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EFFECT OF XIPHIDIOCERCARIAL INFECTION ON THE OXYGEN CONSUMPTION OF THE FRESH WATER SNAIL LANISTES CARINATUS

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Xiphidioserker enfeksiyonlarının tatlısu sümüklüsü Lanistes carinatus'un oksijen tüketimi üzerine etkisi

Özet: *Xiphidioserker taşıyan ve taşımıyan tatlısu sümüklüsü Lanistes carinatus'ların* 25 °C. *daki oksijen tüketim oranlarının belirgin olarak sümüklülerin büyüklüğüne bağlı olduğu ve sümüklülerde vücut büyüklüğü arttıkça solunum oranının azaldığı gözlenmiştir.*

Serker taşımıyan L. carinatus erkek ve dişilerinin 25 °C. *daki oksijen tüketim oranlarında belirli bir fark gözlenmemiştir.*

Xiphidioserkerle enfekte sümüklüler, parazitli olmayanlardan daha fazla oksijen tüketmektedirler. Parazitli ve parazitsiz L. carinatus'lar arasındaki ortalama oksijen tüketim oranı farkı, değişik büyüklükteki gruplar arasında yüzde olarak 29.77, 22.78 *ve* 40.71 *bulunmuştur. Bu gruplar A,B ve C olarak kabuk çaplarına göre sırasıyle* 10–20 *mm,* 20.1–30 *mm. ve* 30 *mm. den büyük olan sümüklüleri kapsamaktaydı.*

Summary: *The rate of oxygen consumption at* 25 °C *of unparasitized freshwater snail Lanistes carinatus Olivier and those parasitized with xiphidiocercariae was found to be markedly size dependent, the respiration rate decreases as the body size increases. No significant differences were observed in the rate of oxygen consumption at* 25 °C *between males and females unparasitized L. carinatus. Parasitized specimens with xiphidiocercariae have a higher rate*

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of oxygen consumption compared with those unparasitized snails. The difference in the mean rate of oxygen consumption between parasitized and unparasitized L. carianatus (as a percentage) was 29.77, 22.78 *and* 40.71 *for three different size groups. These groups were A,B, and C ranging between* 10–20, 20.1–30 *and over* 30 *mm in shell diameter respectively.*

Introduction

Oxygen consumption has long been used as an index of metabolic rate, and biological literature contains many values of oxygen consumption and the factors affecting it.

Several studies dealt with the oxygen consumption including in general molluscs (17, 21) and in special snails (1, 2, 3, 4, 10, 11, 12, 13, 14, 15, 17, 18, 19).

The evidence concerning the effect of the parasite on the metabolism of the host is relatively scarce and conflicting despite the confident assertion of Cheng (5) that the oxygen consumption is increased as a result of parasitism.

Von Brand and Files (27) were unable to detect any difference in metabolic rate between parasitized and uninfected *Australorbis glabratus*, when measured at 30 °C. Becker (3) reported a lower metabolic rate in parasitized molluscs than uninfected snails when the rate was measured at 25 °C. Duerr (9) has shown that wild *Lymnaea stagnalis* parasitized with larval trematodes, also respire at a lower rate than laboratory raised uninfected snails.

In contrast, Vernberg and Vernberg (25) have shown that in both cold and warm acclimated *Nassarius obsoleta* (Say), the parasitized animals had a significant higher metabolic rate than non-parasitized ones at two temperature extremes, 10 °C and 20 °C, but not at intermediate temperatures.

Cheng and Snyder (7) presented histochemical evidence that at least a part of the host's glycogen is degraded to glucose and this is absorbed by sporocysts. This information indicated that intermolluscan larval trematodes can derive their glucose requirement either directly from the haemolymph or indirectly from the breakdown products of stored polysaccharide in the digestive gland. Robson and Williams (23) found that the concentration of glycogen in both digestive gland and the foot of *Littorina littorea* parasitized with *Cryptocotyle*

lingua was markedly reduced in both sexes compared to uninfected animals.

Cheng and Lee (6) commenting on the glucose level of *B. glabrata* parasitized with *Schistosoma mansoni* suggested that the reduction of glucose level in parasitized snails may be attributed, at least in part, to uptake and utilization by the parasites.

Miracidiae and cercariae are aerobic, utilizing the oxygen present in their aquatic environment, on the other hand, intermolluscan larvae, particularly when found in the reproductive system or in the digestive gland of their host, are essentially in anaerobic environments, Cheng (5).

Recently Kamel (16) working on the effect of *Cryptocotyle lingua* on the snail *Littorina littorea* showed a much greater rate of oxygen consumption in parasitized specimens compared with unparasitized ones at four different experimental temperatures (10, 15, 20 and 25 °C). He suggested that the low rate of oxygen consumption of unparasitized *L. littorea* is indicative of a maintenance metabolism, whilst high rate of oxygen consumption in parasitized snails indicates active metabolism.

The present study involving *L. carinatus* and xiphidiocercariae was undertaken in order to determine the rate of oxygen consumption of both unparasitized and parasitized snails at an experimental temperature of 25 °C.

Material and Methods

In the present work, the snails used were wild stock, collected from irrigation canals located at Giza Governorate, Cairo. Snails after being collected from the field were allowed to remain for a week in glass aquaria to adapt themselves to the new condition at the laboratory. Snails were classified into three size groups according to shell diameter. Group A includes snails of 10–20 mm, group B from 20.1–30 mm and group C contains snails over than 30 mm in shell diameter.

Oxygen uptake of the experimental snails was measured by means of the direct method of Warburg's manometric technique. The flask had a total capacity of 15 cc, air was the gas phase, and manometers were filled with Bordie's fluid. Before the actual determination of

respiratory gases, the apparatus was calibrated. Oxygen uptake was measured according to Umberiet et al. (24).

During the preparation of tissue homoginates the experimental snails were stored on crushed ice during dissection. Individual specimens were transferred to chilled petri dishes. The shell was cracked gently and the soft tissue was removed carefully. Tissues were placed immediately into ice-cold 0.25 M. sucrose solution. After that, tissue of each individual snail was accurately weighed, washed with ice-cold sucrose solution and then blotted on filter paper to remove the adhering solution. Washed tissue was transferred into a previously weighted potter-Evehjem homogenizer tube containing 5 ml. of 0.25 M. ice-cold sucrose solution. The homogenate tissue was centrifuged at 3000 R.P.M. and the supernatant was used. The latter was introduced into Warburg flasks. Carbon dioxide was absorbed in the usual manner by freshly prepared 0.2 ml of 20 % KOH placed in the inner cup which contains folded high-grade filter to increase the absorbed surface. The temperature of the water bath was set at a constant temperature of 25 °C. The manometers were shaken at a rate of 1000 times per minute with an amplitude of 3.5 to 4 cm. An equilibrium period of 10 minutes was allowed before the actual determination. Readings were usually taken after one hour. Results were expressed in ml. Oxygen consumed per gram wet weight of tissue per hour (ml. O_2/gm wet weight/hr).

Results

The mean rate of oxygen consumption of three size groups unparasitized *L. carinatus* at 25 °C is given in Table 1. It is clear from the data presented that the rate of O_2 consumption in *L. carinatus* is always markedly size dependent. The respiration rate decreases as the body size increases in unparasitized specimens. The mean rate of oxygen consumption measured at 25 °C was 0.485 ± 0.07, 0.320 ± 0.02 and 0.297 ± 0.06 ml oxygen/gm wet weight of tissue/hour for three size groups A,B and C respectively.

The mean maximum rate of oxygen consumption measured for the size group A was 0.520 ml/oxygen/gm wet tissue weight compared with a mean maximum rate of 0.329 and 0.301 ml/oxygen/gm weight of tissue/hour recorded for group B and C respectively. While the mean minimum rate of oxygen consumption was 0.470, 0.31 and 0.290 ml oxygen/gm wet weight of tissue for groups A,B and C respectively.

Table 1. Rate of Oxygen consumption (ml. O_2/gm. wet tissue weight/hr) of uninfected *Lanistes carinatus* of different size groups at 25 °C.

Size group	Oxygen Consumption ml O_2/gm. wet tissue weight/hr	
	Range	Mean rate ± S.D. (n)
A 10 – 20 mm	0.470 — 0.520	0.485 ± 0.072 (25)
B 20.1–30 mm	0.310 — 0.329	0.320 ± 0.024 (25)
C Over 30 mm	0.290 — 0.301	0.297 ± 0.064 (25)

(n) Number of snails

It is clear from the data presented in Table 1. that the variations in the rate of oxygen consumption in group B and C is very limited as compared with that of group A.

Table 2 summarized the data obtained for oxygen consumption of both males and females unparasitized *L. carinatus* at a temperature of 25 °C. The data showed no significant differences in the rate of oxygen consumption between unparasitized males and females *L. carinatus* at a temperature of 25 °C. ($P < 0.05$) for the three size groups A,B and C. The mean rate of oxygen consumption of unparasitized males was 0.451 ± 0.08, 0.340 ± 0.03 and 0.281 ± 0.06 ml of oxygen/gm wet tissue weight/hour respectively. The results obtained for unparasitized females showed a mean rate of oxygen consumption of 0.473 ± 0.09, 0.336 ± 0.04 and 0.206 ± 0.07 ml/oxygen gm wet weight of tissue/hour, recorded for groups A,B and C respectively.

Table 2. Rate of Oxygen consumption (ml. O_2/gm. wet tissue weight/hr) of males and females uninfected *Lanistes carinatus* of different size groups at 25 °C.

Size group	Mean rate of Oxygen consumption ± S.D. (n)	
	Male	Female
A 10 – 20 mm	0.451 ± 0.086 (9)	0.473 ± 0.097 (16)
B 20.1 – 30 mm	0.340 ± 0.030 (12)	0.336 ± 0.042 (13)
C Over 30 mm	0.281 ± 0.061 (8)	0.206 ± 0.078 (17)

(n) Number of snails

The results obtained for the rate of oxygen consumption in parasitized and unparasitized specimens of *L. carinatus* are shown in Table 3. It is clear from the data presented that parasitized *L. carinatus* have a higher rate of oxygen uptake compared with those unparasitized snails for the three size groups mentioned before.

Tablo 3. Rate of Oxygen consumption (ml. O_2/gm. wet tissue weight/hr) of uninfected and parasitized *Lanistes carinatus* of different size groups at 25 °C.

SİZE GROUP	Mean rate and range of oxygen consumption			
	Uninfected snails		Parasitized snails	
	Range	Mean ± S.D. (n)	Range	Mean ± S.D. (n)
A 10-20 mm	0.440--0.478	0.450±0.049 (25)	0.575—0.593	0.584±0.059 (15)
B 20.1-30 mm	0.338—0.347	0.341±0.036 (25)	0.412—0.439	0.418±0.091 (15)
C over 30 mm	0.253—0.259	0.256±0.034 (25)	0.355—0.369	0.359±0.061 (15)

(n) Number of snails

The difference in the mean rate of oxygen consumption between parasitized and unparasitized *L. carinatus* (as a percentage) was 29.77, 22.78 and 40.71 for group A,B and C respectively.

The mean oxygen uptake for parasitized animals compared with unparasitized ones at the same temperature increased by 0.184 ± 0.01, 0.077 ± 0.02 and 0.103 ± 0.01 ml, oxygen/gm wet tissue weight/hour.

Discussion and Conclusion

The digenetic larval trematodes are totally dependent on their molluscan host for their energy producing substances which might imply that the host's overall rate of metabolism may be increased. This is indicated by the reduction of glucose level in *Biomphalaria glabrata* infected with trematode larvae, (6), the lower concentration of glycogen in *Littorina littorea* parasitized with *Cryptocotyle lingua* (23), the higher metabolic rate of infected *Nassarius obsoleta* (25), and the higher rate of oxygen consumption of *L. Littorea* parasitized with *Cryptocotyle lingua* (16).

As a rule, the respiration rate decreases as the body size increases (5). The rate of oxygen consumption was found to be markedly size dependent in both parasitized and uninfected animals. The results presented in this investigation run in full agreement with those presented before (8, 16, and 20).

Vernberg and Vernberg (26) observed the effects of developing metacercaria of the trematode *Zoogoninus lasius* on the metabolic rate and enzymatic activity of the polychaete *Leonereis culveris*, they have shown that there is a higher metabolic rate during metacercarial development within the second intermediate host. Although we are dealing with different stages of developing digenetic larval trematode

(rediae in one case and cercariae in the other), the results presented here show a higher rate of oxygen uptake in parasitized *L. carinatus*. This is almost certainly due to the development and reproduction of the parasites within the molluscan host.

If the mass of the parasites could accurately be determined it may be possible to estimate the metabolic rate of the various stages of the parasites themselves. It was found during this observation, and was ascertained by previous work, that parasites occur in the host's visceral haemocoel between the tubules of the digestive gland and gonad. Since the parasite occurs in the haemocoelic spaces which are rich in oxygenated blood, so it is likely that the parasite takes its oxygen requirement directly from the blood, it is thus unlikely that respiration of the parasite is anaerobic, as ascerted by Cheng (5).

On the other hand the heart rate in molluscs is considered to be a good indicator of oxygen consumption and thus the metabolic rate (28).

The preliminary investigation on the heart rate of the snail *L. carinatus* showed a comparatively higher heart rate in parasitized specimens with xiphidiocercariae. The results would appear to reflect the greater metabolic rate of parasitized snails.

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