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PATTERN OF CERCARIAL EMERGENCE OF *SCHISTOSOMA CURASSONI* FROM NIGER AND COMPARISON WITH THREE SYMPATRIC SPECIES OF SCHISTOSOMES

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ABSTRACT: The emergence pattern of *Schistosoma curassoni* cercariae from *Bulinus umbilicatus*, whose adult worms parasitize bovine, caprine, and ovine ungulates in Niger, is of a circadian type with a mean emission time at 0855 hr \pm 1 hr 6 min, characteristic of the schistosome species parasitizing domestic or wild cattle. The comparison of this cercarial emergence pattern with those of the other 3 sympatric species of schistosomes (*Schistosoma haematobium*, *Schistosoma bovis*, and *Schistosoma mansoni*) shows a significant difference between the chronobiology of the cercariae infective for human and those infective for bovine hosts. This difference may improve epidemiological surveys based on snail prevalences by allowing the distinction between bulinids infected with human and bovine parasites.

Since the redescription of *Schistosoma curassoni* by Vercruyse et al. (1984), much attention has been turned to the epidemiology of the species group of schistosomes with terminal-spined eggs in several areas of West Africa where *S. curassoni* Brumpt, 1931, is sympatric with *Schistosoma bovis* (Sonsino, 1876) Blanchard, 1895, and *Schistosoma haematobium* (Bilharz, 1852) Weinland, 1858: Senegal, Mali, Mauritania (Vercruyse et al., 1985; Rollinson et al., 1990), Nigeria (Ndifon et al., 1988), and Niger (Mouchet et al., 1989). The close relationships among these 3 species and the intraspecific polymorphism characterizing each of them means that several markers must be used to identify them. Development in experimental hosts, enzyme profiles, egg structure, snail-parasite compatibility (Southgate et al., 1985), scanning electron microscope studies of the tegument of adult worms (Southgate et al., 1986), and cercarial chaetotaxy (Bayssade-Dufour et al., 1989) were the main characters analyzed. To our knowledge there are no available data concerning the cercarial emergence pattern of *S. curassoni*. Besides its epidemiological interest in the transmission of the parasite, this behavioral character has been used as a genetic marker (Théron and Combes, 1988) among schistosome populations and species (Théron, 1984; Pagès and Théron, 1990). The

description of the emergence rhythms of *S. curassoni* cercariae from *Bulinus umbilicatus*, its natural intermediate host in Niger, is presented and emergence rhythms are compared with the patterns obtained with the other 3 sympatric species, *S. bovis*, *S. haematobium*, and *Schistosoma mansoni* Sambon, 1907.

MATERIALS AND METHODS

All the parasites studied were from either naturally infected snails or the first experimental passage through sympatric snails. Eggs of *S. curassoni* were collected from mucosal scrapings of the rectum of 1 goat and 1 sheep from the abattoir of Zinder in the southeastern Niger. Laboratory-bred *B. umbilicatus* were exposed individually to 3 miracidia. The isolate of *S. bovis* was obtained from naturally infected *Bulinus truncatus* collected in a temporary pond in the Zinder area. Specific determination of the parasite was confirmed by a study of egg structure after infection of rodent experimental hosts. Eggs of *S. haematobium* were collected from human urine originating from the village of Baban-Tapki, 10 km south of Zinder. Cercariae were obtained after infection of laboratory-bred *B. truncatus*. Eggs of *S. mansoni* were collected from human feces in the village of Kawara in the area of Gaya in southwestern Niger. Cercariae were obtained after infection of laboratory-bred *Biomphalaria pfeifferi*.

The cercarial emergence patterns of infected snails were analyzed under identical experimental conditions: individual analysis of cercarial emergence over several consecutive days after an acclimation period of 2 days, automatic hourly sampling of cercariae by a chronocercariometer apparatus, constant water temperature of 25-26 C, and a balanced photoperiod (light/dark: 12 hr/12 hr) and photophase of 0600 hr to 1800 hr (330 lux) with simulated dawn and dusk. Counting was carried out with a stereoscopic microscope after filtration and staining of the cercariae with Lugol's iodine solution. Chronobiological analyses were carried out daily on 13 *B. umbilicatus*/*S. curassoni* (50 cycles), 6 *B. truncatus*/*S. bovis* (29 cycles), 8 *B. truncatus*/*S.*

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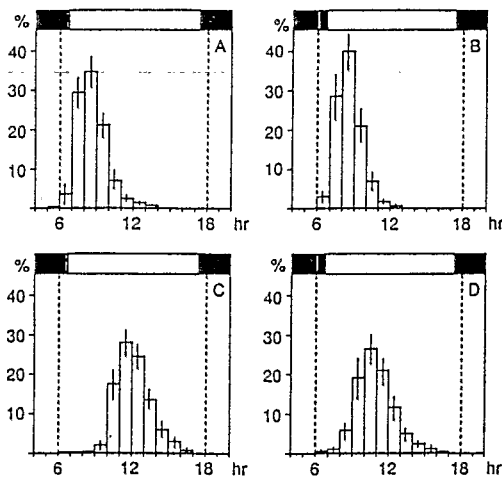


FIGURE 1. Histograms of the mean hourly cercarial productions of the 4 isolates of (A) *Schistosoma curassoni*, (B) *Schistosoma bovis*, (C) *Schistosoma haematobium*, and (D) *Schistosoma mansoni* from Niger (bars = SD). 6 = 0600 hr; 12 = 1200 hr; 18 = 1800 hr.

haematobium (37 cycles), and 7 *B. pfeifferi*/*S. mansoni* (29 cycles).

RESULTS

The mean hourly cercarial productions (Fig. 1A–D) show a peak of emergence between 0800 hr and 0900 hr for *S. curassoni* and *S. bovis*, between 1100 hr and 1200 hr for *S. haematobium*, and between 1000 hr and 1100 hr for *S. mansoni*.

After transforming the data into circular variables (Batschelet, 1981; Chassé and Théron, 1988) and calculation of the mean vector (MST = mean shedding time \pm angular deviation and r = vector length) for each rhythm, chronobiological parameters characterizing the emergence patterns of cercariae (Fig. 2) were as follows: *S. curassoni*, MST = 0855 \pm 1 hr 6 min, r = 0.960; *S. bovis*, MST = 0905 \pm 1 hr 5 min, r = 0.958; *S. haematobium*, MST = 1236 \pm 1 hr 34 min, r = 0.926; *S. mansoni*, MST = 1223 \pm 1 hr 40 min, r = 0.939.

The comparison of these results using the Mardia–Watson–Wheeler test (Mardia, 1972) showed that there was no statistically significant difference between the emergence patterns of *S. curassoni* and *S. bovis* (W = 0.56, df = 2, P < 0.05) or between *S. haematobium* and *S. mansoni* (W = 3.37, df = 2, P < 0.05).

DISCUSSION

The emergence rhythm of *S. curassoni* cercariae from *B. umbilicatus*, whose adult worms

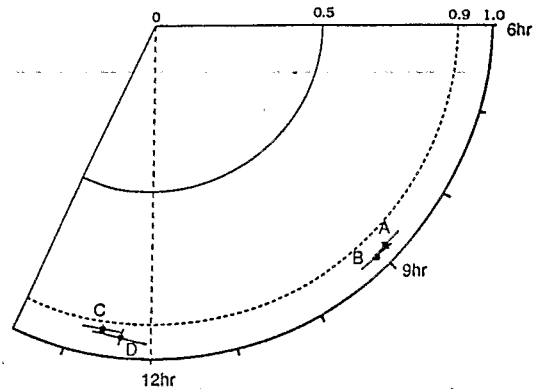


FIGURE 2. Mean vectors and confidence ellipses (axes) giving the mean emergence time of the 4 isolates of (A) *Schistosoma curassoni*, (B) *Schistosoma bovis*, (C) *Schistosoma haematobium*, and (D) *Schistosoma mansoni* from Niger. 6hr = 0600 hr; 9hr = 0900 hr; 12hr = 1200 hr.

parasitize ruminants in West Africa, is described for the first time and is of the circadian type with a diurnal peak of emergence between 0800 and 0900 hr, which is not significantly different from that of *S. bovis*. The cercarial emergence pattern of *S. curassoni* is then typical of the species of schistosome parasites of domestic cattle (*S. bovis*, Mouahid and Théron [1986] or wild Bovidae (*Schistosoma margrebowiei* and *Schistosoma leiperi*, Pitchford and Dutoit [1976])). In contrast, the rhythm of emission of *S. curassoni* cercariae clearly is different from that of *S. haematobium* and *S. mansoni*.

The differences in cercarial chronobiology shown by 4 sympatric species of *Schistosoma* present in Niger allow the distinction between the cercariae that infect bovine hosts (i.e., maximal cercarial emergence limited to the first few hours after dawn) and cercariae that infect humans (i.e., maximal emergence in the late morning and early afternoon). These differences are particularly relevant from an epidemiological point of view. In the sahelian areas it is common to find *S. haematobium*, *S. bovis*, and *S. curassoni* transmitted by the same snail host in the same waterbodies. In the absence of any morphological difference among the cercariae, the use of a simplified test for the rough determination of the maximal shedding period easily can provide a distinction between intermediate snail hosts infected with human or bovine schistosomes, allowing the calculation of their respective prevalence. This simple test might be a comparison between the proportion of cercariae (PC1) emerged during the first 4 hr of the light period

(0600–1000 hr) and that emerged during the rest of the light period (PC2). For bovine cercariae (*S. bovis* and *S. curassoni*), PC1 always is much greater than PC2 whereas for human cercariae (*S. haematobium*) the proportion always is inverted.

At the definitive host level, Albaret et al. (1985) presented data suggesting that *S. curassoni* may develop in humans. This view was not shared by Verduyck et al. (1984). The resemblance between the egg structure of *S. haematobium* and *S. curassoni* does not permit differential diagnosis. Under these conditions, the marked differences between the cercarial shedding patterns of these 2 species could be used to detect the presence of *S. curassoni* in humans after infection of snails by eggs collected in human urine.

It is also necessary to keep in mind that heterogeneity in ecological and epidemiological features that affect the transmission of schistosomes in different endemic areas, as well as the possibility of natural hybridization (Brémond et al., 1990; Rollinson et al., 1990), may lead to intraspecific differences. Consequences of these differences on polymorphism of cercarial emergence rhythms (Théron, 1985) also should be studied in natural populations.

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