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Acute Toxicity of Wood Tar and Dieldrin to *Lebistes reticulatus* (PL)

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The destructive effects of pests in tropical countries where the climatic conditions favor their continual growth pose a great deal of problems to the economic development of such countries. Organochlorine insecticides and relatively persistent pesticides, continue to be used in a number of developing countries for the control of pests. In the building industry in Ghana, termites which destroy wood are controlled with dieldrin. Dieldrin is very effective, but it is persistent, biocumulative, not easily degradable and toxic to nontarget organisms (Brungs et al. 1967; Mount et al. 1966). In addition, its breakdown product due to sunlight, photodieldrin is more toxic than dieldrin itself. Since dieldrin is toxic, biocumulative, nondegradable and persistent it has detrimental effects on nontarget organisms. Hence it is important to search for a suitable substitute.

The wood tar appears to be a good substitute for dieldrin in the preservation of wood against termites. It is obtained by the destructive distillation of wood shavings from the Ghanaian timber species of Nauclea diderrichi (Kusia), Maclura excelsa (odum) and Khaya sp. (Mahogany). At the moment investigations are being conducted to determine the composition of the tar, and then to identify the component which has preservative properties. Since during its use for preservation of wood, the wood tar may leak into the environment, its effects on nontarget organisms should be investigated. The investigation reported here is part of such research. The toxicity of dieldrin to the guppies has been done for purposes of comparison.

MATERIALS AND METHODS

Lebistes reticulatus (PL), guppies, were caught with scoop nets from a stream at Bomso, a surburb of Kumasi City which is on latitude 6° 45'N and longitude 1° 35'W. The guppies were put in glass aquaria which contained filtered pond water and allowed to stand in the laboratory for 1 wk, during which the temperature ranged between 24 and 31°C. During the acclimatization period the guppies were fed on poultry feed and crumbs of bread.

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The wood tar and dieldrin of 20% in emulsifiable concentrate of hydrocarbon solvents (Shell Chemicals, Holland) were obtained from Building and Road Research Institute (CSIR), Kumasi.

Five milliliters of 20% dieldrin was dissolved in 1 L of 95% ethanol. Similarly 10 g of wood tar were dissolved in 100 mL of 95% ethanol. These two solutions were tightly stoppered and used as stock solutions. Various strengths of solutions were prepared from them by diluting measured volumes with filtered pond water for the tests. The filtered pond water had the following physical and chemical characteristics; temperature 24-31°C, alkalinity 23-27 mg as $CaCO_3$/L, acidity 15-21 mg/L, dissolved oxygen 6-7.6 mg/L, phosphate-phosphorus 0.0 mg/L, ammonium-nitrogen 0.0 mg/L, nitrate-nitrogen 0.31 mg/L, SiO_2 50.0 mg/L, Fe 0.0 mg/L, Ca^{++} 8-10.8 mg/L, Mg^{++} 5.6-7.8 mg/L, Na^{+} 3.2-3.4 mg/L. K^{+} 4.2-8.4 mg/L, pH 6.26-7.60, Cl^{-} 6-18.6 mg/L and conductivity of 120-161 μmhos/cm.

The test solutions were prepared freshly daily and put in 400 mL beakers in triplicate. The solution for the conrol experiment was made up of filtered pond water containing 0.1% of ethanol.

Into each test solution and control were placed ten guppies. Observations were made initially at 30 min intervals but later hourly. At each observation the number of guppies dead was recorded. The fresh weights and lengths of the dead guppies were taken. Those alive were transferred to fresh test solutions after 24 hr. The control solutions were similarly changed. The experiments were carried out for 48 and 96 hr respectively. At the end of the test period, all the living guppies were transferred into fresh filtered pond water and observed for 1 day and discarded. The guppies were not fed during the test periods. The percentage mortality was plotted against the concentrations on logarithmic probability paper and the LC50's calculated using the equation (Litchfield and Wilcoxon 1949):

$$S = \frac{LC84/LC50 + LC50/LC16}{2}$$

$$fLC50 = S^{2.77/N}$$

LC50 x fLC50 = upper limit

LC50/fLC50 = lower limit

N = number of fish, S = slope of the line.

A series of LC50's for various lengths of time up to 96 hr were obtained and used to plot Figure 1 (Toxicities of dieldrin and wood tar solubilized in ethanol to guppies) on a semilogarithmic graph paper.

RESULTS AND DISCUSSION

The fresh weights of the guppies used ranged from 0.01 to 0.36 g with a mean of 0.08 g. Their mean length was 2.2 cm and the range

was from 1.3 to 3.6 cm.

The 48-hr LC50 of the dieldrin solubilized in ethanol for the guppies was 0.34 mg/L. Within the 95% confidence limit the upper and lower limits were 0.344 and 0.335 mg/L. For the wood tar the 48-hr LC50 was 1400 mg/L and the upper and lower limits were 1473 and 1330 mg/L.

The 96-hr LC50 of the dieldrin for the guppies was 0.30 mg/L. Within the 95% confidence limits the upper and lower values were 0.32 and 0.28 mg/L. For the wood tar the 96-hr LC50 was 1200 mg/L

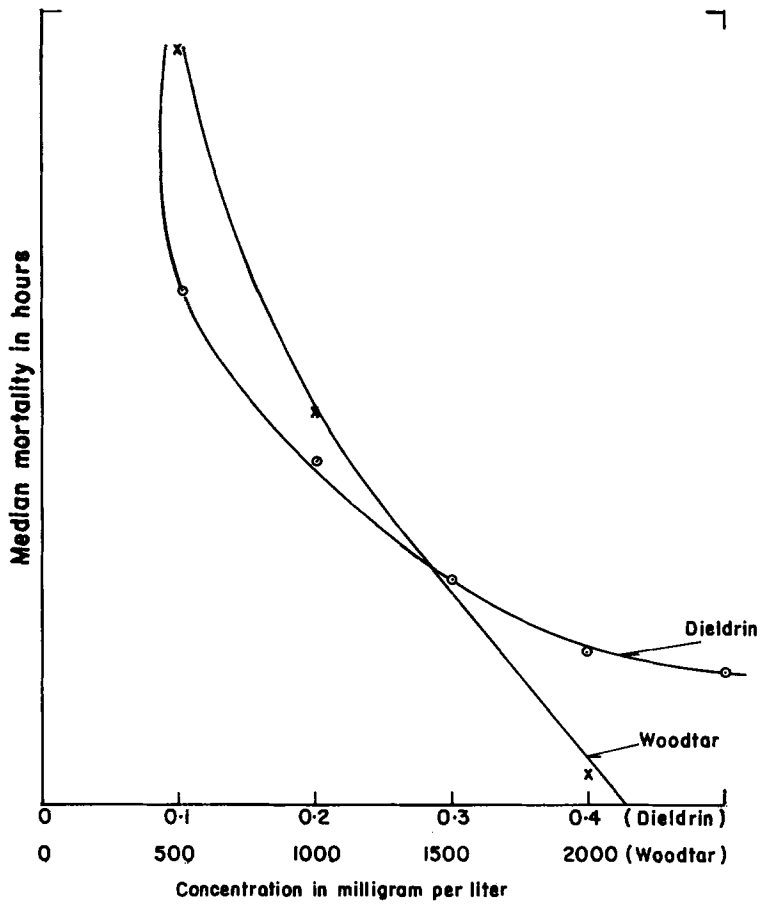

Figure 1. Toxicities of dieldrin and woodtar solubilized in ethanol to guppies

with upper and lower limits of 1234 and 1167 mg/L respectively for 95% confidence limit. From Figure 1, toxicities of dieldrin and wood tar solubilized in ethanol to guppies, the curve for dieldrin was asymptotic about the LC50's. The shape of the curve of the wood tar appeared to lack asymptote at 96 hr and suggests that probably the test would have to be continued much longer. Other-

wise the shape of the curve is probably suggesting that the wood tar is acutely toxic to the guppies even at concentrations weaker than lethal threshold. Further investigations into this is in progress.

The dieldrin was between three and four thousand times more toxic to the guppies than the wood tar. Since the wood tar is effective in preserving timber against termites, provided climatic conditions in the tropics will not affect its efficacy, it appears to be a good substitute for dieldrin, in the building industry. But before embarking on substitution of wood tar for dieldrin its persistence, degradability, biocumulative and other chronic characteristics such as effect on reproductive success and the avoidance reactions of various organisms to the wood tar have to be studied thoroughly. The dieldrin was 6 times more toxic to the guppies than temephos (Kpekata 1983) which was used in controlling Simulium damnosum in the Volta River Basin in some West African countries.

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REFERENCES

Brungs WA, Mount DI (1967) Lethal endrin concentration in the blood of gizzard shad. J Fish Res Bd Canada 24(2): 429-432

Kpekata AE (1983) Acute toxicity of 0,0'-(thiodi-4, 1-phenylene) bis (0,0-dimethyl phosphorothioate) (temephos) to Lebistes reticulatus and Sarotherodon galilaeus. Bull Environ Contam Toxicol 31: 120-124

Litchfield JTJr, Wilcoxon F (1949) A Simplified method of evaluating dose-effect experiments. J Pharm Exp Ther 96: 99-113

Mount DI, Putnicki GJ (1966) Summary of the 1963 Mississipi fish kills. Trans 31st N Am Wild Nat Resources Conf, March 14-16, 1966 177-184

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