CHAPTER 13

Arthropod-borne infections in the tropics: A synopsis

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13. 1 INTRODUCTION

There tends to be some variation in what is meant by the term "vector". Beaver, Jung and Cupp[1] define the term as meaning "Hosts that transmit parasites to man" Where the vector is essential to the life cycle of the transmitted organism, then they term it a "biologic vector". Where the time in the vector is not essential to the life cycle of the transmitted organism, the vector is termed a "mechanical" or "phoretic vector". In some cases, the microbial pathogen can be passed by vertical transmission from the female vector through the eggs, to all offspring (transoval transmission).

While arthropods are not the only vectors of microbial diseases, they comprise the most significant and important group of vector organisms. Arthropod vectors include the insects (the most important of the arthropod vectors); the ticks and mites and, to a much lesser extent, certain crustacea such as copepods, crabs and prawns which can serve to transmit diseases to humans when ingested as food. Other invertebrate sources of infection include the snails serving as intermediate hosts for the schistosomes and *Angiostrongylus cantonensis* which can cause eosinophilic meningitis in humans.

13.2 MODE OF TRANSMISSION

The mode of transmission of disease pathogens by vectors or intermediate hosts can vary considerably. Where the source of the infection is an intermediate host rather than a vector *sensu stricto*, then infection usually occurs by ingestion either deliberately where the invertebrate comprises part of the food source for the humans - eg eating of crabs, (paragonimiasis) prawns or snails (*Capillaria philippinensis*; angiostrongyloidiasis) or accidently (eg snails or slugs on salad plants (angiostrongyloidiasis) or *Cyclops* in water (Guinea worm)[2]. Other examples of this are infection of humans with the dog tapeworm (*Dipylidium caninum*) after accidental ingestion of a dog flea (*Ctenocephalides canis*) or with the rat tapeworm (*Inermicapsifer madagascariensis*) with an oribatid plant mite. Similar infection of humans with the cestode *Hymenolepis diminuta* can follow accidental ingestion of meal worm larvae in flour[2].

House flies (*Musca domestica*) can transmit enteric pathogens mechanically on their feet or mouthparts from faeces to food. This type of transmission can or could be important in the transmission of polio; rotavirus infection; Hepatitis A, cholera, typhoid, amoebiasis, giardiasis;

ascariasis, trichuriasis, toxocariasis, cysticercosis, or hydatid. Trachoma (*Chlamydia trachomatis* A,B,C) can also be mechanically transmitted from the eyes of infected people to the eyes of others by the house flies or bush flies belonging to the genus *Musca*.

Where the transmitter is a true vector (usually a blood sucking arthropod), then infection usually occurs by injection of the transmitted organism with the saliva of the vector (eg the malaria parasite by the female *Anopheles* mosquito; injection of the trypanosome causing African Sleeping Sickness by the tsetse fly, *Glossina*). However, in the transmission of Chagas' disease by the reduviid bugs, the trypanosomes pass out of the bug in faeces passed while feeding is taking place and they then gain entry to their human host by contamination of the mucous membranes or the bite wound. Similarly in the transmission of Bancroftian filariasis, the infective filarial larvae are deposited on the human skin during the feeding process by the mosquito and then gain entry to the human through the bite wound.

In the case of the transmission of epidemic typhus, the rickettsiae are not injected into the human host, but gain entry through the skin when the human scratch the itchy lesions caused by biting louse, crushes the louse, and then scratches the rickettsiae into the skin. Alternatively, transmission can be achieved by inhalation of louse faeces which contain the rickettsial organisms.

Transmission of *Yersinia pestis* by the tropical rat flea, *Xenopsylla cheopis* or *X. brasiliensis* is also different. Here the bacilli ingested by the feeding flea are trapped by spiny hair-like structures in the gut of the flea where they multiply, blocking the gut. The host rat dies and as its body cools, theses infected 'blocked' fleas leave the host and hop onto a new host (rat or human). They attempt to feed but, as the gut is blocked, the blood they ingest cannot pass through. It flows back into the new host from the blocked gut carrying the plague bacilli into the new host.

Table 13.1: Biologic vectors transmitting pathogens by bite[3-7]

Vector	Scientific name/ group	Disease	Disease pathogen
Insects			
Body louse	*Pediculus humanus corporis*	Epidemic typhus Epidemic relapsing fever	*Rickettsia prowazekii* *Borrelia recurrentis*
Cone nose bugs) Reduviid bugs) Assassin bugs)	*Triatoma* spp) *Rhodnius* spp) *Panstrongylus* spp)	Chagas' Disease	*Trypanosoma cruzi*
Tsetse flies	*Glossina* spp	African Sleeping Sickness	*Trypanosoma brucei rhodesiense* *T. b. gambiense*

Horse flies	*Chrysops* spp	Loiasis	*Loa loa*
Sandflies	*Phlebotomus* spp	Leishmaniasis	*Leishmania* spp
		Sandfly Fever	Arbovirus
	Lutzomyia spp	Oroya fever	*Bartonella bacilliformis*
Black flies	*Simulium* spp	River blindness	*Onchocerca volvulus*
Biting midges	*Culicoides* spp	Filariasis	*Mansonella perstans*
			M. ozzardi
		Oropouche Fever	Arbovirus
Mosquitoes	*Anopheles* spp	Malaria	*Plasmodium* spp
		Lymphatic filariasis	*Wuchereria bancrofti*
		Onyog'nyong	Arbovirus
	Culex spp	Filariasis	
		Oropouche)	Arbovirus
		Ross River)	"
		VEE.)	"
		WEE)	"
		St Louis enceph.)	"
		Jap. B. enceph.)	"
	Aedes spp	Yellow fever)	"
		Dengue)	"
		Rift Valley Fever)	"
		Ross River)	"
		Chikungunya)	"
		EEE)	"
		Lymphaic filariasis)	*Brugia* spp
		)	*Wuchereria bancrofti*
	Psorophora spp	VEE)	"
		Mayaro)	"
	Haemagogus spp	Yellow Fever)	"
	Mansonia spp	Lymphatic filariasis)	*Brugia* spp
		)	*Wuchereria bancrofti*
	Coquillettidia spp	EEE	Arbovirus
	Ochlerotatus spp	Ross River[7]	"
Fleas	*Xenopsylla* spp	Bubonic plague	*Yersisia pestis*
		Murine typhus	*Rickettsia typhi*
Mites			
Rat mite	*Leptotrombidium* sp	Scrub typhus	*Rickettsia tsutsugamushi*
Ticks			
Tampan	*Ornithodoros* spp	Endemic Relapsing Fever	*Borrelia duttonii*

Hard tick	*Ixodes* spp	Spotted Fevers	*Rickettsia* spp
		Lyme Disease	*Borrelia burgdorferi*
Snake tick	*Aponomma* sp	Flinders Island Spotted Fever	*Rickettsia honei*[6]
Lone star tick	*Dermacentor* spp	Rocky Mountain Spot. Fever	*Rickettsia rickettsiae*
Brown tick	*Rhipicephalus* spp	Spotted Fevers	*Rickettsia* spp
Bont tick	*Hyalomma* spp	Congo-Crimean Haemorrhagic Fever	Arbovirus
Bont leg tick	*Amblyomma* spp	Spotted Fevers	
		Ehrlichiosis	*Eherlichia chaffeensis*
Dog tick	*Haemaphysalis* spp	Spotted Fevers	*Rickettsia* spp

In the transmission of schistosomiasis, the environment (water) is seeded with cercariae released by water snails and humans are infected when these free swimming cercariae penetrate the skin. In the transmission of the human botfly, *Dermatobia hominis* in Latin America, the botfly lays its eggs on a mosquito (*Psorophora* spp) or ixodid tick and then, when the mosquito or tick feeds, the maggot descends to the human host and burrows into the skin to cause cutaneous myiasis.

Generally speaking, the bedbugs (*Cimex* spp); headlice (*Pediculus humanus corporis*) and pubic lice (*Pthirus pubis*) are not usually implicated as vectors of disease. It is interesting however, that Hepatitis B virus has been isolated from bedbugs and it has been postulated that mosquitoes might be able to rarely transmit viraemic diseases by mechanical contamination of their mouthparts. In the case of HIV, the chances of such transmission is generally considered to be negligible as most infected patients do not have sufficient virus in the blood for them to infect biting mosquitoes.

13.3 PRINCIPLES OF CONTROL

As in all infectious diseases, control and prevention of human infections transmitted by vectors can involve prophylactic and/or curative treatment of humans and animal reservoirs if they are involved. Immunization of both human and mammalian reservoir hosts can also sometimes be used. However, where infections are vector-borne, control measures are usually aimed largely at vector control although barriers to prevent exposure to insect bites also has a place in the prevention of vector-borne infections (eg. use of window screening; bed nets; skin repellents etc)

Methods used in vector control programmes include:

- Insecticides aimed at killing the adult of juvenile stages of the vector. This can involve the specific spraying of human dwellings or larval breeding sites or blanket spraying (‘fogging’) of the entire area.

- Environmental methods such as tree/ bush clearing (where vector requires shade for breeding) or tree planting (where vectors prefer open, unshaded breeding areas). Also here can be included such methods as changing rate of water flow where vectors need slow water (eg water snails) or fast water (e.g. *Simulium* larvae)

- Biological control using parasites, microbial pathogens or predators of the vector.

- Male sterilisation of vectors where female mates only once (eg *Glossina*). This can be achieved using chemicals or radiation and can be combined with vector trapping methods as has been used for tsetse control in Africa.

- Hygiene and sanitation to prevent infection of aquatic intermediate hosts (eg snails in schistosomiasis).

- Filtering/chlorination of water eg to kill *Cyclops*, the intermediate hosts of *Dracunculus medinensis*, the Guinea worm).

- Finally, of course, education of medical personnel and the public is crucial to the success of all infectious disease control programmes.

13.4 REFERENCES

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