INTERRELATIONSHIP OF MOLLUSCICIDAL CONCENTRATION AND TEMPERATURE ON THE RESPIRATION OF BULINUS TRUNCATUS

Khamis ABEL RAHEEM, Hind EL-GINDY & Jassim AL-HASSAN

Zoology Department, Faculty of Science, Cairo University, Giza, A.R.E.

Received August 1, 1979

Keywords: Bulinus truncatus. Bayluscide. Mollutox. influence of temperature and concentration

Abstract

The oxygen consumption of *Bulinus truncatus* subjected to two molluscicides was tested at different temperatures and different concentrations. The most effective combination for field application was discussed.

Introduction

Bilharziasis is one of the public health problems in Egypt, not only because of its high endemicity and prevalence, but also because of its deleterious effect on man power. One of the important method to control the disease is to eradicate the intermediate host the snails. Snail control by the use of chemical agents (molluscicides) has been advocated because they are expected to produce quick and considerable reduction or eradication of the molluscan hosts of schistosomiasis and would thus reduce or stop transmission of the disease (Malek, 1975).

Bayluscide (Niclosamide) and Mollutox are efficient molluscicides against snail vector of schistosomiasis (Gonnert & Schrausfstater, 1959; Foster *et al.*, 1960; Abdalla & Nasr, 1961; Paulini *et al.*, 1961; Ayad & El-Tawil, 1964; Fox *et al.*, 1966a a & b; Abdel-Rahman *et al.*, 1974; Shoeb & El-Emam, 1975; and El-Gindy, 1975a & b). Biological phenomena such as fecundity of snails, viability of eggs, egg-mass size as effected by repeated application of Bayluscide or Mollutox at concentrations 0.25 and 0.5 ppm for (1) hour were studied (El-Gindy *et al.*, 1978a). Also laboratory experiments were carried out to compare the lethal effect of Bayluscide or Mollutox on *Bulinus truncatus* snails at different age groups (El-Gindy *et al.*, 1978b).

In addition to conventional bioassay methods for testing molluscicidal action, respirometry was used as an expedient sensitive and accurate method for the evaluation of molluscicides with different molecular configuration. This method also has the added advantage of observing the behavior of the test organism. (Cheng & Sullivan, 1974; Malek & Cheng, 1974; Ishak & Mohamed, 1975; El-Gindy & Mohamed, 1976; Abdel Raheem *et al.*, 1979).

The effect of many copper molluscicides at different concentrations 1.0, 10, 20 ppm on the oxygen consumption of the snail *Biomphalaria glabrata* was studied by Cheng & Sullivan (1974). Similarly, the effect of varying concentrations of Bayluscide and Mollutox were studied on *Lymnaea Cailliaudi* (Mohamed & El-Gindy 1976) and on *Biomphalaria alexandring* (El-Gindy & Mohamed, 1977). They observed a gradual reduction in the oxygen consumption with the increase of exposure time as well as the molluscicide concentration.

Dependence of molluscicidal activity of copper sulfate on temperature was, studied (Hoffman & Zakhary, 1951; Kuntz, 1957). The lethal concentration of Bayer 73 and Mollutox varied inversely with the temperature of the molluscicide (El-Gindy, 1975b). The mortality rate of snails with the application of Bayluscide and pentachlorophenate was found to be temperature dependent (Strufe & Gonnert, 1962). The interactive influence of temperature and phenol on the rate of oxygen uptake was investigated in a freshwater snail *Helisoma trivolvis* (Sheanon & Trama, 1972).

In our laboratory investigations are being carried out to study the factors affecting the susceptibility of *Bulinus truncatus* to the action of molluscicides. The present paper deals with the interrelationships of temperature and concentration of molluscicides on the respiration of snails.

Material and method

Snails

Adult *Bulinus truncatus* snails were collected from water

Hydrobiologia 74, 11-15 (1980). 0018-8158/80/0741-0011$01.00.

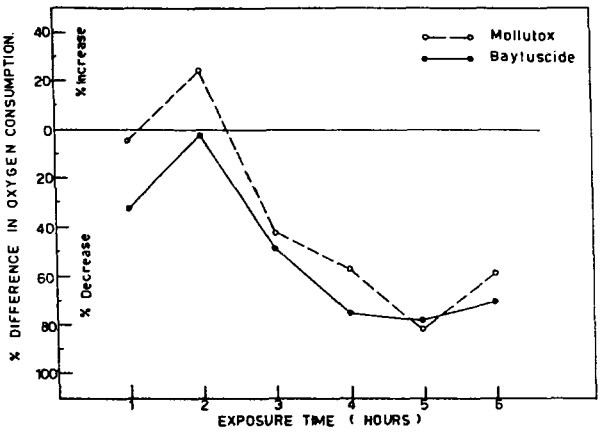


Fig. I. Percentage difference in oxygen consumption as compared to control for *Bulinus truncatus snail* exposed to 0.5 ppm Mollutox or Bayluscide at 25°C.

bodies located in Giza Governorate. Snails were kept in eight-litre capacity glass-aquaria containing tap water for about one month and were fed daily with fresh lettuce leaves. Water was changed every day. The temperature of the water at which the snails were maintained was 25 ± 1°C. Snail survivors of the large numbers collected initially were used for the respiration studies under the effect of the tested molluscicides.

Molluscicides

Bayluscide (Niclosamide, Bayer 73; Mole. wt. 3882). kindly donnated by the Scientific Office of Bayer in Cairo, was used in the present work. Mollutox (Mole. wt. 388.2), a registered trade name of a homologue of the same active ingredient of Bayluscide, was obtained from the Chemical and Insecticidal Company Abou-Zaabal, Egypt.

Exposure to molluscicides

A series of I-litre beakers containing different concentrations (0.5, I, 2 ppm) of the two tested molluscicides was prepared. Exposure periods of the snails to the molluscicides were 1, 2, 3, 4, 5 and 6 hours. At the end of each exposure period, snails were introduced into a Warburg's flask to measure the respiration rate. Similarly snails exposed to the tested substances at the different exposure periods were also used to determine the mortality rate, after a recovery period of 48 hour (WHO, 1965).

Measurement of Oxygen Consumption

The respiration rate was measured by the Warburg's manometric technique (Umbreit *et al.*, 1959) and as described by Ishak *et al.* (1970) and Abdel Raheem *et al.*, 1978). The respiratory medium used was, 2 ml water for untreated (control) snails (Von Brand *et al.*, 1948) or the molluscicide solution for treated snails (Ishak & Mohamed, 1975; Abdel Raheem *et al.*, 1978). To study the effect of concentration, snail groups exposed to 0.5, 1, and 2 ppm of both molluscicides were used to measure the oxygen consumption at 25°C. To study the effect of temperature on the respiration rate of snails treated with the tested substance, snails exposed to 2 ppm of both molluscicides were used to measure the oxygen consumption at four different temperatures of 15, 20, 25 and 30°C.

The rate of respiration was expressed as ml. O_2/gm wet body weight/hour. The data presented are mean ± standard deviation. Statistical analysis was done by the 'Student t-test (Hine & Wetherill, 1975).

Results and discussion

Studies on Bayluscide and Mollutox were mostly concerned with the effect of these two molluscicides on the biology of *Bulinus truncatus* (El-Gindy, 1975; Shoeb & El-Emam, 1975; El-Gindy *et al.*, 1978a & b). Fragmentary work was curried out to study its effects on the respiration of snails (Ishak & Mohamed, 1975; Abdel Raheem *et al.*, 1978).

In the present work, the effect of different concentrations of Bayluscide and Mollutox was studied. The data obtained indicated that the two molluscicides produced similar effects. At 0.5 ppm, an initial depression in the respiration rate, followed by a stimulated respiration were observed at 35°C (Fig. I). The initial inhibition of respira-

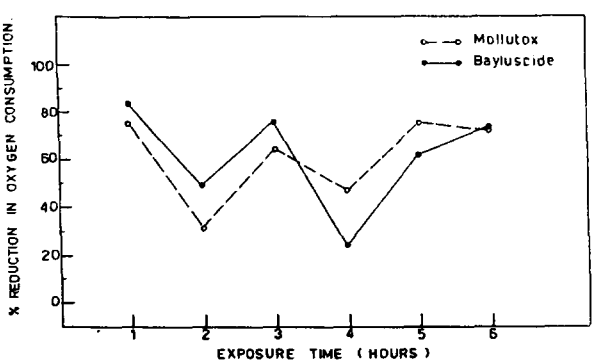


Fig. 2. Percentage reduction in oxygen consumption as compared to control for *Bulinus truncatus* snail exposed to 1 ppm Mollutox or Bayluscide at 25°C.

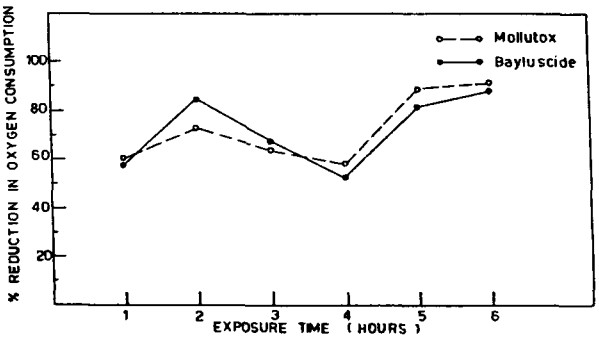


Fig. 3. Percentage reduction in oxygen consumption as compared to control for *Bulinus truncatus* snail exposed to 2 ppm Mollutox or Bayluscide at 25°C.

tion after the first hour of exposure could be due to an initial retraction of snails into their shells (Von Brand *et al.*, 1949). On the other hand, the stimulating effect observed after the second hour of exposure to molluscicides was similarly observed by Weinbach (1954), studying the effect of pentachlorophenate at low concentration on *Australorbis glabratus*. The stimulating effect of the tested molluscicides was followed by a continuously depressed respiration rate. This is similar to observations recorded by Ishak & Mohamed (1975). They reported a long lasting inhibition of respiration of *Biomphalaria alexandrina* at sublethal doses.

Raising the concentration of the molluscicides to 1 and 2 ppm caused a depressed respiration rate, which showed fluctuated changes at one ppm (Fig. 2). Such fluctuating changes became less and the depression of oxygen uptake become definite and increasing at two ppm (Fig. 3). Such observations are concordant with the work of Stufe & Gonnert (1962) on *A. glabratus*. The present data suggest that the depression of oxygen consumption of snails is concentration dependent, the highest depression was achieved at 2 ppm. In this regard, it is important to indicate that the exposure of snails to increasing concentrations of 0.5, 1, and 2 ppm, produced an increase in the mortality rate (Fig. 4). The mortality rate was found to show its highest value at 2 ppm of both tested substances. This runs parallel to the increasing inhibition of oxygen consumption of snails with the increase in the concentration of molluscicides.

The oxygen consumption of snails treated with 2 ppm was measured at three different temperatures in order to find out the proper temperature at which maximum susceptibility of snails to the action of molluscicides is attained.

At 15°C the treatment revealed depression in the respiration rate (Fig. 5). There was an initial drop followed by an increased respiration rate indicating the recovery of such snails from the shock produced by the action of each of the 2 moluscicides. However, with time a gradual fall in respiration was achieved.

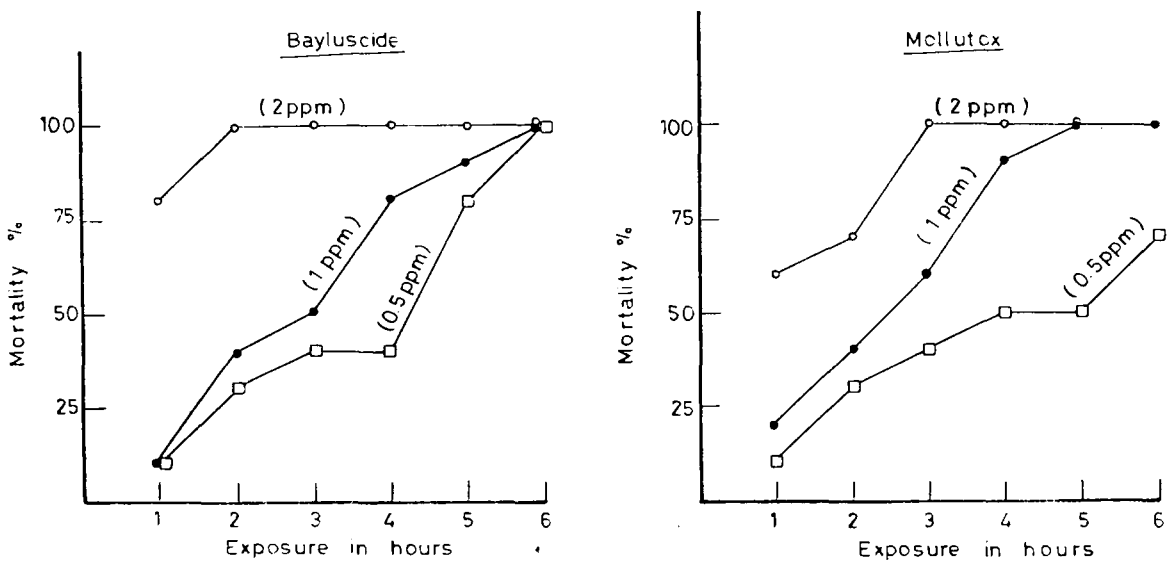


Fig. 4. Treatment of *B. truncatus* with 0.5, 1 and 2 ppm Bayluscide or Mollutox for 1, 2, 3, 4, 5 and 6 hours at 25°C (Recovery period 48 hours).

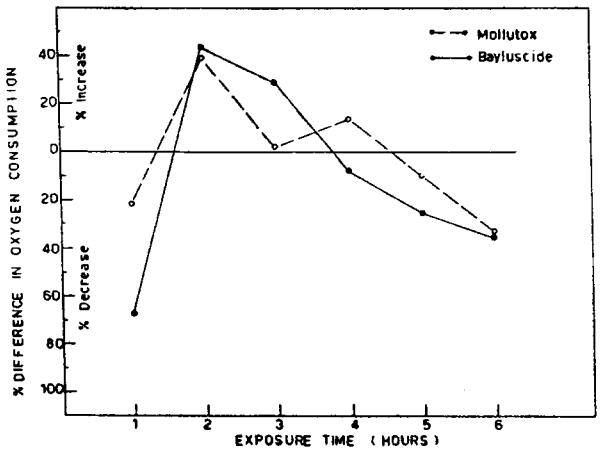
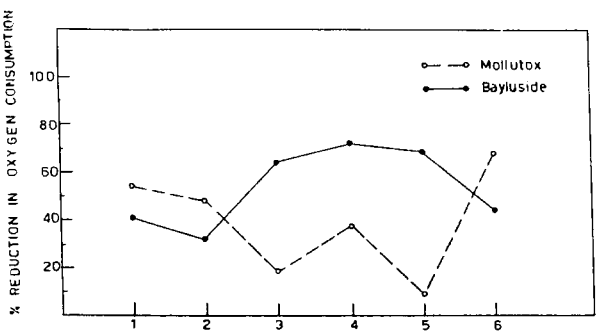


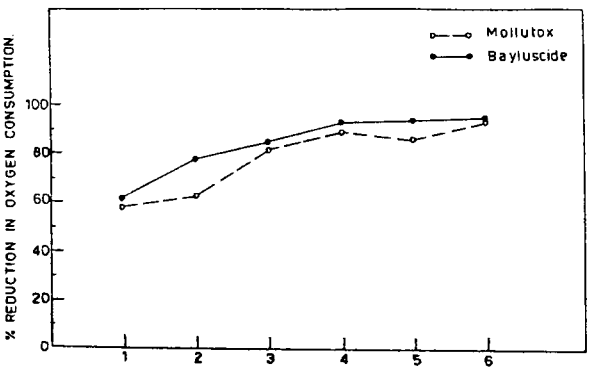
Fig. 5. Percentage difference in oxygen consumption as compared to control for *Bulinus truncatus* snail exposed to 2 ppm Mollutox or Bayluscide at 15°C

Increasng the temperature to 20°C, a definite depression in the oxygen consumption was observed (Fig. 6). The effect of Bayluscide was more pronounced than that of Mollutox. At 30°C (Fig. 7) comparable depressions were observed with the 2 molluscicides. They showed marked and definite inhibition of respiration, which increased gradually with time.

The above mentioned description of data point to the marked effect of temperature on the action of the molluscicides. The higher the temperature, the more the depression in the rate of respiration. This is parallel to observations of Kuntz (1956), who pointed out that sodium pentachlorophenate was more lethal at low concentration in summer than at lower temperatures of winter. Similarly, the application of DCHP in summer was shown by



Exposure time (hours)
Fig. 6. Percentage reduction in oxygen consumption as compared to control for *Bulinus truncatus* snail exposed to 2 ppm Mollutox or Bayluscide at 20°C.



Exposure time (hours)
Fig. 7. Percentage reduction in oxygen consumption as compared to control for *Bulinus truncatus* snail exposed to 2 ppm Mollutox or Bayluscide at 30°C.

Kuntz (1957), to be more effective than in winter. The application of 2 ppm of (PCP) was enough to kill *B. alexandrina* while above 10 ppm, the solution was not lethal to all snails at lower temperatures (El-Gindy, 1960).

The present data suggest that the action of the tested molluscicides would be most effective as temperature increases. Maximum depression was obtained with 2 ppm of both molluscicides.

Summery

1. The oxygen consumption of *B. truncatus* subjected to the actions of Bayluscide and Mollutox at 2 ppm, was measured at four different temperatures. 15, 20, 25 and 30°C.

2. At 15°C the respiration rate was stimulated after two hours of exposure to the molluscicides. A depression followed which increased with time. Raising the temperature to 20°C and 25°C produced depression which showed fluctuating changes. Definite and increasing depression was obtained at 30°C.

3. The effect of increasing the concentration from (0.5) ppm to (1) and (2) ppm was also studied at a constant temperature of 25°C.

4. Exposure of snails to (0.5) ppm at 25°C produced changes identical to those obtained with 2 ppm at 15°C, increasing the concentration produced depression of respiration rate which was pronounced at 2 ppm.

5. The most effective exposure achieved was at 2 ppm and at 30°C, which may recommend the application of molluscicide in spring and summer so as to procure optimum results in snail control.

References

Abdalla, A. & Nasr, T. S. 1961. Evaluation of a new molluscicide, Bayer 73 J. Egypt. Med. Assoc. 44, 160-170.

Abdel Raheem, K., El-Gindy, H. I. & Al-Hassan, M. J. 1979. Susceptibility of different body-sized Bulinus truncatus to molluscicidal action at two different temperature. Hydrobiologia vol. 65, 2, Pag. 129-133.

Abdel-Rahman, M. O., Abdel-Samei, M., Aboul-Enein, M. N., El-Hamawy, H., El-Sawi, M. R., Osman A. K., Sidky, M. M. & Taha, R. M. 1974. Studies on the Newly formulated 5, 2-dichloro-4-Nitrosalicylanilide, 'Mollutox'. Egypt. J. Bilh., I, No. I, 153-169.

Ayad, N. & El-Tawil, M. F. 1964. (Recent advances in molluscicides) Proc. of the 1st national symposium on bilharziasis. Vol. I, 135-150.

Cheng, T. C. & Sullivan, J. T. 1974. Mode of entry, action and toxicity of copper molluscicides. In: 'Molluscicides in Schistosomiasis Control' edited by Thomas C. Cheng, Academic Press, New York and London, Page: 89-153.

El-Gindy, Hind, I. 1975. A comparative study on the effect of repeated application of Bayer 73 and Mollutox on Biomphalaria alexandrina. J. Egypt. Med. Assoc. 58: (5/6): 313-23.

El-Gindy, Hind I, 1975b. Mollutox and Bayer 73 as molluscicides against Bulinus truncatus and Biomphalaria alexandrina. Egypt. J. Bilh., (2): 213-220.

El-Gindy, Hind, I. & Mohamed M. A. 1976. Oxygen consumption of different size groups of Lymnaea cailliaudi, especially after application of Bayer 73 or Mollutox. J. Egypt. Soc. Parasit; 6: 95-104.

El-Gindy, H. I. & Mohamed, M. A. 1977. Comparative study on the effect of Bayluscide and Mollutox application against Biomphalaria alexandrina on l-oxygen consumption. J. Egypt. Med. Assoc. (In Press).

El-Gindy, H. I., El-Gindy, M. S. & Al-Hassan, M. J. 1978a. Acquired susceptibility in Bulinus truncatus to Bayluscide or Mollutox due to repeated applications. J. Egypt. Soc. Parasit. Vol. 8 (2): 243-258.

El-Gindy, H. I., El-Gindy, M. S. & Al-Hassan, M. J. 1978b. Age as a main factor in susceptibility of Bulinus truncatus to Bayluscide or Mollutox. J. Egypt. Soc. Parasit. (In Press).

El-Gindy, M. S. 1960. Scientific Aspects in the control of snail vectors of Bilharziasis. J. Egypt. Med. Ass. (43) No. 10,717-736.

Foster, R., Teesdal, C. & Poutin , G. F. 1060. (Trials with a new molluscicide) Bull. Wld. Hlth. Org. 22, 543-548.

Fox, I. Rivera, G. A., Ritchie, L.S., & Frick, L. P. 1966a. Effect of Bayluscide against Australorbis glabratus of different ages, strains and cultural conditions. Bull. Wld. Hlth. Org. 43, 505-506.

Fox, I., Rivera, G. A., Ritchie, L. S. & Frick, L. P. 1966b. Effect of aging on molluscicidal activity of Bayluscide Bull. Wld. Hlth. Org., 34, 307-308.

Gonnert, R. & Schrausfstatter, E. 1959. A new molluscicide, Bayer 73. Proc. 6th. Intl. Congr. Trop. Med. Maler. Lisbon, 2, 197-202.

Hine, J. & Wetherill, G. B. 1975. A programmed text in statistics. Book three, t-test and X2 goodness of fit. Chapman and Hall, London.

Hoffman, D. O. & Zakhary, R. 1951. The effect of temperature on the molluscicidal activity of copper sulfate. Science, 114, 521-523.

Ishak, M. M. & Mohamed, A. M. 1975. Effect of sublethal doses of copper sulphate and Bayluscide on survival and oxygen consumption of the snail Biomphalaria alexandrina. Hydrobiologia Vol. 47, 3-4, Page 499-512.

Ishak, M. M., Mohamed, A. M., Wafa, A., Mousa, A. H. & Ayad N. 1970. Physiological studies on Biomphalaria alexandrina and Bulinus truncatus, the snail vectors of Schistosomiasis. l-Oxygen consumption. Hydrobiologia vol. 35, 333-344.

Kuntz, R. E. 1956. Evaluation of sodium-pentachloraphenata as a molluscicide in Egypt. Amer. J. Trop. Med. Hyg. (5): 274-285.

Kuntz, R. E. 1957. Relationship of temperature to molluscicidal activity. Amer. J. Trop. Med. Hyg. (6): 940-945.

Malek, E. A. 1975. Realistic goals in the use of molluscicides in different endemic areas of schistosomiasis. Proc. Int. Conf. Schisto. Cairo, Egypt October 18-25, 1975 Page 359-391.

Malek, E. A. & Cheng, T. C. 1974. Medical and Economic Malacology Academic Press, New York and London Page 302-307.

Mohamed, A. M. & El-Gindy, Hend I. 1976. Comparative study on the effect of Bayluscide and Mollutox application on oxygen consumption of young Lymnaea cailliaudi. J. Egypt. Soc. Parasit. 6: 105-118.

Paulini, E. Chaia, G. and Freitas, J. R. de. 1961. Trails with the molluscicides, Rhodiacid and Bayer 73 Bull. Wld. Hlth. Org. 25, 706-709.

Sheanon, M. J. & Trama, F. B. 1972. Influence of phenol and temperature on the respiration of a freshwater snail Helisoma trivolvis Hydrobiologia vol. 40, 3, 321-328.

Shoeb, H. A. & El-Emam, M. A. 1975. The molluscicidal properties of some Bayluscide homologues. Proc. Int. Conf. Schisto., Cairo, Egypt October 18-25, 1975 page 495-503.

Strufe, R. & Gonnert, R. 1962. Comparative studies on the influence of environmental factors upon the efficiency of Bayluscide. Pflanzenschutz Nachrichten - Bayer 15/1962, 1, 50-70.

Umbreit, W. W. Burris, R. H. & Stauffer, J. F. 1959. Manometric Techniques, Burgers Pub. Co. Chapter I, (1-17).

Von Brand, T., Mehlman, B. & Nolan, M.O. 1949. Influence of some potential molluscicides on the oxygen consumption of Australorbis glabratus. J. Parasit. 35: 475-481.

Von Brand, T. Nolan, M. O. & Mann, E. R. 1948. Observations on the respiration of Australorbis glabratus and some other aquatic snails. Biol. Bulletin 95; 199-213.

Weinbach, E. D. 1954. The effect of pentachlorophenol on snail metabolism. Federation Proceedings vol. 13, 318.

World Health Organization 1965. Molluscicide screening and evaluation. Bull. Wld. Hlth. Org. 33: 567-581.