Urinary Bladder Involvement in the Langur (Presbytis) Infected with Schistosoma haematobium (Bilharz, 1852) Weinland, 1858

BETTY JUNE MYERS, ROBERT E. KUNTZ, TAO CHENG HUANG, AND JERRY A. MOORE

Division of Microbiology and Infectious Diseases, Southwest Foundation for Research and Education, San Antonio, Texas 78228

ABSTRACT: The langur (Presbytis cristatus sondaicus Robinson and Kloss, 1919), an Asiatic primate, has been included in a broad scope program to evaluate different nonhuman primates as models for experimental schistosomiasis haematobia. Preliminary observations have indicated that this monkey maintains its infection well, and may serve as a host in which S. haematobium (Iran strain) gives rise to involvement of the urogenital system in a manner somewhat comparable to that reported for man.

The schistosomiasis parasites constitute one of the more serious parasite infections in many populations. With an estimated worldwide prevalence of no less than 200,000,000 cases, there has been much effort and time expended on investigations directed to a better understanding of the basic biology of a parasite which is on the increase. Due to varied circumstances, including availability of study materials, more attention has been given to Schistosoma japonicum and S. mansoni than to S. haematobium. In man infected with S. haematobium there may be a predilection for residence by parasites in the vesical plexus and variable involvement of the urogenital system, whereas with S. japonicum and S. mansoni, the parasites are more closely associated with the liver and different levels of the intestinal tract. Details on the involvement of the urogenital organs in an experimental system are essentially lacking since there has been no suitable model in which these conditions could be developed. As a consequence, a broad scope program has been instituted with a search for biomedical models acceptable for investigations with S. haematobium.

There are scattered references to the use of nonhuman primates in schistosome research (Edwards and McCullough, 1954; Jordan et al., 1967; Kuntz and Malakatis, 1955; Standen, 1949; Webbe and Jordan, 1966). However, there is limited information on the use of these mammals, especially the Asiatic primates, for S. haematobium. The present report is based upon observations of urinary bladder involvement in the langur (Presbytis cristatus sondaicus Robinson and Kloss, 1919), one of a series of primates being evaluated for use in experimental schistosomiasis haematobia.

Materials and Methods

Current investigations involve several schistosomes, but emphasis is given to the use of the Iran strain of S. haematobium which is maintained in Bulinus truncatus rohlfisi (Clessin) of Ghana (West Africa) origin. Stock Bulinus are maintained in 2–5 gallon capacity glass aquaria in constant light at 75–80 F, and fed fresh lettuce as well as supplemental food (Gerophyl, 4 parts; wheat germ, 2; Glandex fish food, 2; and dried milk, 1 part). Syrian hamsters (Mesocricetus auratus), exposed to 300 cercariae and sacrificed at 18–24 weeks, serve as a source of eggs for continuation of the parasite cycle.

Primates were obtained from an import dealer and kept several weeks prior to use. Hosts were anesthetized with Sernylan (phenylcyclidine hydrochloride) and, after immobilization, were taped ventral side up on a table top. Pooled cercariae (188–192 snails) were counted in drops of water on 18 × 18 mm coverslips. Cercarial suspensions on coverslips were placed on shaved and water cleansed...
belly skin for 30 min. Hosts were maintained in separate cages and fed on a standardized (Southwest Foundation) primate chow.

Primate cages with hosts under study were placed on a stand provided with screened cover collection trays to obtain urine and fecal samples. Samples were collected twice weekly beginning at the 50th day after infection. Urine sediments were examined for eggs, and 1 g of stool specimen was processed by the Stoll technic (Stoll, 1923). All viscera were examined separately shortly after death of hosts, and some organs were perfused to enhance worm recovery. Pathology samples were taken at random as well as from areas in organs with obvious parasite involvement. Egg deposition in tissues was determined by KOH digestion (4%, 12–24 hr) (Cheever, 1968) of weighed samples of organ systems.

**Results**

*Schistosoma haematobium* was obtained from two experimentally infected langurs. One hundred and forty-three immature worms were recovered from the liver of an adult female which succumbed 3½ weeks after exposure to 2,000 cercariae. Formalin fixed parasites measured from 0.3–1.8 mm, with the majority in the range of 1.0–1.6 mm. Although the cause of death was not apparent, it was assumed, judged upon observations at autopsy, that it was not associated with the schistosomes. There was some fluid in the abdominal cavity and several of the mesenteric lymph nodes were enlarged, but otherwise the visceral organs appeared normal. Preinfection stools indicated the presence of *Entamoeba coli* and light infections with *Trichuris* and an unidentified trichostrongyloid.

The situation was entirely different in a second adult female which was exposed to 1,000 cercariae and died 17 weeks later. This animal showed pronounced schistosomiasis haematobia, the infection leading to death. A total of 146 worms, including 63 pairs, was recovered, with the majority consisting of medium size parasites in the liver (Table 1). The sex ratio was approximately four males to three females. Nine pairs of mature worms were found in the vesical plexus with several in vessels near the urethral entrance, and others in the wall of the urinary bladder. Most of the worms along the intestinal tract were located in vessels adjacent to but not in the walls of the intestine.

Upon gross examination there were minute white spots indicating the presence of eggs in as well as on the surface of the liver and the spleen. There were small (1–2 mm) hemorrhagic spots in the walls of the small intestine associated with egg deposits and internal lesions. Scattered nodules of varying size and consistency and enclosing numerous eggs occurred on the walls of the descending colon and in contiguous mesenteries. Several pairs of worms were removed from nearby vessels. Other egg deposits accompanied internal lesions, and areas of hemorrhage were scattered along the walls of the rectum to the anus.

The greatest pathological damage was associated with the urinary bladder. Externally, the bladder showed mild diffuse hemorrhage, appeared swollen, and there were hardened tissues with egg deposits. There was marked involvement of the inner walls (Fig. 1). With more than ¼ of the organ affected, its urine retention capacity was greatly reduced. There were several large (10 × 14 mm), elevated

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**Table 1. Distribution of worms and eggs in organs of langur (Presbytis) exposed to 1,000 cercariae of Schistosoma haematobium (Iran).**

<table>
<thead>
<tr>
<th>Organs</th>
<th>Worms recovered</th>
<th>Measurements (mm)</th>
<th>Egg deposits (eggs/gram)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Actual</td>
<td>Percentage return</td>
<td>Males</td>
</tr>
<tr>
<td>Lungs</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Liver</td>
<td>26 prs + 12♂♂♂</td>
<td>43.9</td>
<td>4.0-6.0</td>
</tr>
<tr>
<td>Spleen</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hepatic portal veins</td>
<td>9 prs + 5♂♂♂</td>
<td>15.7</td>
<td>6.0-8.0</td>
</tr>
<tr>
<td>Stomach</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Small intestine</td>
<td>4 prs + 2♂♂♂</td>
<td>6.8</td>
<td>4.0-7.0</td>
</tr>
<tr>
<td>Large intestine</td>
<td>15 prs + 1♂♂♂</td>
<td>21.2</td>
<td>4.0-7.0</td>
</tr>
<tr>
<td>Cecum</td>
<td>6 prs + 0♂♂♂</td>
<td>12.3</td>
<td>10.0-12.0</td>
</tr>
<tr>
<td>Urinary bladder</td>
<td>9 prs + 0♂♂♂</td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

* Worms fixed in hot 10% buffered formalin.
(2–4 mm) plaques or hemorrhagic areas with protrusions into the bladder. Many minute petechiae at the site of micro lesions in the less thickened part of the bladder wall allowed for obvious loss of blood. Viable and nonviable eggs were present in large numbers in snips taken at random from polypoid folds. Preliminary pathology examination of section of bladder showed numerous eggs and surrounding inflammatory reaction.

The host was emaciated, had lost blood in excreta, and suffered with diarrhea for 3 weeks prior to death. Preinfection stools revealed presence of *E. coli*, *Trichuris* and a trichostrongyloid. Schistosome egg passage was detected in stools 76 days after date of infection but, unfortunately, only five samples, all containing eggs, were taken prior to death. Egg sampling for urine had not been instituted at the time of death, although it seems likely eggs must have been present in urine. Digests with KOH revealed the presence of eggs in the major visceral organs.

**Discussion**

Even though there has been random experimental infection of nonhuman primates, and some have been found naturally infected (Nelson et al., 1962; DePaoli, 1965; Swellengrebel and Rijpstra, 1965), little attention has been given to the potential use of these mammals as models in which serious involvement of the urogenital system may be evaluated. A number of species of nonhuman primates has been exposed to infection by *S. mansoni* (Sadun et al., 1966; Jordan et al., 1967), but the list of primates used for *S. haematobium* is definitely limited (Webbe and Jordan, 1966). Nelson et al. (1962) reported natural infections of nonhuman primates in Kenya, and DePaoli (1965) found a natural infection of *S. haematobium* in a chimpanzee imported from West Africa. One of the first reports of bladder involvement is that described by Edwards and McCullough (1954) for a West African baboon infected with West African *S. haematobium*. Vogel (1967) has shown marked involvement of the urogenital system in a series of mangabeys (*Cercopithecus*) and chimpanzee (*Pan*) infected with *S. haematobium*, with passage of numerous eggs in feces and urine.

Our demonstration of marked pathological involvement of the urinary bladder in the langur is similar to that seen in baboons in Tanzania by Jordan et al. (1967). Observations in the present study, plus available information on *S. haematobium* in nonhuman primates, indicate that some probably can be used for critical evaluation of host-parasites relationships in schistosomiasis haematobia. However, a compilation of data, plus experience with several species of nonhuman primates, also indicates the desired studies with *S. haematobium*, i.e. predictable involvement of urogenital system, will depend upon more efficient management of the parasite in the laboratory, as well as on a better understanding of the biology of this parasite in relation to numbers of worms involved and duration of infections.

**Acknowledgments**

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**Baylisascaris procyonis** (Stefanski and Zarnowski, 1951) from the Kinkajou, *Potos flavus*, in Colombia

Robin M. Overstreet

Department of Parasitology, Tulane University School of Public Health and Tropical Medicine, New Orleans, Louisiana 70112

**Abstract:** Specimens of *Baylisascaris procyonis* are described from the kinkajou, *Potos flavus*, and compared with others from the raccoon, *Procyon lotor*, from California. This new host record extends the geographical range of the worm into South America.

While in Colombia, South America, during 1966 and 1967, Dr. M. D. Little collected several specimens of *Baylisascaris procyonis* from the kinkajou, *Potos flavus*. This ascarid has previously been reported only from the raccoon, *Procyon lotor*, in North America and Europe. Additional reports of *Ascaris columnaris* or *Ascaris* sp. from the raccoon in North America have been listed by Sprent (1968; also see Leigh, 1940; Babero and Shepperson, 1958), but Sprent (1968) suggested that these records probably apply to *B. procyonis*. Hartwich (1962) redescribed *B. procyonis* from raccoons in Europe.

**Methods and Materials**

All worms used in this study except one specimen of *B. columnaris*, which was fixed in