Bull. Environ. Contam. Toxicol. (1994) 52:286–291

Environmental Contamination and Toxicology

Short-Term Effects of Carbosulfan on Drifting Invertebrates in the Black Volta, Ghana

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Received: 10 July 1992/Accepted: 15 July 1993

Since 1974 temephos (0,0,0',0'-tetramethyl 0,0' - thiodi-p-phenylene bis (phosphorothioate) has been the main insecticide of choice used against *Simulium damnosum* larvae in the Onchocerciasis Control Programme (OCP) in the Volta Basin area. Screening of new insecticides became necessary when in 1980 resistance to temephos (Guillet et al. 1980) and then to Chlorphoxim (Kurtak et al. 1982) was reported in one of the forest subspecies of the *S. damnosum* complex. Other insecticides that have been tested and used in the OCP are *Bacillus thuringiensis* serotype H-14 (i.e., B.t. H-14) a biological control agent, Talcord permethrin and carbosulfan. Hydrobiological monitoring on rivers to determine the effects of these insecticides on the non-target fauna is in progress in the OCP.

Weekly treatment of the Black Volta with carbosulfan commenced on October 3, 1986. Carbosulfan (2,3-dihydro-2, 2-dimethyl-7-benzo-furanyl [(dibutylamino) thio] methyl carbamate) or Marshal is a carbamate and like the organophosphate insecticides it is a cholinesterase inhibitor (FMC Corporation 1983). It is a relatively new insecticide in Ghana for which limited information on its effect on river fauna is available. This paper reports on short-term effects of carbosulfan on drifting invertebrates during one of the weekly treatments on the Black Volta.

MATERIALS AND METHODS

The study was undertaken on the Black Volta (Figure 1). Drifting invertebrates were collected with a set of standard drift nets used in the OCP Invertebrate Monitoring Programme (Lévêque et al. 1977). Each drift net was made of a square metal frame 25 cm wide, fitted to a 1.5 m long nylon net (pore size 200 μm). Commencing at 1500 hr on October 9, 1986, a complement of three 15-min drift samples were collected at hourly intervals for 53

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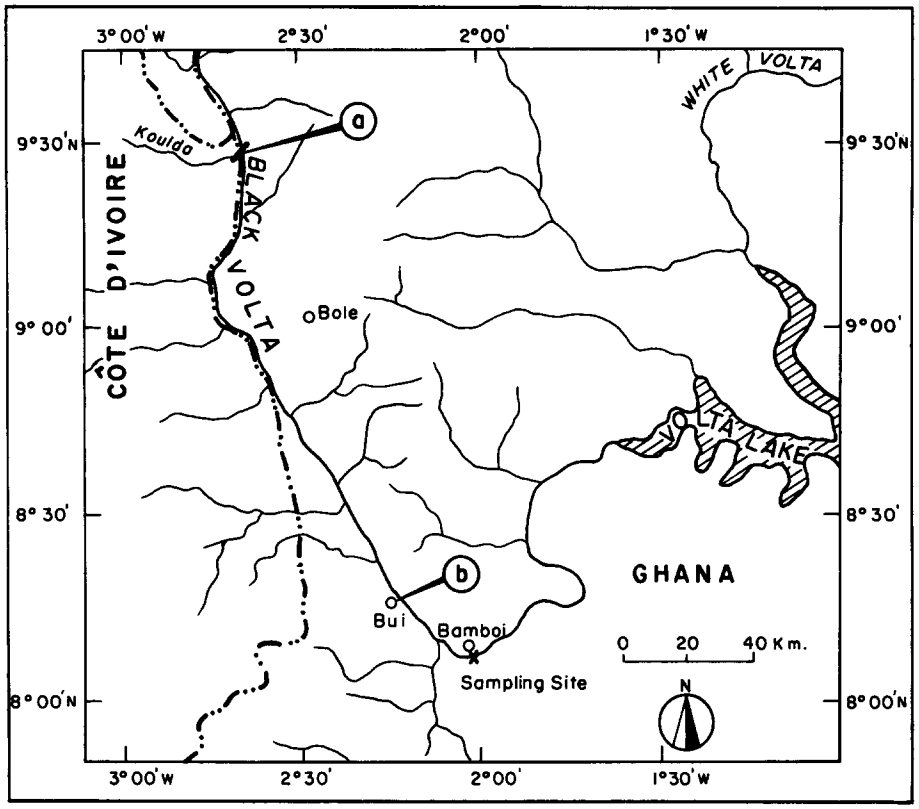

Figure 1. Carbosulfan treatment area (between a and b) and sampling site (x) on the Black Volta, Ghana.

hr.

Carbosulfan was applied to the river at weekly intervals for 11 weeks. The volume of the insecticide applied depended on the river discharge. At about 1400 hr on October 10, 79 L of carbosulfan was applied upstream of the sampling site using a helicopter. The treatment, which ended at about 50 km upstream of the sampling site, covered about 300 km along the river course from Koulda to Bui (Figure 1).

The expected effective concentration of the insecticide flowing along the treated part of the river was 0.05 mg/L for 10 min.

The drift samples collected were preserved in 4% formalin. The invertebrates in each sample were sorted out and counted. The number of invertebrates per cubic meter of water (drift index) was calculated by dividing the volume of water that passed through the net during the 10 min by the number of invertebrates that were sampled. The ratio of drift index of the post-treatment set of samples

compared with pre-treatment samples was used to estimate the effect of the insecticide.

RESULTS AND DISCUSSION

The drift indices of invertebrates collected from the Black Volta during the study are presented in Table 1. The pre-treatment data showed that Chironomini, Tanypodiinae, Elmidae, Copepoda and Coelenterata were the predominant groups. Groups that were also collected in large numbers were the Baetidae, Caenidae, Leptophlebiidae, Simuliidae, Hydropsychidae, Odonata and Hydracarina.

Table 1. Invertebrate drift indices (numbers of invertebrates per cubic meter of water) and ratio comparing drift before and after treatment with carbosulfan on the Black Volta.

Taxon	Pre-Treatment drift index	Post Treatment drift index	Ratio
Ephemeroptera			
Baetidae	0.046	0.148	3.22
Caenidae	0.014	0.095	6.79
Leptophlebiidae	0.020	0.136	6.80
Heptageniidae	0.002	0.052	26.0
Diptera			
Chironomini	0.115	0.278	2.42
Tanypodiinae	0.290	0.300	1.04
Simuliidae	0.015	0.076	5.07
Orthocladiinae	0.010	0.028	2.80
Ceratopogonidae	0.004	0.012	3.00
Coleoptera			
Elmidae	0.133	0.244	1.84
Dytiscidae	0.007	0.004	0.57
Copepoda	0.407	0.192	0.47
Ostracoda	0.011	0.006	0.55
Tricoptera			
Hydropsychidae	0.028	0.181	6.46
Leptoceridae	0.008	0.019	2.38
Other Tricoptera	0.007	0.014	2.00
Coelenterata	0.280	0.102	0.36
Odonata	0.016	0.065	4.06
Hydracarina	0.014	0.064	4.57
Oligochaeta	0.004	0.008	2.00
Other invertebrates	0.017	0.090	5.29
Total	1.448	2.114	1.46

Sunrise and sunset were at about 0600 hr and 1800 hr, respectively. The majority of the invertebrates showed the natural drift pattern of increased drift in the night between sunset and sunrise (Figure 2).

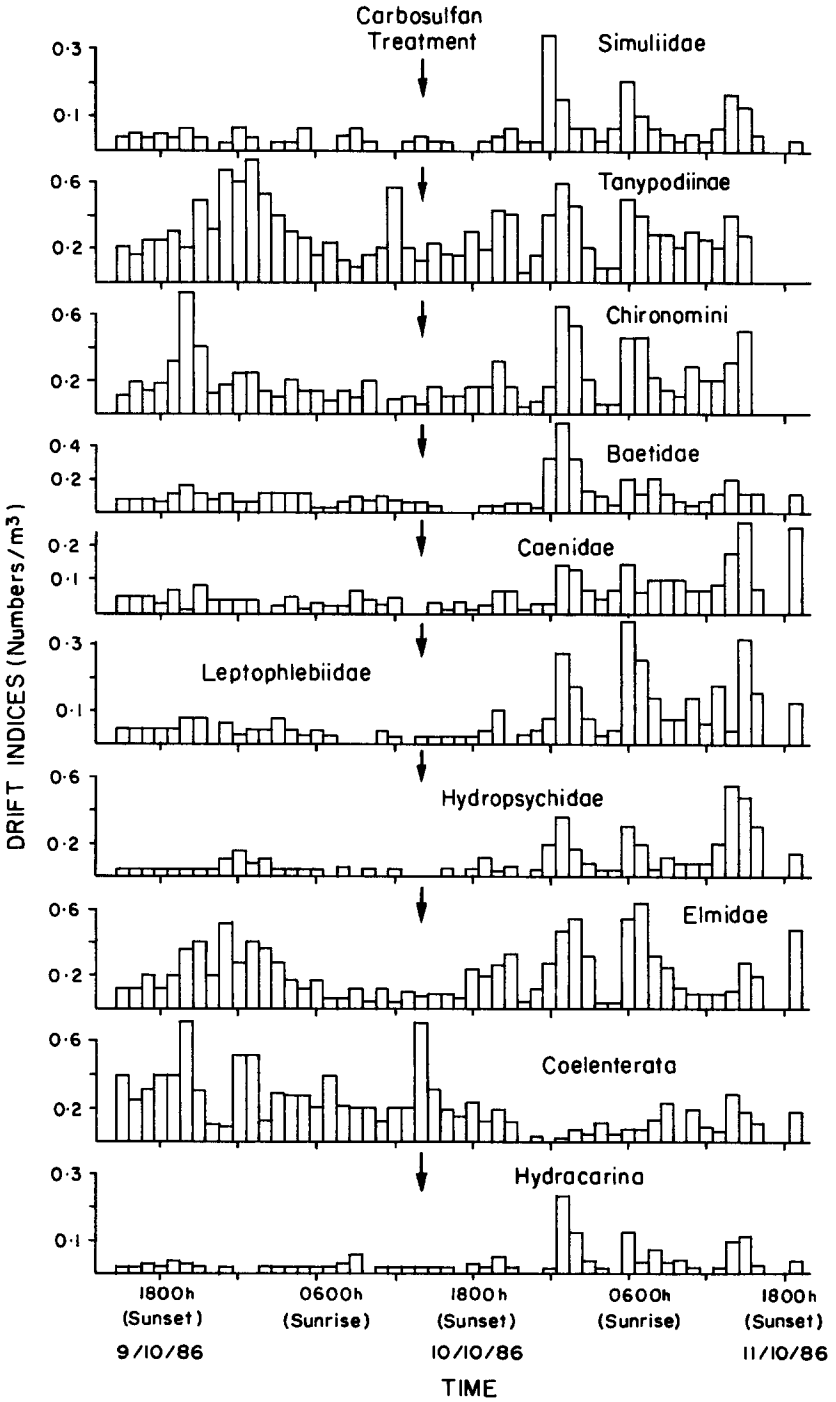

Figure 2. Drift indices of some invertebrates collected from the Black Volta at hourly intervals for 53 hours (before and after carbosulfan treatment)

The effect of the carbosulfan treatment indicated by increased drift indices was first observed at 0000 hr on October 11, although the treatment was done at about 1400 hr on October 10, i.e., 10 hr earlier (Figure 2). The time lapse between the treatment and the time of the first observation reflected the transport or movement of the treated water downstream.

A comparison of the pre-treatment and the post-treatment data shows that the insecticide caused a five-fold increase in the drift of the Simuliidae in the river (Figure 2 and Table 1). The treatment also affected the majority of the recorded non-target invertebrates. Among the predominant groups, Caenidae, Leptophlebiidae and Hydropsychidae were affected most. About 6.0 ratio of increased drift occurred in each of these taxa. The highest ratio of 26.0 was recorded among the Heptageniidae. This group was, however, rare in the river. In similar studies on short-term effects undertaken on the river Wawa in Togo and White Bandama in Côte d'Ivoire, Yaméogo and Coulibaly (1986) and Yaméogo et al. (1986) also observed that carbosulfan treatment caused an increase in the drift of invertebrates. While Ephemeroptera and Tricoptera were quite severely affected, the Chironomidae appeared to be least susceptible to the insecticide. The present investigation on the Black Volta confirms the observations of Yaméogo et al.

Earlier, a study on the short-term effect of Talcord permethrin (a synthetic pyrethroid) on the drift of invertebrates had been undertaken on the Black Volta under similar hydrological, sampling and treatment conditions (*Samman J and Asobayire M W unpublished*). In that study, permethrin was applied at 0.015 mg/L for 10 min as compared with 0.05 mg/L carbosulfan applied for 10 min in the present study. A comparison of the overall increases in drift caused by the two insecticides shows that permethrin was more toxic than carbosulfan. Permethrin increased the drift by five-fold while carbosulfan caused only two-fold increase in the drift. Also, Hydracarina was more susceptible to permethrin while carbosulfan was more toxic to the Tricoptera and Odonata. Both insecticides were, however, highly toxic to the Ephemeroptera.

A few of the invertebrate groups (Tanypodiinae, Dytiscidae, Copepoda, Ostracoda and Coelenterata) appeared to be insensitive to carbosulfan at the applied concentration. The post-treatment data rather showed decreases in the drift of some of these groups (Table 1).

Acknolwedgments. This study was undertaken with financial and material support from the OCP of the WHO

and from the Institute of Aquatic Biology. We are grateful to Dr. M. A. Odei, the Director of the Institute for his useful suggestions and to Messrs S. Niampomah, M.I. Attu and S. Nortey for their assistance in the field work.

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