Review Article

A Review on Biogeography and Evolution of *Schistosoma*

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ABSTRACT

Schistosoma is a genus which infects by parasitic trematode worms commonly known as blood flukes. They are highly responsible to cause infections in humans majorly in the regions African and Asian origins especially in rural areas in agricultural land, inland fisheries. The origin of *schistosoma* was unclear, but was believed that this genus origin was from Africa where its genus DNA species infect hippo could be basal in the era of Cenozoic. In the earlier, it was first mentioned from 2000-1000 BC in ancient Egyptian Papyri. According to Davis, *schistosoma* genus was aroused in Gondwanland before 150 years ago based on phylogenetics of the pomatiopsid host snails. Gondwanan separated into Africa, South America, Antarctica and Australia. Asia as India separated from Africa and identified *S. japonicum* and *S. indicum* which were demonstrated by analyzing DNA sequence, mitochondrial gene order and C-banding patterns. From Africa *S. mansoni* was identified during Holocene and transmitted to South America by slave trade and understood by lineage specific gene duplications. Genus *Schistosoma* in the form of *Orientobilharzia turkestanicum* primarily hosts in the cattle, sheep, goat and Cashmere goat. Some other genus Schistosoma also appears in the form of *Bivetellobilarzia* which hosts in an elephant. *S. incognitum* and *S. nasale* are closely related to the African species rather than japanicum group. During the time of Pliocene *S. sinensium* appears to radiate and in the Mid-Pleistocene, *S. mekongi* appears to have invaded in South East Asia.

Keywords: Evolution, biogeography, *Schistosoma*, Gondwanland, hippo, snail.

INTRODUCTION

Schistosoma is a genus which causes parasitic infectious disease by trematode worms, chiefly in tropical regions. It is also commonly known as blood flukes. Trematodes are parasitic flatworm responsible for a highly significant group of infections in humans which can be termed as Schistosomiasis. It is also called with the term as *Bilharzia*.[1]

Depending on the type of infecting species adult flatworms infest in blood capillaries of mesenteries and the plexus of the bladder. They are unique trematodes and they are dioecious, with distinct sexual dimorphism between male and female. The eggs are released in thousands and reach either in bladder or intestine and these are then excreted in urine or feces as according to the infecting species. The larvae then pass in snail as an intermediate host. The same larvae parasite may also emerge into a new mammalian host by directly penetrating into the skin.[2]

Some ponds and rivers as much as thousands can be found in a square meter. They are the freshwater snails belonging to the genus *Bulinus*, in which they act as specific hosts to the larval stages of the *Schistosoma haematobium* worm.[2]

The miracidium is a young form of life is attracted by the mucous secretion of snail and burrows into the soft tissue of the mollusc. The miracidium transforms on its own into sporocysts which are meant to be as sowing, seed and sack, which gives rise to daughter sporocysts. A single miracidium may produce thousands of cercariae in a few weeks and this production may carry in the snail for months.

In the pond of El Mamoun, water was teeming with this kind of microscopic life when the tourists arrived at the oasis. Previous visits to the oasis by Bedouins had left the pond infected, a legacy of the disease was spreaded to the tourists to contract. When divers jump from their boats, the cercariae are stimulated by the high temperature and bright light of the day, abandon the snails. Under the microscope, it appears like miniature tadpoles with a pear-shaped buoy and a long tail ending in a y-shaped fork which acts as a propeller to move the organism through the water. They swim in a desperate race searching for a human host to ensure their survival. Cercariae attract by the lubricating oily secretion of the human body, they then attach themselves to the skin with their oral suckers. They do not need to find a wound or break in the skin since they secrete an enzyme which splits the 'cement' holding the cells of the skin together and penetrates into the skin by shedding their tails.[2]

HOST RANGE

Schistosomes are the parasites of human and animal, which is spread throughout Africa, Asia, and South America, especially in rural areas such as agricultural land and inland fisheries. Distribution of parasite is linked to that of their intermediate hosts in the snail, which differ in their habitual preferences for slow-flowing or still waters. Many activities of human showed an influence in

parasite distribution, especially the construction of irrigation channels, dams and flood irrigation of crops. Parasitic infections have been noted and recorded throughout in the history of humanity. In the earlier, it was first mentioned from 2000-1000 BC in ancient Egyptian Papyri. At the time of 18th-century hematuria became the scourge of Napoleon's army in Northern Africa and later it was known to be a disease as *Bilharzia* in honour of the discoverer of the causative agent. *Schistosoma spp.* vary in their specificity for intermediate hosts, some infect only in humans possibly in primates white others may infect in domestic and wild animals which acts as a reservoir for human infection.[3]

BIOGEOGRAPHY AND EVOLUTIONARY ORIGINS OF THE GENUS *SCHISTOSOMA*

The origin of this *Schistosoma* genus was unclear, but it was believed that this genus had an origin from Africa where this genus DNA species that infect the hippo could be basal. In the era of Cenozoic, the *Schistosoma* genus might have originated from hippos as parasites. However, in both Africa and Asia hippos were present in the Cenozoic era. In South East Asian species original hosts are from the rodents.[4]

Davis proposed that genus *Schistosoma* genus was aroused in Gondwanaland before 150 million years ago that is before the separation of the supercontinent, now which is made up of Africa, South America, Antarctica, and Australia. It was understood that based on the phylogenetics of the pomatiopsid host snails it seems to be an evolution of *Schistosoma* genus which was an extensive fossil record in Gondwanan origin.[5, 6, 7] This means to say that the spread of these parasites was due to continental separation and the ancestor of Asian schistosomes was moved across to Asia as India separated from Africa and moved towards Asia during 70-148 million years ago and giving rise to *S.indicum* and *S. japanicum* groups.[6] This theory again put forward for consideration that remaining African stock diverge over 120 million years ago, giving rise to ancestral lineages of the *S. mansoni* and the *S. haematobium groups*. This would suggest that an ancestral lineage of the *S. mansoni* appears to be approximately 80 million years ago for both parasite and snail vector *Biompalaria* and colonize in South America.[4, 7]

Throughout Asia, two groups were primarily identified. They are *S. japanicum* and *S. indicum*. Schistosoma group was founded throughout eastern and southeastern Asia, including China, the Philippines and Malaysia and the *Schistosoma* indicum group appeared to be at the western and southern regions including India, Srilanka and Thailand. Davis theory implies that the ancestors of the *S. japanicum* and *S. inducum* species group were from African and arrived in Asia via the Indian Plate. This was demonstrated by analyzing DNA base sequences, mitochondrial genome gene order and C- banding patterns.[8, 9]

S. mansoni affects about 237 million people worldwide. The study says that it has been more than 45% of the encoded proteins and homologs which comprises the evolutionary histories across 12 other organisms. The analysis of phylogenesis understood the identification of lineage-specific gene duplications pointed to the diversification of several protein families that are relevant for host-parasite interaction, including proteases, tetraspanins, fucosyltransferases, venom allergen-like proteins, and tegumental-allergen-like proteins.[10]

S. mansoni and *S. rodhaini* were found in ancestor between of 107.5 to 147.6 thousand years ago.[11] *S. mansoni* appears to originate in East Africa and appears to have evolved in 0.43-0.30 million years ago. *Schistosoma mansoni* also identified throughout Africa and has experienced a decrease in effective population size 20-90 thousand years ago before dispersing across the continent during the Holocene. Later this *S. mansoni* was transmitted to South America by the slave trade which is mainly restricted to areas of Brazil, Venezuela, Surinam and the Caribbean.[12]

Synder & loker implies the radiation of *S. japanicum* group to that of their pomatiopsid hosts in the mid-Miocene. If this would be the case, it would indicate that the schistosomes were colonised in Africa before 15-20 million years ago. After 70 million years the Gondawanaland drifted apart from moving South America and African Plates. The parasites evolved to exploit pulmonale snails after the invasion of the African continent, exclusively, thus developing a more specialised host range.[13]

The genus *Schistosoma* also appears to be in the form of *Orientobilharzia turkestanicum* which primarily hosts in the cattle, sheep, goat and Cashmere goat.[14, 15] Some other genus Schistosoma also appears in the form of *Bivetellobilarzia* which hosts in an elephant.

S. incognitum and *S. nasale* are closely related to the African species rather than japanicum group.

In Hungary red deer was found to be infected with *S. turkestanicum*. These strains have been travelled from China and Iran. Its divergence was expected to occur before 270,000 years before present.[6]

During the time of Pliocene *S. sinensium* appears to radiate and in the Mid-Pleistocene, *S. mekongi* appears to have invaded in South East Asia.

African and Asian origin maps display the hypotheses of schistosomes in figure no-1.

1a. showing the African origin by Davis GM, 1992; Davis GM, 1980:

1 & 2. Indicate the African *Schistosoma* moving over to Asia on the Indian plate 70-148 million years ago, giving rise to the *S. indicum* group and diversifying into the *S. japonicum* group.

3 & 4. Suggest the *Schistosoma* ancestor remaining in Africa diverged above 120 million years ago, giving rise to the *S. mansoni* and *S. haematobium* groups.

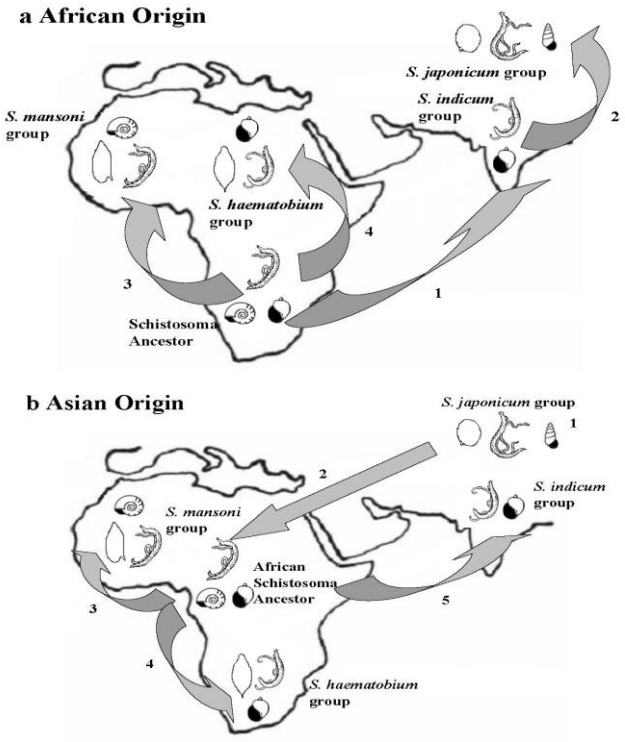

Figure 1: African and Asian origin Maps display the hypotheses of schistosomes.[17]

1b. showing the Asian origin by Rollinson, 1997; Snyder, 2000:

1. *S. japonicum* like ancestor arises and diversifies in Asia.

2. Asian descendants of the ancestral schistosome move into Africa with the widespread mammal migration between 12-19 million years ago.

3 & 4. The African schistosome diverges 1-4 million years ago, giving rise to the *S. mansoni* and *S. haematobium* groups. At this time, the ancestors of the *S. indicum* group emerge and move to India again via the mass movement of large mammals.

CONCLUSION

From the view of many literatures schistosoma species has spreaded majorly in the African and Asian origins through snails. Despite of awareness programmes in this generation it is becoming possible to prevent infection by hygienic human waste, eradication of snail and parasitic eggs in water stills, rivers and ponds by molluscicides, avoiding long standing in water stills.

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