A. Ü. Vet. Fak. Derg.
33 (1) : 134-143, 1986

THE CONTROL OF BIOMPHALARIA ALEXANDRINA BY THE SNAIL MARISA CORNUARIETIS, UNDER SEMI-ENVIRONMENTAL CONDITIONS IN EGYPT

Erian G. Kamel*

Mısır'da yarı doğal şartlar altında Schistosoma mansoni'nin aracısı olan Biomphalaria alexandrina'nın Marisa cornuarietis tatlı su sümüklüsü ile kontrol olanakları

Özet: *Marisa cornuarietis adlı sümüklünün 4 Biomphalaria alexandrina populasyonuna etkisi, benzer büyüklük, sayı ve yetişme mevsimleri gözönüne alınarak hazırlanan kontrol populasyonu ile mukayeseli olarak araştırılmıştır.*

Bu konudaki gözlemler, yapay olarak hazırlanan toprak zeminli ve devamlı olarak akıtılan Nil nehri suyu ile sulanan hendeklerde seri halinde yapılmıştır.

Gerek deneysel ve gerekse kontrol olarak muhafaza edilen sümüklü populasyonlarının yoğunluklarının kantitatif hesapları, standart olarak, ayda iki defa uzun saplı ağ kullanılarak elde edilen sümüklü örnekleriyle yapılmıştır.

Yapılan bu çalışmalar sonunda, deneysel olarak kullanılan sümüklü populasyonu yoğunluğunda kontrol populasyonlarına göre belirli bir azalma görülmüştür.

Bu sonuçlar, Mısır'da doğal Biomphalaria alexandrina populasyonlarının kontrolünde Marisa cornuarietis'in, biyolojik bir kontrol aracı olarak büyük bir değer taşıyabileceğini göstermektedir.

Summary: *A study has been made of the effect of Marisa cornuarietis on 4 populations of Biomphalaria alexandrina, exactly matching control populations in size, number and season of nurture. The observations were made in a series of artificial earth-lined ditches with continuously flowing Nile water. Quantitative estimation of the densities of the experimental and control populations was made by standard twice a month samplings with a dip net.*

Significant reductions in density of the experimental populations, as compared to the control populations, were observed. The results suggest that Marisa cornnuarietis could be of great value as a biological control agent against natural populations of Biomphalaria alexandrina in Egypt.

* Associate Professor, Zoology Department, University College For Women, Ain Shams University, Cairo, Egypt..

Introduction

The objective of the present investigation was to study the effect of the fresh water snail *Marisa cornuarietis* on *Biomphalaria alexandrina*, the snail host of *Schistosoma mansoni* in Egypt, under conditions approximating as closely as possible to those prevailing in the natural environment in Egypt with a view of assessing its potential value as a biological control agent. Such a use, if effective, would represent a much easier and cheaper means of control than the chemical control measures now applied.

It is very important to note that *Marisa* has demonstrated to be refractory to infection with the common animal and human trematode parasites (14) and those does not present any health hazards. There are also indications that *Marisa* does not constitute a serious threat to terrestrial crop plants, including rice (2).

Observations made in laboratory have shown that *Marisa* does not only take over the food supply of the vector snails confined with it but also consumes their eggs and actively predates on them, eating out their soft parts (1,5,6,7,8,12).

In the field at West Indian island of Puerto Rico, the American ampullariid snail *Marisa cornuarietis* acted as an efficient competitor of *Biomphalaria glabrata*, the snail vector of *Schistosoma mansoni* (9,10,13, 15,16).

Under semi-environmental conditions in Egypt, Demian and Kamel (4) illustarted a remarkable ability of the snail *M. cornuarietis* to eliminate and replace the fresh water snail *Bulinus truncatus*, the intermediate host of *Schistosoma haematobium* in Egypt.

The present work was aimed to determine whether *M. cornuarietis* can also compete successfully with *B. alexandrina* under semi-environmental conditions, and to investigate the real aspects of any such competition, and thereby to gain a more complete picture of the potentialities of *M. cornuarietis* as an effective biological control agent in Egypt.

Material and Methods

The present work was carried out in a series of earth-lined ditches established in the botanical garden of the Faculty of Science, Ain Shams University, Abbasia, Cairo, The experimental area described in greater detail by Kamel (11).

Biomphalaria alexandrina used in the present study were collected from some drains at Giza governorate, South of Cairo. *Marisa cornuarietis* were taken from a laboratory stock colony founded with snails originally obtained from Puerto Rico by courtesy of Dr. F.F. Ferguson, Former director of the Puerto Rico field station, Tropical Diseases Section, Communicable Diseases Centre, U.S. Public Health Service.

The snail population in each ditch was sampled in a uniform manner twice a month, by the author himself, by taking a dip with a deep-net (4) at a six marked collecting spots, 180 cm, apart from one another. After assessment, the snails caught in those six dips were returned alive to their respective sites in the ditch. The number of snails of any population collected by the 12 dips made in one month (one sample) founded the basis of comparison.

The monthly average maximum and minimum air and water temperatures recorded throughout the period of this study are shown in Table 1.

Table 1. Monthly mean, maximum and minimum, air and water temperatures in the experimental area (December 1981–December 1983).

Months	Air temperature C°		Water temperature C°	
	Mean Max.	Mean Min.	Mean Max.	Mean Min.
December 1981	22.8	11.6	18.6	15.6
January 1982	18.6	10.4	16.5	13.2
February	17.8	9.8	14.8	13.4
March	22.2	11.8	17.6	15.0
April	29.4	16.8	24.6	21.4
May	30.4	17.6	26.1	22.0
June	35.2	21.2	30.2	24.6
July	33.2	22.2	30.0	25.0
August	35.8	24.6	32.1	27.2
September	34.0	22.0	30.4	25.1
October	32.0	20.6	28.2	23.6
November	23.6	12.8	20.8	16.0
December	20.0	10.4	15.6	13.2
January 1983	17.6	8.6	14.2	11.9
February	19.9	9.9	17.0	14.2
March	25.0	12.7	20.3	16.4
April	29.8	16.6	23.8	20.0
May	31.5	18.4	26.9	22.6
June	35.8	22.1	30.8	26.0
July	34.9	23.1	31.2	27.1
August	36.9	23.0	32.4	28.3
September	33.1	21.5	28.5	25.6
October	31.6	20.4	26.0	23.1
November	23.8	13.9	17.8	15.3
December	22.3	11.6	16.4	13.9

Experiments

Four experimental populations of *B. alexandrina* (B1, B2, B3 and B4), exactly matching control populations in size, numbers and season of nurture, were placed each into an experimental ditch containing a certain population of *M. cornuarietis*. The four experiments were set up as follows:

Experiment 1

On November 15, 1981, a cohort of 125 juvenile *B. alexandrina* averaging between 4–5 mm in shell diameter was placed in a ditch already containing a group of 85 adult *M. cornuarietis* (30–32 mm in shell diameter) comprising 50 females and 35 males, which had been placed in the same ditch 7 days earlier (on November 8). In a separate ditch, on November, 15 a group of 125 juveniles *B. alexandrina* (4–5 mm) were placed which paralleled in every respect the experimental population Bl and served as control population.

The experimental populations of *Biomphalaria* and *Marisa* were sampled twice monthly starting from December 3, 1981, and the results were compared with those for the control population of *Biomphalaria*. Comparisons were made until the following December.

Experiment 2

In this experiment a relatively great group of *B. alexandrina* consisting of 200 adults of 8–9 mm in shell diameter were added on April 25, 1982 to a population of *Marisa* consisting of 125 specimens (70 female and 55 male) having shell diameter of 28–30 mm. Another population of *Biomphalaria*, practically identical with the experimental population, was established in another ditch on the same day served as a control population. Snails in both experimental and control ditches were sampled as in experiment 1 starting from May, 1982 until October, 1982 (6 months).

Experiment 3

The previous experiment was repeated on October 18, 1982 with the same numbers and size of both *B. alexandrina* and *M. cornuarietis*. The experiment ended on April, 1983.

Experiment 4

In this experiment a relatively small group of *B. alexandrina* consisting of 100 snails (10–12 mm in shell dimater) were added on June

14, 1983, to a population of 85 specimens of *Marisa* (28–30 mm in shell diameter) comprising 50 female and 35 male. Another ditch contains the same numbers and size of *B. alexandrina* was used as control ditch for this experiment.

Results

Comparison of the total numbers of *B. alexandrina* sampled monthly from the control and experimental populations are shown in Fig. 1. Table 2 summarized the monthly collected *Biomphalaria* from the experimental and control ditches as regards the mean numbers of snails per dip. The numbers of *M. cornuarietis* dipped out from the experimental ditches (M1–M4) are given in Table 3.

The data presented in Table 2 show that in experiment 1 (B1) in December 1981, there was no obvious difference in density between the control population and experimental populatin ($P < 0.05$). Starting from January, 1982, onward differences in the mean numbers of collected *Biomphalaria* per dip from the control and experimental ditches became readily observed. The differences were highly significant ($P < 0.01$).

The data summarized in Table 2 and Fig. 1 show that in experiment 2 (B2) there was a significant difference in population density between control and experimental populations ($P < 0.01$). In experiment 3 and 4 (B3 and B4 respectively) the data obtained show a significant reduction in the density of experimental populations. The numbers of *Biomphalaria* collected from experimental ditches decreased quite markedly than those collected from the control ditches ($P < 0.01$).

Marisa, in the light of the present study, seems to be more adapted to warmer weather than *Biomphalaria*. Survival of *Marisa* was high and breeding was most intense in Summer (Table 3). During the Winter months *Marisa* was noted to be inactive but from March, 1982 onward, with increasing temperatures (Table 1) *Marisa* resumed its normal activities.

Discussion and Conclusion

Snail control is considered to be the method which offers the best present hope for interrupting the transmission and spread of Schistosomiasis. The methods available for snail control fall into three

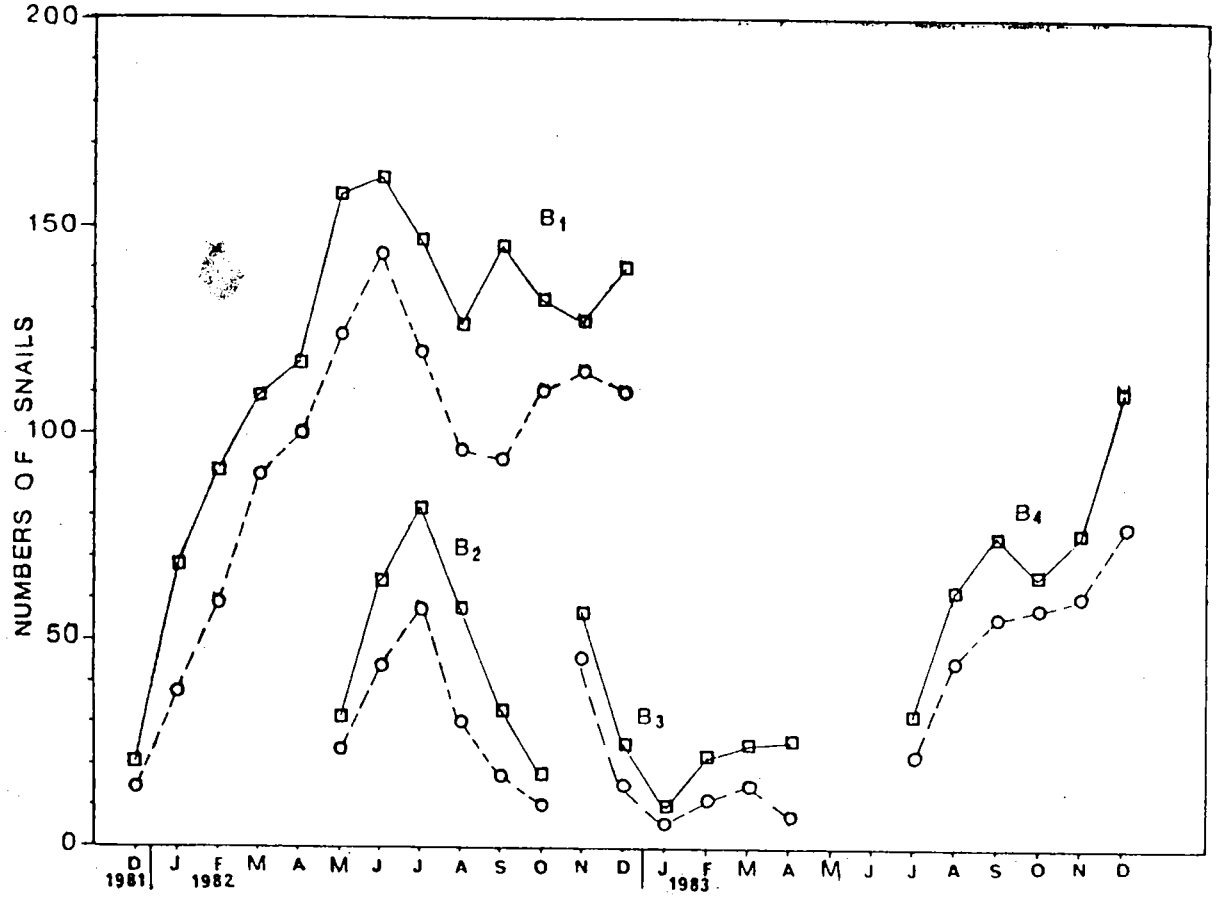

Fig 1. Numbers of Biomphalaria alexandrina sampled monthly from control □ - - - □ and experimental O——O populations.

Table 2. Comparison of the mean numbers of *Biomphalaria alexandrina* sampled per dip in successive months from the control and experimental populations.

		Control population	Experimental population		
Month	No. of dips	Mean No of. snails per dip (X_1)	Mean No. of snails per dip (X_2)	X_1-X_2	P
DEC. 1981	12	1.66	1.25	0.41	P<0.05
JAN. 1982	12	5.66	3.16	2.50	P<0.01
FEB.	12	7.58	4.92	2.66	P<0.01
MAR.	12	9.08	7.50	1.58	P<0.01
APR.	12	9.75	8.33	1.42	P<0.01
MAY	12	13.16	11.16	2.00	P<0.01
JUNE	12	13.50	12.00	1.50	P<0.01
JULY	12	12.25	10.00	2.25	P<0.01
AUG.	12	10.50	8.00	2.50	P<0.01
SEP.	12	12.08	7.83	4.25	P<0.01
OCT.	12	11.25	9.16	2.09	P<0.01
NOV.	12	10.58	9.58	1.00	P<0.01
DEC.	12	11.66	10.00	1.66	P<0.01
MAY 1982	12	2.58	2.00	0.58	P<0.01
JUNE	12	5.33	3.66	1.67	P<0.01
JULY	12	6.83	4.75	2.08	P<0.01
AUG.	12	4.83	2.58	2.25	P<0.01
SEP.	12	2.75	1.50	1.25	P<0.01
OCT.	12	2.91	0.91	2.00	P<0.01
NOV. 1982	12	4.75	3.83	0.92	P<0.01
DEC.	12	2.08	1.25	0.83	P<0.01
JAN. 1983	12	0.83	0.50	0.33	P<0.5
FEB.	12	1.83	1.00	0.83	P<0.01
MAR.	12	2.08	1.25	0.83	P<0.01
APR.	12	2.16	0.66	1.50	P<0.01
JULY 1983	12	2.66	1.83	0.83	P<0.01
AUG.	12	5.16	3.75	1.41	P<0.01
SEP.	12	6.25	4.66	1.59	P<0.01
OCT.	12	5.50	4.83	0.67	P<0.01
NOV.	12	6.33	5.08	1.25	P<0.01
DEC.	12	9.16	6.50	2.66	P<0.01

categories including physiological, biological and chemical control (17).

Some organisms have been evaluated as snail controlling agents in the field or laboratory, the more important of which is the snail *Marisa cornuarietis*.

The principal importance of the results seen in the present experiments lies in thier practical implications with regard to the control of *Biomphalaria alexandrina* in Egypt. The data obtained in the pre-

Table 3. Total numbers of *Marisa cornuarietis* sampled every month from the experimental ditches.

Month	Numbers of sampled snails		Month	Numbers of sampled snails	
	M_1	M_2		M_3	M_4
December 1981	23		Oct.82	70	
January 1982	27		Nov.	66	
February	29		Dec.	54	
March	30		Jan.83	49	
April	32		Feb.	47	
May	49	87	Mar.	59	
June	97	96	Apr.	112	
July	125	117	May		
August	135	150	June		
September	153	178	July		63
October	170	210	Aug.		91
November	181		Sep.		142
December	160		Oct.		125
			Nov.		115
			Dec.		98

sent study undoubtedly provide encouraging indications of the possible utility of *M. cornuarietis* as a biological control agent of that noxious schistosome transmitting snail.

The significant reduction in the density of the experimental populations of *B. alexandrina* examined, as compared to the control populations, illustrate a remarkable ability on the part of *Marisa* to eliminate *Biomphalaria* under semi-environmental conditions of the present investigation. The observed effects on *Biomphalaria* could not possibly be attributed to other predators or competitors, or linked to any environmental or climatic factors, because all ecological conditions were closely similar for both the control and experimental populations.

The present results lend strong support to earlier reports made by Demian and Lutfy (5,6), those authors have already provided conclusive evidence that *Marisa* in the laboratory deliberately attacks and preys upon *Bulinus truncatus*, ingests its young, and purposefully consumes its egg masses. Results of semifield trials in ditches supplied with water from the Nile reported by Demian and Kamel (4) showed the capacity of *Marisa* to destroy and completely eliminate *Bulinus truncatus* within 5–8 months.

M. cornuarietis would qualify as an efficient biological control agent against *B. alexandrina*. The data presented before (4,11), suggest

that *Marisa* will, doubtlessly be able to maintain itself in the natural environment in Egypt.

Confirmation of the predatory behaviour in the experimental ditches used in the present study was not feasible. The details of the interactions between *Marisa* and *Biomphalaria* could not be as closely observed in the ditches as in the laboratory. Thus, whether the observed effects of *Marisa* on the experimental populations (B_1–B_4) was due to direct predation, or to competition for food and space, or to a combination of both factors, could not be determined from the present investigation.

Should the observation made by Demian and Lutfy (5,6) in the laboratory and the results obtained through the series of semi-field experiments by Demian and Kamel (4) as well as the data presented here prove broadly valid in nature. *M. cornuarietis* could be of great value in the control of natural population of *Bulinus truncatus* and *Biomphalaria alexandrina* in Egypt.

The present study would then constitute an important step toward the solution of the so far unsoluble snail control problem in Egypt.

References

1- **Chernin, E., Michelson, E.H. and Augustine, D.L.** (1956). *Studies on the biological control of schistosome-bearing snails. I. The control of Australorbis glabratus populations by the snail, Marisa cornuarietis, under laboratory conditions.* J. trop. Med. Hyg., 5: 297–307.

2- **Demian, E.S. and İbrahim, A.M.** (1969). *Feeding activities of the snail Marisa cornuarietis (L.) under laboratory conditions.* Proc. Sixth Arab Sci. Congr., Damascus 1969, Part I: 145–165.

3- **Demian, E.S. and Kamel, E.G.** (1972). *Growth and population dynamics of Bulinus truncatus under semi-field conditions in Egypt.* Proc. Egypt Acad. Sci., 25: 37–60.

4- **Demian, E.S. and Kamel, E.G.** (1978). *Displacement of Bulinus truncatus by Marisa cornuarietis under semi-environmental conditions in Egypt.* Proc.Int. Conf. Schisto., 731–739.

5- **Demian, E.S. and Lutfy, R.G.** (1964). *Prospects of the use of Marisa cornuarietis in the biological control of Limnaea caillaudi in the U.A.R.* Proc. Egypt. Acad. Sci., 18: 46–50, Pls. I–III.

6- **Demian, E.S. and Lutfy, R.G.** (1965a). *Predatory activity of Marisa cornuarietis against Bulinus (Blinus) truncatus the transmitter of urinary schistosomiasis.* Ann. trop. Med. Parasit, 59: 331–336.

7- **Demian, E.S. and Lutfy, R.G.,** (1965b). *Predatory activity of Marisa cornuarietis against Biomphalaria alexandrina under laboratory conditions.* Ibid., 59: 337–339.

8- **Demian, E.S. and Lutfy, R.G.** (1966). *Factors affecting the predation of Marisa cornuarietis on Bulinus (B) truncatus, Biomphalaria alexandrina and Limnaea caillaudi.* Oikos, 17: 212–230.

9- **Ferguson, F.F., Oliver-Gonzalez, J. and Palmer, J.R.** (1958). *Potential for biological control of Australorbis glabratus, the intermediate host of Puerto Rican shistosomiasis.* Amer. J. trop. Med. Hyg., 749–493.

10- **Jobin, W.R.** (1970). *Population dynamics of aquatic snails in three farm ponds of Puerto Rico.* Ibid., 19: 1038–1048.

11- **Kamel, E.G.** (1973). *Studies on the biology and biological control of schistosome-carrying snails in Egypt.* M.Sc. Thesis, Faculty of Sicence, Ain Shams University, Cairo, Egypt. 1973.

12- **Michelson, E.H. and Augustine, D.L.** (1957). *Studies on the biological control of schistosome-bearing snails. IV. The control of Biomphalaria pfeifferi populations by the snail, Marisa cornuarietis, under laboratory conditions.* J. Parasit., 43: 135.

13- **Oliver-Gonzalez, J. and Ferguson, F.F.** (1959). *Probable biological control of Schistosomiasis mansoni in a Puerto Rican Watershed.* Amer. J. trop. Med. Hyg., 8: 56–59.

14- **Penalver, L.M.** (1956). *Infection experimental de molluscos fluviale Cubanoc con Schistosoma mansoni.* Arch. Venez. Patol. Trop. Parasit. Med., 2: 297–308.

15- **Radke, M.G., Ritchie, L.S. and Ferguson, F.F.** (1961). *Demonstrated control of Australorbis glabratus by Marisa cornuarietis under fields conditions in Puerto Rioc.* Amer. J. trop. Med. Hyg., 10: 370–373.

16- **Ruiz-Tiben, E., Palmer, J.R. and Ferguson, F.F.** (1969). *Biological control of Biomphalaria glabrata by Marisa cornuarietis in irrigation ponds in Puerto Rico.* Bull. Wld. Hlth. Org., 41: 329–333.

17- **World Health Organization** (1965). *Snail control in the preveniton of Bilharziasis.* W.H.O. Monograph Series No-(50).