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EFFECTS OF LINDANE ON SWIMMING PERFORMANCE OF CARP (*CYPRINUS CARPIO*)

WPŁYW LINDANU NA AKTYWNOŚĆ LOKOMOTORYCZNĄ U KARPIA (*CYPRINUS CARPIO*)

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The influence of lindane on swimming performance of carp was investigated. Lindane was found to significantly effect fish swimming performance. It is suggested that lindane may influence the exchange of respiratory gases or the metabolic pathways involved in the mobilization of energy.

INTRODUCTION

Lindane, a Gamma-isomer of hexachlorocyclohexane, is very hazardous to aquatic organisms because this chemical is highly toxic, resistant to degradation and easily absorbed by the fish (Lakota et al. 1983).

There is an abundant literature available on the effects of lindane on aquatic organisms (Reddy et al. 1986; Demael et al. 1987; Bondy and Halsall, 1988; Hawkinson et al. 1989; Mourad, 1990), yet not information has been published about its effect on swimming performance. Swimming performance, depending as it does on the immediate recruitment of energy, has been recommended for use as a criterion in the determination of the sublenthal effects of pollutants on fish (Brett, 1967; Sprague, 1971). Pulpwood fiber (MacLeod and Smith, 1966); sodium pentachlorophenate (Webb and Brett, 1973), fenitrothion (Peterson, 1974), detergents (Węgrzynowicz et al. 1975) are some of the substances found to effect swimming performance.

* Lindane is one of the plant protection chemical agents.

The aim of this paper is to study the effects of lindane on swimming performance of carp under the applied load of a given work.

MATERIALS AND METHODS

The investigation was carried out upon 32 carp (*Cyprinus carpio*), weighing 105 ± 20.3 g after acclimation period of one week. The experiments were made in a glass aquarium containing 100 liters of aerated dechlorinted tap-water. The value of temperature, pH and dissolved oxygen content were 18 ± 0.5°C; 7.5 ± 0.5; 9.8 ± 0.6 mg/1, respectively. Fish performance was measured with the method of Węgrzynowicz and Kłyszejko (1972). According to this method, a float of determined force buoyancy (5%) was fixed to the dorsal fin. To overcome the buoyancy force of the float, the fish were constantly swimming.

In these experiments, four parameters were estimated in the following way:

1. Fish swimming speed by a direct measurement of the time required for the fish to swimm over a gauged distance.
2. Time of fatigue i.e. the fish were swimming up to water surface and remained there for some time without any motion.
3. Fish travel, as defined from the formula:

$$S = V\,T$$

where:

S = fish travel (m)
V = fish speed (M/s)
T = swimming speed (s.)

4. Physical effort, as defined by the formula:

$$L = F_w S \text{ Ctg } \alpha$$

where:

L = physical effort (Kg/m)
F_w = buoyancy force of float (Kg)
S = fish travel (m)
Ctg α = angle between long axis of the fish and water surface.

A stock solution of lindane (99.2%) was prepared in acetone. The fish were subjected to 5, 10.6, 21.2 µg/1 lindane and changes in swimming performance were estimated. To evaluate the significance of changes caused by lindane, Student's t test was used.

RESULTS AND DISCUSSION

Changes in swimming performance as measured by swimming speed, fatigue time, fish travel and physical effort under the applied load work are illustrated in

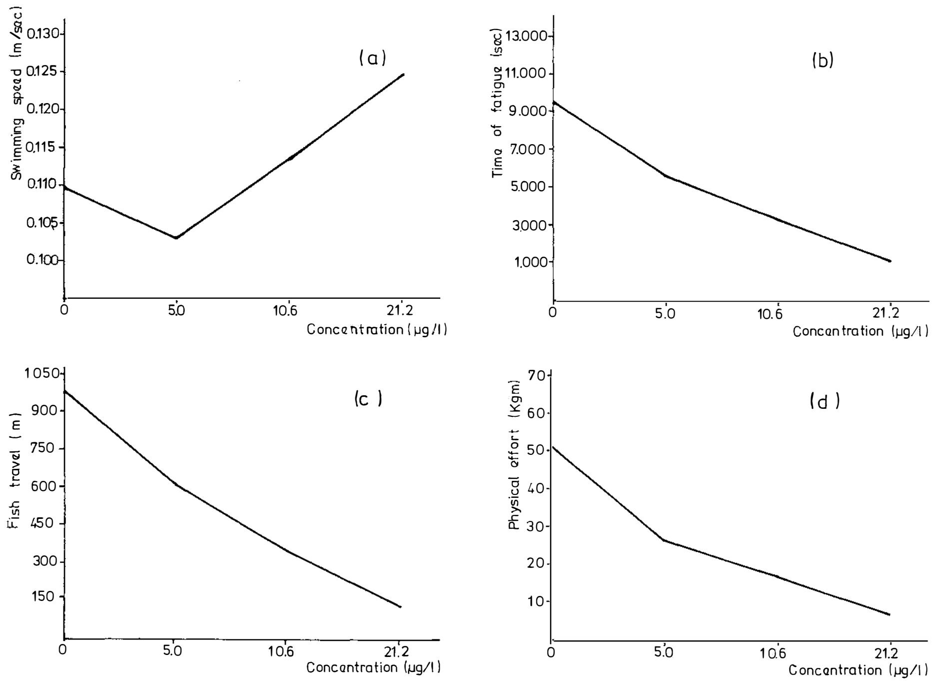

Fig. 1. Effect of lindane on fish swimming performance:
(a) swimming speed, (b) time of fatigue, (c) fish travel, (d) physical effort

Fig. 1 (a–d). As shown in Fig. 1(a), the mean swimming speed for the fish control was 0.110 m/s. The mean decreased to 0.103 m/s. after exposing the carp to 5 μg/l lindane. The reduction in swimming speed may be explained as an attempt of the fish to decrease its oxygen consumption as well as the rate of energy expenditure. Williams and Brett (1987) showed that swimming speed is among the major factors affecting the rate of energy expenditure.

On the other hand, a rise in lindane concentration to 10.6 and 21.2 μ g/l results in increasing the mean swimming speed to 0.113 and 0.125 m/s., respectively, which indicates some sort of hypertoxic stress and increased oxygen consumption. Rao and Venugopalan (1984) found that lindane induced a significant increase in oxygen consumption and inhibited the oxygen uptake. The elevated rate of oxygen consumption serves not only to meet the routine metabolic requirements but also to replace muscle supplies of adenosine triphosphate, creatin phosphate and glycogen (Biliński, 1974). Statistically, changes in swimming speed were non-significant except at a concentration of 21.2 μg/l.

As shown in Fig. 1(b), the mean time of fatigure following exposure to different concentrations of lindane were 57.3%, 34.0%, 12.7%, respectively of the control. The decrease in fatigue time following exposure to lindane could be due to direct action on muscle, effect on areas of the nervous system concerned with muscle activity, or indirect effects thorough motivational disturbance i.e. carbohydrate metabolism. Boulekbache and Spiess (1974) found changes in the histological structure of the muscle and the level of the glycolytic enzymes after exposure of the trout to lindane.

From Fig. 1(c) we can see that the mean fish travel rollowing exposure to different concentrations of lindane were 61.6%, 35.7%, 14.8% respectively of the control. Also, the mean physical effort were 51.4%, 33.7%, 13.1% of the control as shown in Fig. 1(d). Statistically, changes in fatigue time, fish travel and physical effort were significant.

The impairment of swimming performance of the fish after exposure to lindane is thorought to be related to a reduction in their respiratory efficiency. Lindane is known to cause desquamation of the epithelial layer of the gills (Matei and Malgina, 1979), extensive disarray of the secondary lamellae (Drewett and Abel, 1983); histological damages in the gill tissues (Studnicka et al., 1981).

It has become clear that lindane interferes with some of the mechanisms involved in the uptake of oxygen at the gill level of the fish, eventually causing prevalence of hypoxic condition in the tissues. Basha et al. (1984), Madhu et al. (1984), Zlateva and Yurukova (1984), demonstrated that lindane is well known to cause hypoxic condition in the tissues and reduce the rate of oxidative metabolism.

CONCLUSIONS

1. Lindane significantly affects fish swimming performance.
2. Swimming performance changes depended upon the concentrations of lindane.
3. Impairment of swimming performance is thought to be related to a reduction in their rerspiratory efficiency.

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WPŁYW LINDANU NA AKTYWNOŚĆ LOKOMOTORYCZNĄ U KARPIA (*CAPRINUS CARPIO L.*)

STRESZCZENIE

Przeprowadzono badania nad wpływem lindanu na aktywność lokomotoryczną u karpia przy zastosowaniu metody Węgrzynowicz-Kłyszejko 1972. W wyniku badań stwierdzono, że lindan istotnie obniża zdolność ryb do aktywnego wysiłku fizycznego, w zależności od dawki. Uzyskane wyniki pozwalają stwierdzić, że lindan blokuje oddychanie skrzelowe.

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