echinostome infection in *Bul. truncatus*, the annual rate is 31.5%.

Of the 8 types of trematode cercaria found in *Bul. truncatus* by El-Gindy & Rushdi (1962), we found only 4. In a nearby area, we found a longifurcate holostome cercaria also mentioned by El-Gindy & Rushdi (*op. cit.*).

Little is known of the prevalence of echinostomes in Egypt, although Abdel-Azim (1930) found that this type of cercaria (*Echinostomum recurvatum*) was present in large numbers of *Bul. truncatus* (= *Bul. contortus*, *Bul. dybowski*, and *Bul. innesi*) in the Cairo area. The final hosts of the echinostome are not known. Laboratory white mice were quite susceptible to infection when they were fed with naturally and experimentally encysted *Biom. alexandrina* and *Bul. truncatus*. Echinostome eggs started to appear in the faeces of mice 8–9 days after cysts had been eaten, and collar spines were well developed in adult worms in the fifth week after infection.

Recent evidence (Lie et al., 1965, 1966, 1967) shows that echinostome cercariae are antagonistic to the development of larvae of other trematode species in the same host. Lie et al. (1968) also suggested that competing echinostome larvae might be used to control other trematodes, i.e., by introducing echinostomes into an area to suppress the target species, a schistosome. Judging from the results obtained at Tamama and reported here, nature is already exercising some biological control of *S. haematobium*, and hence of urinary schistosomiasis, by means of echinostomes in one area in Egypt. The effect of such natural control on the endemicity of urinary schistosomiasis is as yet unclear. It may foreshadow the possibility of also using echinostomes for the biological control of intestinal schistosomiasis in the Nile Delta.

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Laboratory evaluation of the molluscicidal potency of a butanol extract of *Phytolacca dodecandra* (endod) berries

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Abstract

The effect of butanol extracts of endod against Biomphalaria choanomphala, B. pfeifferi, *and* Bulinus (Physopsis) nasutus *was tested at different concentrations and for different exposure periods. Exposure to 19–25 ppm for 6 hours or to 6–7 ppm for 24 hours caused about 100% mortality.*

A number of substances of vegetable origin have been found to have molluscicidal activity. Mozley (1939, 1952) reported that the fruits of *Balanites aegyptiaca*, *Sapindus saponaria*, and *Swartzia madagascarensis* were among the most promising natural molluscicides. An investigation of the molluscicidal properties of the fruits of *Sapindus saponaria* on the snail *Bulinus* (*Physopsis*) *africanus* was made by Msangi & Zeller (1965).

In many developing countries in the tropics, schistosomiasis is endemic and the snails that transmit the disease are widespread. Therefore, large-scale schistosomiasis control programmes based on the control of snails by means of conventional molluscicides may be expensive. Further studies on the possibilities of using vegetable molluscicides are therefore desirable.

Dried berries of *Phytolacca dodecandra* (endod) are widely used in Ethiopia instead of soap for washing clothes. It was observed that in natural bodies of water where endod had been used there

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was a high mortality of snails. Subsequently, the molluscicidal effects of various parts of the plant were determined, and the berries were found to have the greatest activity (Lemma, 1970). Lemma (personal communication) has found that butanol extracts of endod are toxic to *Biomphalaria glabrata* snails.

This report describes experiments made to evaluate the molluscicidal effect of butanol extracts of endod against snails collected from Lake Victoria and from streams and ponds in Mwanza, Tanzania. Mature snails of the following species were used: *B. choanomphala* (average shell diameter, 6.5 mm), *B. pfeifferi* (average shell diameter, 11.0 mm), and *Bulinus* (*Physopsis*) *nasutus* (average shell diameter, 10.5 mm). Snails for experimental purposes were kept in the laboratory for 2 days in basins containing lake water at pH 6.4. A total of 20 snails of each species were used for each dosage. Groups of 10 snails were placed for 6 hours in 250-ml plastic glasses containing the following concentrations (ppm) of endod extract: 25, 19, 12, 10, 6, 5, and 3. Other groups of 10 snails per container were exposed to the following concentrations (ppm) for 24 hours: 7, 6, 5, 4, 3, 2, and 1. Concentrations of 3.6 ppm and 3.3 ppm were included in the series for trials with *B. pfeifferi*, and concentrations of 2.6 ppm and 2.3 ppm were included for trials with *B.* (*P.*) *nasutus*. The temperature during exposures was 23° ± 1°C.

After exposure, all snails were washed in clean lake water and left for 24 hours to recover in clean lake water before being reexamined. Death was determined by the absence of movement and failure of the snail to withdraw inside its shell when touched with a needle; characteristic bleeding was frequently also a useful indication of death.

Statistical estimations of the LD_{50} and LD_{90} values were calculated from the probit transformation as described by Finney (1947), and the fiducial limits of the median lethal dose at the 95% probability level were obtained.

Results

The death rates for snails exposed for 6 and 24 hours to different concentrations of endod extract are shown in Table 1. Clear differences in mortality rates at the two exposure periods were observed. While exposure of snails for 6 hours to higher concentrations (19–25 ppm) caused a mortality rate of about 100%, the same effect was obtained with exposure for 24 hours to concentrations of 6–7 ppm.

Table 1. Number of dead snails out of 20 exposed to different concentrations of endod extract [a]

Species of snail	Exposure for 6 hours							Exposure for 24 hours									
	Concentration (ppm) of endod extract							Concentration (ppm) of endod extract									
	25	19	13	9	6	5	3	7.0	6.0	5.0	4.0	3.6	3.3	3	2.6	2.3	2.0	1.0
B. choanomphala	20 (100)	19 (95)	13 (65)	10 (50)	4 (20)	4 (20)	1 (5)	20 (100)	19 (95)	16 (80)	15 (75)	—	—	10 (50)	—	—	5 (25)	1 (5)
B. (P.) nasutus	20 (100)	20 (100)	20 (100)	18 (90)	15 (75)	2 (10)	1 (5)	20 (100)	20 (100)	20 (100)	20 (100)	—	—	15 (75)	13 (65)	13 (65)	6 (30)	0 (0)
B. pfeifferi	20 (100)	18 (90)	14 (70)	8 (40)	7 (35)	2 (10)	1 (5)	20 (100)	20 (100)	20 (100)	17 (85)	16 (80)	14 (70)	4 (20)	—	—	0 (0)	0 (0)

[a] Percentage mortality rates in parentheses.

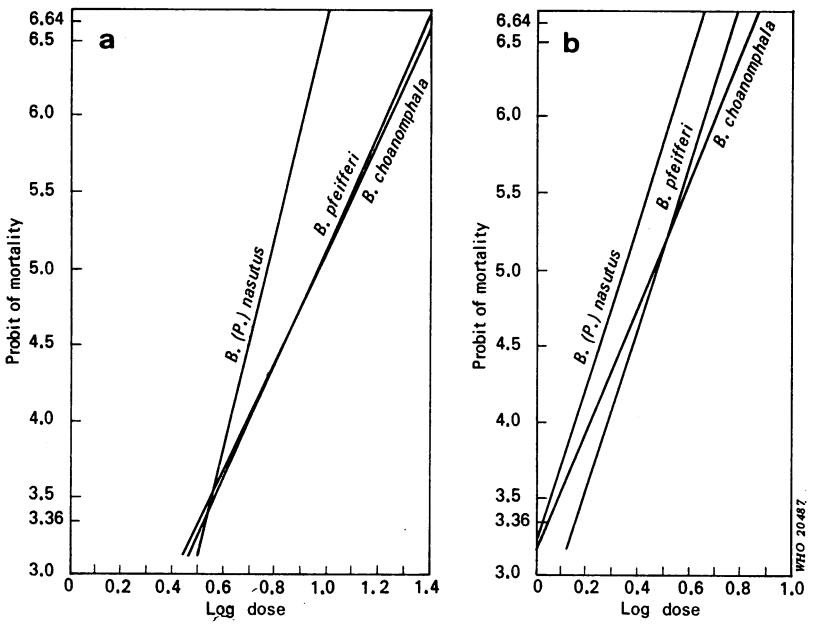

Fig. 1. Relationship of log dose to mortality (probit scale) for snails exposed to endod extract for (a) 6 hours, and (b) 24 hours.

The log-dose–probit lines plotted from the test data are given in Fig. 1. The LD_{50} and LD_{90} values calculated from the data are shown in Table 2.

An analysis of the results showed that the calculated LD_{50} and LD_{90} values for both species of *Biomphalaria* were nearly the same for both exposure periods. For *B.* (*P.*) *nasutus* the LD_{50} and LD_{90} values were about half those for the other two species of snail for the 6-hour exposure period but only slightly less than those for the other species for the 24-hour exposure period. In general, the endod extract was more effective against *B.* (*P.*) *nasutus*.

For an exposure period of 24 hours the slope function values for all species of snail are nearly the same and for an exposure period of 6 hours the values for *B. pfeifferi* and *B. choanomphala* are almost the same, but compared with that for *B.* (*P.*) *nasutus* the slopes are less steep.

Discussion

An LD_{90} value of about 20 ppm for a 6-hour exposure period and a value of about 5 ppm for a 24-hour exposure period in a natural molluscicide are noteworthy results. Since endod is a natural material that can be produced under suitable climatic conditions in the tropics, and since the extraction

Table 2. Statistical analysis of expected effective doses of endod for 3 species of snail

Species of snail	Exposure for 6 hours				Exposure for 24 hours			
	LD_{50} (ppm)	LD_{90} (ppm)	Slope function (S)	Lower and upper values of LD_{50} at 95 % probability level (ppm)	LD_{50} (ppm)	LD_{90} (ppm)	Slope function (S)	Lower and upper values of LD_{50} at 95 % probability level (ppm)
B. choanomphala	9.0	20.4	1.9	7.6–10.7	2.8	5.9	1.8	2.4–3.3
B. (*P.*) *nasutus*	5.8	8.8	1.5	5.2–6.5	2.1	3.9	1.6	1.7–2.4
B. pfeifferi	9.9	19.2	1.7	8.7–11.1	2.9	5.2	1.6	2.3–3.5

procedures are neither complicated nor expensive, it can be used with reasonable economy in field programmes for the control of snail vectors of disease.

The effective dose of endod varies somewhat for the different species of snail tested; in exposures for 6 hours 100% mortality was recorded at 25 ppm in both species of *Biomphalaria* but only half that concentration was needed to kill all *B.* (*P.*) *nasutus*. Responses to the extract by the three species of snail were approximately the same after 24-hour exposures.

These differences in toxicity will result in different field application costs, depending on the species of snail to be controlled. In the laboratory, low concentrations of the extract apparently irritated snails of the species *B.* (*P.*) *nasutus* inducing them to crawl out of the container. Under field conditions, therefore, care will be needed to choose a suitable dosage level since a sublethal dose may induce the snails to avoid contact with the treated water.

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Studies on the prophylactic and radical curative activity of RC-12 against *Plasmodium cynomolgi* in *Macaca mulatta* *

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Abstract

The compound 4-(2-bromo-4,5-dimethoxyphenyl)-1,1,7,7-tetraethyldiethylenetriamine (RC-12) has been shown to be active against the exoerythrocytic (EE) stages of the malaria parasite. Experiments on Plasmodium cynomolgi *in rhesus monkeys showed that single weekly doses of 25 mg per kg of body weight would prevent the development and/or maturation of EE stages. The usefulness of RC-12 for effecting radical cures is, however, still open to doubt.*

The compound 4-(2-bromo-4,5-dimethoxyphenyl)-1,1,7,7-tetraethyldiethylenetriamine (RC-12), developed in the course of studies by Schulemann & Kropp (1930), has been shown to be active against the exoerythrocytic (EE) stages of the malaria parasite. In a report on the antimalarial activity of RC-12, Schmidt et al. (1966) briefly outlined the chemistry of the compound and summarized the results of some studies made with it. They demonstrated that RC-12 was very effective in preventing patent infections of *Plasmodium cynomolgi* in rhesus monkeys *(Macaca mulatta)* when it was administered for a total of 9 days—on the day before the monkeys were challenged with intravenous inoculations of approximately 500 000 sporozoites of *P. cynomolgi*, on the day of challenge, and for a further 7 days after challenge. It was found that 9 of 10 monkeys treated prophylactically with individual doses of 6.25 mg of RC-12 per kg of body weight were protected, and that all the monkeys in a group of 15 treated with individual doses of 25 mg per kg were protected. Schmidt et al. (*op. cit.*) found that RC-12

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