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DISTRIBUTION , ECOLOGY AND EPIDEMIOLOGICAL ROLE OF SNAILS IN
THE TRANSMISSION OF HUMAN AND ANIMAL SCHISTOSOMIASIS

by

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ABSTRACT

Four species of Schistosomes of medical and veterinary incidence have been identified in Senegal i.e. *Schistosoma haematobium* , *S. mansoni* , *S. bovis* and *S. curassoni* .

Malacological surveys carried out in the different regions of Senegal and in different periods of the year permit to study the ecology of intermediate host snails of schistosomiasis , as well as their distribution , their abundance and their epidemiological role .

The principal snails potential intermediate hosts of these schistosomes are : *Bulinus globosus* , *B. umbilicatus* , *B. truncatus* , *B. forskalii* , *B. senegalensis* and *Biomphalaria pfeifferi*.

Field snails surveys and laboratory experiments permit to establish their role in the transmission of schistosomiasis :

Bulinus senegalensis , *B. globosus* and *B. umbilicatus* transmit *S. haematobium* ; *Biomphalaria pfeifferi* is the intermediate host of *S. mansoni* ; *B. forskalii* , *B. truncatus* and *B. globosus* transmit *S. bovis* ; *B. umbilicatus* and *B. globosus* are intermediate hosts of *S. curassoni*.

Particular studies have been done on the ecology and population dynamics of these snails intermediate hosts of schistosomiasis , and the results are summarized :

-Two years study in the field on temporary ponds and laboratory experiments on the ecology and behaviour of *Bulinus* species have shown that *Bulinus umbilicatus* , *B. truncatus* , *B. globosus* and *B. senegalensis* have a certain ability to resist drought which lasted 6 to 8 months. The ecological behaviour of these snails in the natural Sahel conditions (ponds are dry 6 to 8 months per year) is very important in the epidemiology of human and animal trematodosis and requires a new controlling strategy .

-In a recent foci of intestinal schistosomiasis in the Senegal river basin , *Biomphalaria pfeifferi* is widespread , it colonised all the hydrographic network (river , irrigation canals , drains , and marigots) with high densities . Monthly observations shown seasonal fluctuations regarding snail abundance and infestation rate. The transmission was acting in all water bodies and during all the year .

Major changes in water management and other ecological factors caused an increase of snail habitats . So , these optimal conditions led to the development and extension of trematodosis in Senegal , particularly in the Senegal river basin .

Key words : Snails - *Bulinus* - *Biomphalaria* - Schistosome - Schistosomiasis - Epidemiology - Transmission - Ecology - Drought - Senegal .

RESUME

Quatre especes de schistosomes d'incidences médicales et vétérinaires sont identifiées au Sénégal : *Schistosoma haematobium* , *S. mansoni* , *S. bovis* et *S. curassoni* .

Des prospections malacologiques effectuées dans les différentes régions du Sénégal et à différentes périodes de l'année ont permis d'étudier l'écologie des mollusques hôtes intermédiaires de ces schistosomes ainsi que leur distribution , leur abondance et leur rôle épidémiologique.

Les principaux mollusques hôtes potentiels de ces schistosomes au Senegal sont :

Bulinus senegalensis , *Bulinus forskalii* , *Bulinus truncatus* , *Bulinus globosus* , *Bulinus umbilicatus* , et *Biomphalaria pfeifferi* .

Leur rôle épidémiologique sur la transmission des trématodoses humaines et animales a été établi à partir des études sur le terrain et au laboratoire :

Bulinus senegalensis , *B. globosus* et *B. umbilicatus* transmettent *S. haematobium* ; *Biomphalaria pfeifferi* intervient dans la transmission de *S. mansoni* ; *Bulinus globosus* , *B. forskalii* et *B. truncatus* sont hôtes intermédiaires de *S. bovis* ; *Bulinus umbilicatus* et *B. globosus* transmettent *S. curassoni* .

Certaines études particulières ont été entreprises sur l'écologie et la dynamique des populations de ces mollusques . Les résultats sont résumés dans ce travail :

- Une étude sur le terrain pendant 2 ans , au niveau de 3 mares temporaires , et une autre menée au laboratoire sur l'écologie et la résistance à la sécheresse des mollusques , ont montré que *Bulinus umbilicatus* , *B. truncatus* , *B. globosus* et *B. senegalensis* ont une certaine aptitude pour résister à un assèchement complet de 6 à 8 mois . Dès la remise en eau 10 à 48 % de la population malacologique ayant résisté à l'assèchement reprennent leur activité .

Dans les conditions naturelles du Sahel où les points d'eau s'assèchent 6 à 8 mois par an , ce comportement écologique a une importance primordiale dans l'épidémiologie des trématodoses humaines et animales et nécessite une nouvelle stratégie de lutte .

- Un suivi malacologique dans un récent foyer de bilharziose intestinale à Richard-Toll (delta du fleuve Sénégal) avec une prévalence globale de 43 % , a montré que *Biomphalaria pfeifferi* inconnu dans cette zone jusqu'à cette date , a fortement colonisé tous les points d'eau du réseau hydrographique très dense (fleuve Sénégal , marigots , canaux d'irrigation et drains , etc .) .

Les observations mensuelles montrent des fluctuations concernant l'abondance et le taux d'infestation . La transmission se fait au niveau de tous les points d'eau et a lieu toute l'année . Le taux d'infestation global est de 44 % , mais il varie d'un site à l'autre suivant les points d'eau et d'un mois à l'autre (0 à 100 % et 2 à 58 %) .

Les bouleversements écologiques de ces dernières années ainsi que le développement de l'irrigation et des aménagements hydro-agricoles ont créé des conditions favorables à l'installation et à la prolifération des mollusques hôtes intermédiaires de trématodoses . Ainsi , on assiste pendant ces quatre dernières années à un développement considérable et à une extension de ces trématodoses humaines et animales dans tout le Sénégal et en particulier au niveau du bassin du fleuve Sénégal .

Mots Clés : Mollusque - Bulins - Biomphalaria - Schistosome - Schistosomes - Bilharziose - Epidémiologie - Transmission - Sécheresse - Sénégal .

Distribution , ecology and epidemiological role of snails in the transmission of human and animal schistosomiasis in Senegal .

by

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I) INTRODUCTION

Senegal is a country in the west African savana with a vegetation stratification changing from desert in the north to tree savana in the south parts .

Major changes in the environment occurred during the last decades : drought in the mid seventies and eighties , construction of two big dams (Diama and Manantali) in the Senegal river and smaller ones in the south (regions of Kolda and Ziguinchor) and increased rainfall in the late eighties .

The change in water management and other ecological factors caused an increase of snail habitats . So these optimal conditions permit to snails to proliferate particularly in the Senegal river basin (1989- 1990) . (6)

The snails of genus *Bulinus* and *Biomphalaria* are the potential intermediate hosts of human and animal schistosomes .

In Senegal with the recognition of *Schistosoma curassoni* (1) , four Schistosome species must be considered to be endemic , the other ones being *Schistosoma bovis* , *Schistosoma mansoni* and *Schistosoma haematobium* .

Schistosoma bovis and *S. curassoni* localised in cattle are widespread in the country (3) , *S. haematobium* endemic throughout Senegal and *S. mansoni* limited in some areas are human schistosomes .

The study of snails intermediate hosts of these schistosomes , their distribution, their ecology and their role in the transmission is fundamental for the epidemiology of schistosomiasis .

In this paper we resume some results of our malacological research in Senegal regarding the epidemiology of human and animal trematodosis particularly schistosomiasis .

II) MATERIALS AND METHODES

Malacological surveys carried out in the different regions of Senegal and in different seasons and periods of the year permit to study the distribution and the epidemiological role of snails intermediate hosts of human and animal schistosomiasis .

Snails are collected from irrigated canal and drains , ponds, marigots , lakes and rivers , etc . All freshwater habitats with human and animal contacts were screened . Snails were searched using long handled sweep nets and by examination of submerged and emerged vegetation as well as floating plants. The collected snails were placed in wide mouthed plastic buckets and taken back to the laboratory where they were washed , identified (2 , 9) and counted .

After identification the snails were screened for cercariae after exposure to sunlight for 30 to 45 minutes . The cercariae are then identified with the key of Frandsen (8) and also experimental infestation are done with small animal (mice , hamster , etc) and sometimes with sheep and goats.

After 2 or 3 months , snails free of infestation are kept in accord to be used in experimental infestation for the study of compatibility of snails with the different schistosomes.

For animal schistosomiasis surveys are done in slaughter-houses in the different regions .

III) RESULTS

Since 1978 a serie of many surveys in the different regions of Senegal provided data on the identification of the different snails intermediate hosts of schistosomes occuring in Senegal . They permit to study in each region the dynamic population of snails in natural and man -made habitats and their seasonal infestation .

It has been established from snail surveys that there is a definite association between the occurency of large populations of snails hosts of the schistosomes and aquatic vegetation. However , snails were found in some habitats without vegetation.

The principal snails incriminated in the transmission of the schistosomes in Senegal are :

Bulinus senegalensis , *B. forskalii* , *B. truncatus* , *B. globosus* , *B. umbilicatus* and *Biomphalaria pfeifferi* .

They were encountered in stagnant water , in slow flowing water or in an moderately flowing water .

B. truncatus , *B. forskalii* and *B. globosus* are the most widespread snails . They are encountered in all the regions of Senegal , but the abundance varies from an ecological zone to the other .

- *Bulinus senegalensis* is more frequent in lateritic biotops particularly in the Senegal river basin (in the north) and in Tambacounda and Kaolack departments (Eastern and Center). The principal habitats are the rain-fed laterite pools .

- *Bulinus forskalii* has a widest repartition .It is encountered in all ecological zones however it is more frequent in the South (region of Kolda) and in the North (Senegal river basin) .

- *Bulinus truncatus* widespread in the Senegal , but it is more frequent and abundant in the Senegal river basin , particularly in the delta and Lac de Guiers .

- *Bulinus globosus* is encountered in the Southern and Eastern regions (Kolda , Tambacounda and Kedougou) . It is also present in irrigated sheme , in marigots and in the river in the Senegal river basin .

- *Bulinus umbilicatus* is more frequent in the North (High and Middle Valley of Senegal river basin) and in the East (region of Tambacounda and Kedougou) . Its habitat is frequently temporary water bodies.

- *Biomphalaria pfeifferi* is meet in permanant water bodies in the South (region of Kolda) , in the East(Tambacounda) and South-East (Kedougou) . Not known in northern Senegal before 1980-ies , occasionally seen , but not established firmly in the north and central Senegal .

Since 1989-90 it became more abundant and widespread in the Senegal river basin particularly in the delta and Lac de Guiers . It colonized irrigation canals , drains , marigots , and the Senegal river allong Richard-Toll and Rosso .

The areas where the snails intermediate hosts of schistosomes are more abundant and frequent are the North , the East and the South of Senegal .

There is a seasonal fluctuation in the presence and abundance of snails according to the species , the habitats and ecological areas .

The data of these surveys in the different regions of Senegal permit to establish a map of the distribution of the snails intermediate hosts of schistosomiasis . (3)

Concerning the epidemiological role of these snails in the transmission of schistosomiasis in Senegal , the study of their natural infestation has shown that :

- *Bulinus globosus* , *B. senegalensis* and *B. umbilicatus* are the intermediate hosts of *Schistosoma haematobium* .

- *Biomphalaria pfeifferi* transmits *Schistosoma mansoni* .
- *Bulinus forskalii* , *B. truncatus* and *B. globosus* are intermediate hosts of *Schistosoma bovis* .
- *Bulinus umbilicatus* and *B. globosus* transmit *Schistosoma curassoni* .

The snails were collected in areas where schistosomiasis are not endemic , and generally the natural infestation rate is very low (0 to 2 p 100) . But, during the outbreak of intestinal schistosomiasis in Richard-Toll. *Biomphalaria* were found heavily infested with a prevalence of 40 to 100 p 100 . (7) .

In a recent foci of *S. haematobium* in the delta, *B. globosus* has a prevalence of 29p100(11)

Experimental infestations are also done with the different snails and schistosomes to study their susceptibility. (cf. Tab. 1).

Tab. 1- Epidemiological role of snails in the transmission of Schistosomes

Schist.	Natural Infestation			Experimental Infestation		
	S. h.	S. b.	S. c.	S. h.	S. b.	S. c.
Snails						
B. truncatus	0 ⁰ %	0,5 ⁰ % 0,8 ⁰ %	0 ⁰ %	7,6 ⁰ % (145)	63,6 ⁰ % (100)	0 ⁰ % (30)
B. umbilicatus	1 ⁰ % 2 ⁰ %	0 ⁰ %	0,79 ⁰ % 1,3 ⁰ %	27,6 ⁰ % (756)	13,3 ⁰ % (100)	70 ⁰ % (50)
B. globosus	0,5 ⁰ % 1 ⁰ %	1,5 ⁰ % 2 ⁰ %	0,6 ⁰ % 1 ⁰ %	41 ⁰ % (145)	--	13 ⁰ % (24)
B. senegalensis	0,3 ⁰ % 0,8 ⁰ %	0 ⁰ %	0 ⁰ %	0 ⁰ % (145)	0 ⁰ % (80)	0 ⁰ % (80)
B. forskalii	0 ⁰ %	0,3 ⁰ % 1 ⁰ %	0 ⁰ %	0 ⁰ % (190)	48,9 ⁰ % (228)	0 ⁰ % (24)

S. h. = *Schistosoma haematobium* : S. b. = *S. bovis* : S. c. = *S. curassoni* : () = snails tested

Particular studies are done concerning the ecology and population dynamics of snails in different habitats in Tambacounda (in the East of Senegal) and in Richard-Toll , north of Senegal (Senegal river basin) .

The results of these two studies are summarized :

- Ecology and resistance to the drought of *Bulinus* species

Laboratory experiments have shown that *Bulinus truncatus* , *B. globosus* and *B. umbilicatus* intermediate hosts of trematodosis in Senegal have a power resistance to the drought. Ten to 48 p. 100 of these molluscs have endured this drought which lasted 7 to 8 months . The snails recovered are particularly the medium sized ones (6 to 8 mm) . (4)

The results of two years study on the field (3 temporary ponds) in a North-Soudanian area of Senegal (region of Tambacounda) on the ecology of bulinus species confirm this resistance to the drought particularly *B. umbilicatus* and *B. senegalensis* . Monthly observations shown that the relative abundance of *B. umbilicatus* is higher than that of *B. senegalensis* . These ponds are dry during 6 to 8 months per year . However the populations of snails regenerate regularly , a fact which presupposes a certain ability to resist drought . Some come through this period succesfully and 70 to 80p. 100 of these snails are the middle sized ones. Immediately after the first rains they resume their activity and lay intensively in order to reconstitute the population . In this area only *B. umbilicatus* intervenes in the transmission of schistosomes : *S. haematobium* and *S. curessoni* which occurs between September and November . (5)

In the natural Sahel sonditions the epidemiological cycle is short and everything happens within 4 to 6 months with the regeneration and the growth of the population of molluscs , its infestation and the transmission of schistosomiasis

This ecological behaviour of these bulinus species in the North-Soudanian region is very important in the epidemiology of human and animai trematodosis and requieres a new controlling strategy .

-Distribution and prevalence of *Biomphalaria pfeifferi* in Richard -Toll

A recent outbreak of intestinal schistosomiasis (1989) has been reported in Richard-Toll (Delta of Senegal river) with a global prevalence of 43 % (10) . A malacological survey has been carried in this area to study the density of *Biomphalaria pfeifferi* ,their distribution in the different water bodies and their infestation .

Four epidemiological aquatic systems were identified : irrigated system with irrigation canals and drains of the C.S.S.(Senegal Sugar Company) , the system of " Taouey Canal" , system of "Taouey Marigot" and the " Senegal River" . All have permanent water .

The irrigated system includes 73 p. 100 of snails , the "Taouey Marigot" 16 p. 100, the "Taouey Canal" 8 p. 100 and the " Senegal River" 3 p. 100 .The density of *Biomphalaria* is very hight and varies from 0 to 200 .

Seasonal fluctuations are observed regarding snail abundance and infestation rate .

The transmission is acting in all aquatic systems and during all the year , the overall rate of infestation of *Biomphalaria* is 44 % , but it varies from site to site according to the water body and from month to month (0 to 100 p. 100 and 2 to 52 p. 100) . (7)

Monthly observations shown that the peaks of the abundance of *Biomphalaria* are localised in the warmer periods (June to October) . but the highest rates of infestation are observed during the coldest periods (November to May) .

The study is on going .

IV) DISCUSSION

Surveys are necessary to study the dynamic population of snails in natural and in man-made habitats . and their distribution and seasonal infection with schistosomes and other trematodes.

In Senegal we have seen that snails are concentrated in the North . the South and in the East where ecological conditions are better for their development . They are areas with a high hydrographic network density (river , lakes marigots , irrigation canals , drains . ponds . water bodies , etc) and a relatively heavy rainfall .

These areas are those where trematodosis in general and particularly human and animal schistosomiasis are very developed .

Major factors which influence disease epidemiology include environmental changes (" natural" and or man- made) and human behaviour .

The typical example we have in Senegal is the outbreak of intestinal schistosomiasis in Richard-Toll in the Senegal river basin which occurred 3 years after the Diama dam (10) . This outbreak is the combination of several factors :

- The dam and the irrigation schemes created more favorable habitats for snails particularly *Biomphalaria pfeifferi* which before was unknown in the North , proliferate in the delta and Lac. de Guiers ,

- A relative heavy rainfall in 1989 -1990 ,

- Presence in Richard-Toll of migrant laborers from different regions particularly the South carrying *schistosoma mansoni* .

In the Senegal river basin . the opening of Diama and Manantali dams . the increasing of irrigated systems and the rainfall led to the development and extension of human and animal trematodosis (high prevalences of human schistosomiasis and a n i m a l fasciolosis , paramphistomiasis and schistosomiasis are observed in 1992- 1994) .

Concerning the epidemiological role of snails . we need to elucidate the role of *B. truncatus* particularly in the Senegal river basin in the epidemiology of *S. haematobium* .

Every time we need to update our knowledge on the epidemiology of these diseases considering that it is a dynamic interaction between environment . host , intermediate-host and parasite . Repeated malacological surveys are necessary for the study of epidemiological role of snails whose distribution and abundance are not static .

Malacological data are fundamental for epidemiological studies of trematodosis particularly schistosomiasis and their control .

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