List of slides and explanatory notes

**Topic B: Relevant disease vectors**

B.1 Principal genera of aquatic snails and the form of schistosomiasis they transmit

B.2 Shells of various snail intermediate hosts of schistosomiasis

B.3 The life cycle of schistosome parasites

B.4 Mosquitoes and the diseases they transmit

B.5 Mosquito life cycle

B.6 *Anopheles gambiae*, feeding

B.7 Sandfly, feeding

B.8 Blackfly, feeding

B.9 Blackfly larvae

B.10 Tsetse fly

B.11 Tsetse fly with its riverine ecology in West Africa

Credit individual slides:

World Health Organization
B.1, B.3, B.4, B.5, B.6, B.7, B.8, B.9

Danish Bilharziasis Laboratory
B.2

Agricultural University Wageningen, Netherlands
B.9, B.10

*Slide B.1*
The three snail genera, *Biomphalaria*, *Bulinus* and *Oncomelania* each transmit a different species of *Schistosoma*. Apparently, within this system there is also a great deal of parasite strain specificity for snail species. *Oncomelania* snails are amphibious, and therefore environmental risk factors for japonicum schistosomiasis differ markedly from those of the other parasite species, whose intermediate hosts are strictly aquatic, even though they survive periods of drought for periods up to twelve months, a phenomenon known as aestivation.

Snail intermediate hosts of *Schistosoma haematobium* and *S. mansoni* are remarkably tolerant in terms of physical and chemical conditions. Sunlight and relatively high water temperatures put stress on the snail populations because bacterial decomposition processes may result in reduced oxygen tension.

In the context of irrigation schemes, stream velocities in canals are considered a crucial issue in relation to schistosomiasis transmission. Aquatic weeds slow down the stream velocity and they also provide a substrate for snail populations. Research by professor Martin Fritsch has given further insight into the hydraulic characteristics related to stream velocity. The impact of flushing canals on snail populations is not based on the drag force effect, but rather on turbulent and fleeting, short-lasting shear stresses along the transition zone of various embankment vegetation and river bed sediments.

**Reference:**

Fritsch, M., 1993. *Environmental management for schistosomiasis control - river flushing, a case study in Namwawala, Kilombero District, Tanzania*. Verlag der Fachvereine, Zurich, Switzerland

**Slide B.2**

Shells are important for the determination of snail species. This is the work of a malacologist. The Danish Bilharziasis Laboratory in Charlottenlund, Denmark, is the global authority for species identification. To many non-specialists the size of the snail intermediate hosts comes as a surprise. The maximum length of the elongated *Bulinus* shells is 20-22 mm, while the flat Biomphalaria shells have a maximum diameter of 13-17 mm. One snail can daily shed between 1000 and 1500 of cercariae (the infective larvae of the *Schistosoma* parasite) and snail colonies themselves can be very sizable. The snails serve as prey to certain fish and to other, predator snails. Such predators have been used as biological control agents, with different levels of success. Fish that live of aquatic weeds have been used for the same purpose, because the destruction of the snail habitat can also contribute significantly to a reduction of transmission risks under specific circumstances.

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**Slide B.3**

The life cycle of the *Schistosoma* parasite is complex, and involves various transformations, adapting the parasites to different micro-environments. The adult parasites, belonging to the group of trematodes (flukes), live as male/female pairs in the bloodstream of humans, either in the blood vessels of the mesenteric plexus surrounding
the large intestine \((S. \textit{mansoni} \text{ and } S. \textit{japonicum})\) or of the venous plexus of the bladder \((S. \textit{haematobium} \text{ and } S. \textit{intercalatum})\).

The eggs they produce have to pass through the tissue to reach the intestinal tract or me bladder. In this process they cause damage, and many eggs get trapped and calcify - the accumulated effect is what causes the illness. Eggs leave the body of their \textit{host} with either feces or urine.

In fresh water the eggs hatches and a free-living larval stage, called \textit{miracidium}, starts its search for an appropriate intermediate snail host. In an internal organ of the snail (equivalent to the liver and pancreas combined) the \textit{miracidium} transforms into a \textit{cercaria} (the infective larval stage) in about a month.

The shedded cercariae will attach to and penetrate the skin of humans in touch with water and once in the human bloodstream the larva will reach its final destination (described above) via a complicated route, while undergoing a transformation into an adult worm.

While the details of the life cycle are the domain of parasitologists, the non-expert working in the area of agricultural development should remember the two crucial stages in the Life cycle where he/she can exert influence:

The sanitation aspect: if communities have adequate sanitation and permanent health education keeps them aware of the need to use this sanitation and to teach their children to use it, then contamination of water bodies can be minimized.

The water contact aspect: if communities have access to safe water (for drinking and for laundry) then (re-)infection can be avoided. Children and adolescents will always remain a vulnerable group and deserve special monitoring and treatment Men and women working in irrigated agricultural production are also at risk, depending on their water contact patterns, and need special attention, as well.

\textbf{Slide B.4}

Mosquitoes are cosmopolitan, but only a few genera are medically important and within these genera not all species are vectors. The capacity to transmit human diseases depends first and foremost on specific physiological characteristics and feeding behaviour. Most parasites undergo a transformation inside the vector and require compatibility (in molecular terms: matching receptors) and the correct micro-environment for their development Female mosquitoes take blood meals in order to develop eggs. With each blood meal the chances of obtaining an infection from a human host and passing it on to another is increasing, and life span or \textit{longevity} is, therefore, another important parameter of the vectorial capacity of a mosquito species.

The introduction of irrigation in large areas may lead to an increase in the relative humidity and this may result in a longer average life span of mosquitoes. As a result, the transmission of, for instance, malaria may intensify significantly.

\textbf{Slide B.5}
Some clear differences between *Anopheles* and *Culex* mosquitoes include the shape of the so-called egg-raft (all mosquitoes lay their eggs in water), the position of the larvae in relation to the water surface (dependent on the position of the siphons through which the larvae breath) and the position of the adult female when taking a blood meal. The difference between anophelines and culicines is particularly important to identify malaria vectors: malaria is only transmitted by anophelines.

**Slide B.6**

**Slide B.7**

**Slide B.8**

Adult insects taking a blood meal: an *Anopheles* mosquito, a *Phlebotomus* sandfly and a *Simulium* blackfly, respectively.

At the start of the blood meal, the insect will inject an anticoagulant from its salivary glands into the host on which it feeds. If previously infected by another blood meal, the infective parasite larvae will be injected with the saliva into the hosts bloodstream. Not all parasites pass through a transformation inside the vector and remain in the salivary glands: filarial parasites are attached to the so-called proboscis (the mouth-part penetrating the skin) and are therefore transmitted mechanically.

**Slide B.9**

The larvae of the blackfly (*Simulium damnosum spp.*) live attached to a substrate in the fast flowing parts of rivers, where they filter out particles for their nutrition.

In addition to their natural habitat (rapids, water falls etc), they can also colonize spillways of dams, and there is one documented case where they colonized an irrigation canal with high velocity water running through it.

**Slide B.10**

**Slide B.11**

Tsetse flies (genus *Glossina*) are relatively large, bloodsucking flies which are easily recognizable. Their reproduction requires a habitat of moist soil, where they produce one pupa at a time, which wriggles itself into the soil. The species transmitting gambian sleeping sickness live in the riverine forest zones and human-vector contact is associated with human water needs and uses.