Bufo Marinus as a Vector of Helminth Ova in Puerto Rico*

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THE INNUMERABLE representatives of *Bufo marinus*, designated the giant Surinam toad by Wolcott,[1] are descended from a few individuals brought from the Barbadoes by May in 1920, and forty transported from Jamaica in 1924 by Menéndez Ramos. The activities of the "sapo" have effected a marked reduction in abundance of white sugar cane grubs and other insects. The results obtained through the agency of this beneficial animal have led to its importation from Puerto Rico to Hawaii, Mauritius and Louisiana.

The junior author first noted ova of *Schistosoma mansoni* in feces of toads captured at Sabana Llana, about ten miles east of San Juan, and recognized its significance. The fortuitous occurrence of parasitic helminth ova might take place anywhere. However, if this phenomenon were repeated with a degree of frequency, then some importance might be attached to the finding.

Accordingly, arrangements were made for the collection of toads in various localities, special emphasis being placed upon foci of schistosomiasis. We are grateful to the Medical Division of the Puerto Rico Reconstruction Administration and to individuals who procured "sapos" for us. These were transported to the laboratory as soon as possible and isolated. Their excreta was then examined by the sedimentation-concentration method.[2]

The localities where toads were collected were fairly well distributed throughout the Island: Sunoco, Martin Peña, Río Piedras, and Sabana Llana, either part of or a relatively short distance from San Juan, north; Utuado, Comerío, Aibonito, Barranquitas, Caguas and Gurabo, central; Fajardo and Naguabo, east; Guayama, south; Mayagüez and San Sebastián, south. Some of these places, as for example, Guayama, Naguabo, Aibonito and Utuado are schistosomiasis foci of considerable intensity. In all probability the negative results shown in the table for these places would have been modified had it been possible to collect additional samples. Moreover, the adaptation of certain means unfavorable to the spread of

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schistosomiasis, namely, construction of a modern sewage plant, thus preventing the transportation of crude sewage to certain sugar lands, and the erection of a wire fence to keep individuals from a reservoir heretofore containing a high percentage of snails infected with *S. mansoni* would tend to reduce positive findings in the section of Guayama where toads had been collected.

In brief, roundworm, whipworm and schistosome ova were able to pass in a viable state through the alimentary canal of toads ingesting them. The ova of ascaris and trichuris were cultured and reached the vermiform stage. Of three series, each consisting of six clean snails of the species *Australorbis glabratus*, intermediate host of *S. mansoni* in this region, six, one and five, respectively gave off cercariae within a month after exposure to schistosome ova recovered from toad excreta. Adult examples of *S. mansoni* were later found in the livers of two rats exposed to cercariae from this source.

To eliminate the improbable hypothesis that *Bufo marinus* might serve as a definitive host of *S. mansoni*, toads passing schistosome ova were carefully dissected and, as was expected, no evidence of adult schistosomes could be found.

The low incidence of hookworm (see table) in this series of toad feces may be attributed to the fact that, as a rule these toads were not collected from sites of high uncinarial endemicity. As yet we have no knowledge regarding the ability of hookworm ova or larvae to survive or develop in toad feces.

The explanation for the presence of helminth ova in toad excreta, seems, at least in part, quite obvious. Some flies, members of the genera *Musca* and *Sarcophaga*, among others, may utilize human excreta as a medium of larval development. In Puerto Rico *Bufo marinus* has exercised a preference for adult beetles of the family Scarabaeidae. With the tremendous increase of toads and a decrease of white grubs or May beetles, due to the feeding activities of the toads, other food must be sought. Observations made during the course of this study indicate that while *Bufo marinus* may have preferences, yet it is an adaptable organism, and may be definitely omnivorous in its feeding habits.

Due to widespread, promiscuous defecation by man, the coprophagous Diptera find an abundance of excreta more or less satisfactory for the development of their offspring. The toad, seeking a substitute for its preferred food, consumes the dipterous maggots. In doing so, some excreta is undoubtedly ingested, and with it the helminth ova.

We may infer that the "sapo" may, on occasions, be coprophagous.

Some were sent from San Sebastián. Degenerated ova of ascaris and trichuris in the vermiform stage, and dead ones of hookworm and schistosomes were found. No fly larvae were present, nor could any indication of their presence be noted. The sample of excreta consumed was obviously an old one. On other occasions maggots were lacking in toad excreta in which helminth ova occurred. The presence of coprophagous dipterous larvae can be considered a good, though not absolute, indication of fecal ingestion.

There exists a possibility that under favorable conditions schistosome ova may survive for an appreciable period. One toad passed viable eggs three to four days after arrival in the laboratory. Obviously ingestion must have occurred at least one day before arrival at the laboratory. It might be mentioned that morphological details of the embryo can be more readily discerned in schistosome ova following the intestinal journey through the amphibian than when recovered directly from human feces.

Hookworm, roundworm and whipworm ova, to give rise to an infection must be so distributed that access to or contact with man is assured. For schistosomes to achieve this goal, their ova must reach water. Many of the toads used in this study were taken from schistosome infested streams. In our field experience we have frequently found them in this environment. We have also observed that under laboratory conditions these amphibians apparently defecate as readily in water as upon a dry surface. It therefore seems logical to assume that at times, the molluscan host may become infected through this mechanical means of transmission.

Under laboratory conditions it has been demonstrated that ascaris, whipworm and schistosome ova may pass unharmed through the toad subsequent to ingestion, that the first two can be cultured to the vermiform stage, and the third can give rise to infections in the molluscan intermediate and laboratory definitive hosts. Whether a similar chain of events can be duplicated in nature is a matter not readily determined. The presence of these helminth ova and coprophagous maggots in the toad intestine can serve as an indication of soil pollution.

Bufo marinus may also function as a distributing agent of *Australorbis glabratus*, for living representatives of this snail were recovered from a toad captured near Rio Piedras. Usually, however, snails swallowed by toads succumb. In the worst schistosome infested section of Guayama, small examples of *A. glabratus*, seldom attaining a diameter of half an inch, constituted an important article of the toads' diet. One toad contained twenty. This amphibian may there-

fore be considered a factor in the natural control of schistosomiasis. The omnivorous habits and adaptibility of "sapos" enable them to survive under a variety of conditions.

We may tentatively conclude that although *Bufo marinus* is not an unmixed blessing, the benefits it confers upon the Island far outweigh its drawbacks. If it does constitute a potential menace as a mechanical vector of parasitic helminth ova, this condition has been brought about through the long standing and objectionable habit of promiscuous defecation on the part of the "Jíbaro" (countryman) and his children, to which the toad has adapted itself.

REFERENCES

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TABLE

RESULTS OF FECAL EXAMINATIONS

Locality	*No. of Toads*	*S. mansoni*	*A. lumbricoides*	*T. trichiura*	*Hookworm*	*Miscellaneous*
Sunoco	5	0	3	3	0	
Sunoco	5	0	1	2	0	
M. Peña (Las Casas)	9	0	0	0	0	
Bo. Cupey, Río Piedras	15	0	1	0	0	
Sabana Llana*		–		–		
Utuado (Río Viví)	9	0	0	0	0	
Comerio	14	9	10	9	6	*E. coli* cysts? *Hymenolepis nana* ova.
Aibonito	16	0	0	0	0	
Barranquitas	12	2	2	2	0	
Central Defensa, Caguas	9	9	3	1	3?	1 *Strongyloides stercoralis* larva?
Slaughter House, Caguas	11	0	0	0	0	
Above " " "	12	0	0	0	0	
Bo. Mamey, Gurabo	5	2	2	1	1?	
Fajardo	4	0	0	0	0	
Naguabo (Río Duque)	12	0	0	0	0	
Guayama (Colonia Vives)	9	0	1	0	0	
San Sabastián	12	4	3	7	1	
San Sabastián	6	2	3	3	2	
Mayagüez (Dulces Labios	8	0	2	0	0	
Totals	173	26	31	28	13	

* The number of toads whose excreta contained ova could not be given because examinations were made from pooled fecal samples.