considered, whilst in Figure 2, the probability of an infective larva of *O. volvulus* to reach maturity in the human host is reduced by 90 %. Such a reduction could either stem from crossprotective immunity caused by *O. ochengi* L3 or from a vaccination programme.

Even at moderate levels of cross-protection (50 % reduction) and bloodfeeding on non-human hosts (50 % of all bloodmeals) the threshold level for endemicity, below which onchocerciasis cannot maintain itself, increases from an Annual Biting rate of 200 flies per man and year (if all flies fed on man and there is no immunity) to 1 500 flies per man and year. However, the protection by immunity would have to achieve or even surpass 99,9 % to eradicate onchocerciasis under the worst conditions, i.e. at places as observed in the Cameroon rain forest, where the Annual Biting Rate at the river is as high as 600 000 *Simulium damnosum* s.l. per man and year (Duke et al., 1972) and where almost all flies fed on the human population.

Whilst our model predicts that an increase in the proportion of bloodmeals on animals (cattle) is very unlikely to increase transmission of human onchocerciasis (for example by an increase of the fly-population due to better survival and/or fecundity), and this is supported by our field data, the situation may be different with regard to the transmission of malaria by Anopheles.
ZOOPROPHYLAXIS

Here, an increase in the number of blood-host could enhance malaria transmission, in case the availability of a bloodmeal is a limiting factor for the fly-population. There is no Plasmodium species from cattle that could afford protection by vaccination. In contrast to onchocerciasis, where severe infection is a result of the accumulation of many worms over 10 years, in malaria, a single infective bite can lead to the full clinical picture. Applying to model analyses of the effectiveness of zooprophylaxis in malaria control by Sota & Mopii (1989) to the local conditions in North-Cameroon, it would however appear that the high number of cattle in the Adama highland (5 times more cattle than men) can only reduce the malaria infection rate in the human population, but the extend of this protection remains yet undetermined.

CONVINCING EXAMPLES OF CROSS-PROTECTIVE IMMUNITY

Convincing examples of cross-protective immunity come from field observations and from experimental schistosomiasis in cattle and baboons (Taylor et al., 1991). In areas like Sardinia, Corsica and Sicily where Schistosoma bovis occurs in cattle, there was no S. baematobium in man, despite a highly susceptible population of Bulinus truncatus. In baboons, exposed to cercariae of S. bovis, protection could be achieved against a challenge infection with S. baematobium, but this protection was less marked with S. mansoni and it was suggested that the degree of heterologous immunity was related to the phylogenetic closeness between the Schistosoma species involved (loc. cit.). Although no detailed study has yet been carried out, it seems possible, that the low prevalence of S. baematobium (but not of S. mansoni) in the Adamawa highland (Ratard et al., 1990) might be due to such crossprotective immunity. Bovine schistosomiasis (S. bovis) and Trichobilharzia species in birds are very common there.

![Graph showing worm load in human population](image1)

**Fig. 1.** Relation between the worm load in the human population (w, microfilariae per skin biopsy), the size of the Simulium vector population in relation to the human population (m, flies per man) and the proportion of bloodmeals taken from the human population (h). The annual biting rate of the flies on man can be calculated by multiplying m with the average number of bloodmeals taken per day from the human population (1/3.55h) and the number of days per year (365).

![Graph showing worm load in human population](image2)

**Fig. 2.** Reduction in endemicity of onchocerciasis, if the chance of an infective larvae to reach maturity is reduced by the factor 10, either by crossprotective immunity or by vaccination with an anti-L3 vaccine. The dotted area delimits threshold values of m and h, below which onchocerciasis cannot be endemic and the black area shows the additional gain by a vaccine achieving 90% reduction. The proportion of infective larvae found in the flies that develop to maturity, prior to density-dependent regulation, is set to 0.0625 in Fig. 1 (50% of larvae leave the fly during the bloodmeal, 50% penetrate the skin and 25% develop to the adult stage) and 0.00625 in Fig. 2.
CONCLUSION

- More results from our ongoing studies in Cameroon and Nigeria become available, modifications and better adjustments of our model will be made. Rapid socio-economic, ecological and cultural changes in rural areas of Africa influence the epidemiology of the major parasitic diseases in various ways. Some conclusions and recommendations may already be drawn from our work on onchocerciasis:
  - In the Cameroon Sudan savanna, where severe blinding onchocerciasis is hyperendemic, nomadic Bororo herdsmen nowadays increasingly come with their cattle into the rive- rine areas during the dry season, when the contrast between human and fly-population is closest, thus introducing a considerable effect of zooprophylaxis.
  - Keeping cattle throughout the year at strategic site between the village and the Simulium breeding river should afford the highest degree of protection.
  - The proportion of bloodmeals on the human population is very low at present (10 to 30%). Individual protection from the bites of the flies must therefore not necessarily increase the risk for the non-protected part of the population, but on the other hand, the vectorial capacity of the local flies could increase considerably, if the availability of animal bloodhosts decreases or if the density of the human population increases.
  - The reservoir of *O. ochengi* in cattle could possibly be affected by anthelminthic treatment of cattle. Acaricide treat- ments (pour-on) repel biting *Simulium* flies thus increasing the proportion of bloodmeals on the human population and reducing the vaccination effect.
  - Mass distribution of ivermectin for treatment of human onchocerciasis will enhance the protective effects of *O. ochengi* L3 by reducing the proportion of *O. volvulus* L3 in the flies.

Our present field-studies concentrate on the influence of cattle on the epidemiology of human onchocerciasis, but the way in which domestic animals influence other parasitoses should also be considered. Investigations on the epidemiological links between onchocerciasis, schistosomiasis and malaria are therefore suggested.

REFERENCES


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