Bull. Environ. Contam. Toxicol. (1984) 33:210–214

Environmental Contamination and Toxicology

Effects of Dyestuff Effluents on Nigeria Macro-Benthic Invertebrates *Hippopera nigeriae*

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Our techno-industrial society functions as a complex system that exploits and utilizes resources, provides employment, goods and services, and produces many complex, biologically reactive substances. Many of these substances are advantageous to our society. However, some may possess properties deemed disadvantageous to humans and biota when they are released in the ecosystems where bioaccumulation and biomagnification of these substances may occur.

The River Kaduna in Nigeria is highly polluted by dyestuff. The color in dye is due to the unsaturated C=C bond, and an increase in unsaturated bonding intensifies coloration. The acidic and basic radicals (NO_2, NO, azo NN, azoxy NNO, OH) deepen colour. The River Kaduna is blue green because of the dyestuff discharges. These discharges were highly alkaline with pH of 11.48, soapy to touch and when left to decay gave off choking smell of ammonia.

In this demonstration, the effect of dyestuff on the Nigerian earthworm Hippopera nigeriae is reported.

MATERIALS AND METHODS

A pair of ten adult worms, standard length 10 cm. and above were exposed in wide mouthed beakers of 1000 mL capacity. Pre-trial exposures with embroyonic worms demonstrated their unsuitability for the experiment hence the choice of adult worms. The embryonic worms died quickly without wriggling movements as soon as they were exposed to the dyestuffs. Each exposure was replicated twice with varying concentrations (100%, 90%, 80%, 60%, 50%, 30%, 10%, 5% and 0%) of dyestuff pollutants added to the beakers. The time of death was recorded, and microscopic examinations were made using Griffin optical dissecting microscope to ascertain the probably cause of death. Time graph of log time - mortality was constructed from the results of the exposures.

RESULTS AND DISCUSSION

The results of concentrations over time is shown below (Table 1).

TABLE 1. Nigerian earthworm (Hippopera nigeriae) mortality after exposure to dyestuff effluents.

Conc.	100%	90%	80%	60%
A				
Time of death (mins)	0 20 43 58	0 25 47 71	0 26 48 68	0 21 44 53
No. dead	0 6 8 10	0 4 9 10	0 2 9 10	0 1 9 10
B				
Time of death (mins)	0 25 45 50	0 27 50	0 26 48 68	0 21 45 63
No. dead	0 4 8 10	0 2 10	0 2 9 10	0 5 8 10

Conc.	50%	30%	10%	5%
A				
Time of death (mins)	0 23 41 63	0 111 146 251	0 256 1256	0 451 1256
No. dead	0 3 8 10	0 5 6 10	0 1 10	0 1 10
B				
Time of death (mins)	0 24 42 64	0 114 253 323	0 413 541	0 451 1256
No. dead	0 1 8 10	0 3 8 10	0 1 10	0 1 10

Conc.	0%
A	
Time of death (mins)	0 280 340 470 1270
No. dead	0 2 5 7 10
B	
Time of death (mins)	0 280 1270
No. dead	0 1 10

High concentrations of dyestuff effluents were highly toxic. In 100% concentration (A and B) all the worms died within 50 and 58 minutes of exposure, and at 90%, 71 and 50 minutes. Intermediate concentrations of 60% and 50% gave high mortality. Within 44 and 45 minutes 17 worms out of 20 died at 60% and at 50%, 16 out of 20 exposed died within 41 and 42 minutes. At the concentration of 10%, 2 worms out of 20 died within 251 and 413 minutes (Table 1) and at 5% concentration only 2 worms died within 451 minutes. The numbers of worms dying decreased with decreasing concentrations. It took 1256 minutes for all the worms to die at 10% concentration and at 100% concentration only 58 minutes were needed for all the worms to be dead.

Evidence showed that the immature worms below 5 cm. were very susceptible to rapid death, regardless of the exposure concentrations. The microscopic examinations showed that death was biphasic, namely, copious mucous secretion coupled with thinning of the body and anoxamia. The worms exposed to the dyestuff were in perpetual motion trying to wriggle out of the toxicants. As the epithelia became thinned the body volume decreased. It would appear that the body fluid of the worms were exposed to the dyestuff with anisotonic concentration because the worms became flaccid immediately after death. The copious mucous secretions appeared to be a defensive mechanism to increase the pollutant diffusion distance of the worms and to clean the worms of the pollution. With the over secretion of mucous, the body epithelium became thinned and death followed. All the worms exposed to the dyestuff disintegrated shortly after death when slightly touched, apparently due to the thinned epithelia.

The log-time percentage mortality gave the following results. For 100% pollutant a straight line graph was obtained. This showed that toxicity was linear regardless of exposure time. The dyestuffs were very toxic to the benthic invertebrates. The copious secretion of mucous by the mucous membranes could not reduce toxicity. For the 90% and 80% toxicity was linear and later deviation occurred. These concentrations appear to give similar toxicity with time. Equally, 60% and 50% gave similar linearity. But for the low concentrations, 50% and 60%, it would appear that toxicity was a function of many variables. Differences in exposure time, worm resistance, concentrations and anoxamia affected toxicity. At 30%, 10% and 5% toxicity was a function of only two variables as seen from the two deviations of the graphs. Here, death appeared to be a function of exposure to the toxicant (true toxicity) and another deviation from the first linearity as death due to anoxamia. Death came slowly due to the mild toxic effect of the pollutant and more probably to anoxamia since in 0%, the control, all the worms died with time.

Both the micro-organisms and macro invertebrates, especially earth worms, play active roles in the enrichment of the soil. The worms not only aerate the soil by their numerous burrowings but also enrich it by releasing minerals to the soil by their grinding

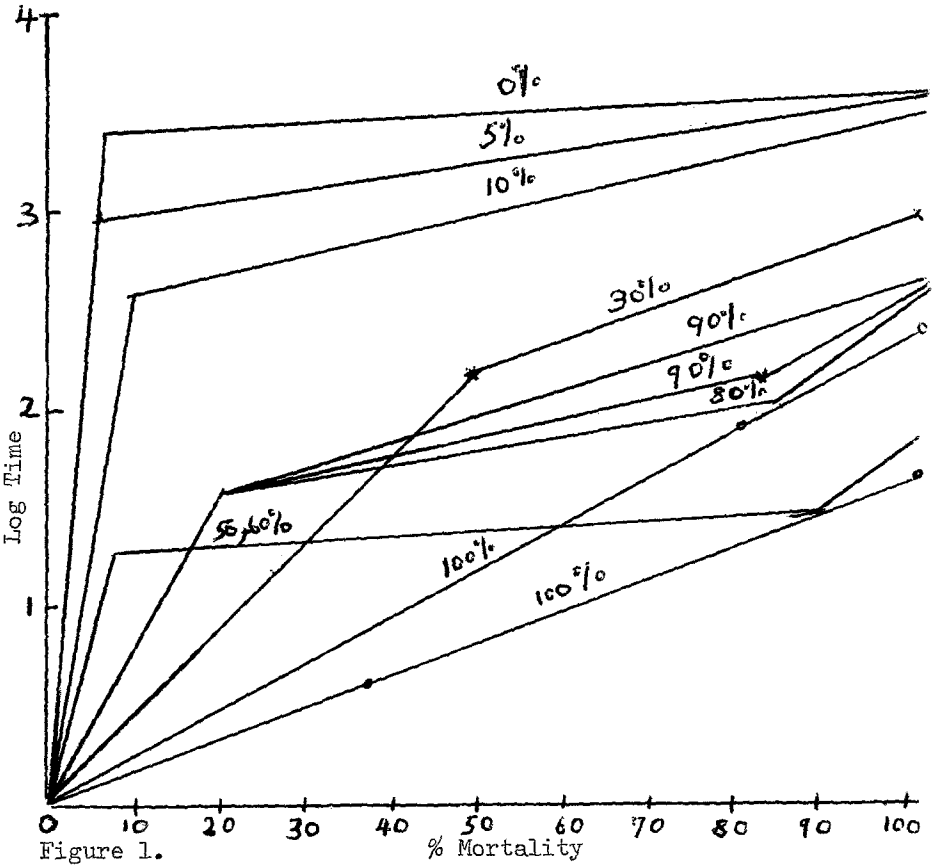

Figure 1.

Log-Time Percentage Mortality of Hippopera nigeriae after exposure to dyestuff effluents.

action of organic matter. The acidity of the soil is reduced by their release of calcium compounds. The soils deep in the ground are brought to the surface and it has been calculated that millions of tons of surface soils owe their existence to the activities of earthworms. In this preliminary investigation, dyestuff effluents were very toxic to the earthworms, more especially the embryonic ones.

Effluent discharges and some pollutants act on the gills of fishes and death occurs as a result of chemical and physical injuries rather than by true toxicity. Mucous precipitation and anoxamia through respiratory and circulatory failures result in death, (Ellis 1937; Carpenter 1927; Jones 1938). Epithelial gill lamellae effect the tolerance of fish to heavy metal poisoning and the presence of calcium and magnesium modify ions entry and toxicity (Jones 1938; Wendelaar-Bonga et al. 1983). The study of Katz (1977) on the physiology of aquatic organisms to the lethality of toxicants, showed that efflux of sodium from the gills is responsible for alteration in membrane permeability barriers. Efflux of sodium and influx of water disrupts the gill by a difference in osmotic pressure. A deficiency in osmoregul-

ation, caused by efflux of sodium leads to gill damage but not skin epithelia after various degrees of toxicosis by the pollutants.

On the other hand, the toxicosis of dyestuff effluents to Hippopera nigeriae might not be due to the efflux of sodium and influx of water. If water influx had occurred the earthworms would have swollen instead of being flaccid. The osmoregulatory properties of the epithelia were destroyed as a result of thinning and this destruction might lead to leaching out of the metabolites resulting to flaccidity of the body. In the low concentrations, death was biphasic as a result of toxicosis and anoxamia. Whether the blood diffusion distance between the worms and the pollutant reduced the toxic effect is left for further experimentation. But the thinning of epithelia might be due to the corrosive nature of the dyestuff. The rapid disintegration of the worms after death might be as a result of osmoregulatory dysfunction. There are no stringent limits on water pollution in Nigeria. No reliance is placed on waste treatment technology to reduce the release of toxic substances into aquatic environment.

ACKNOWLEDGEMENTS. Thanks go to the technicians of the Department of Biological Sciences, Federal University of Technology, Bauchi, for the time mortality recordings.

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Received November 28, 1983; accepted December 30, 1983