ACUTE TOXICITIES OF INSECTICIDES TO MARINE DECAPOD CRUSTACEANS

BY

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INTRODUCTION

Fish and invertebrates that frequent coastal areas are especially vulnerable to chemical insecticides because of the tendency of these compounds to diffuse in drainage systems and to concentrate in estuaries (Butler, 1966). Several studies on the effects of insecticides on marine organisms demonstrate that concentrations which are not sufficient to control many species of pestiferous insects, including several species of salt-marsh mosquitos, nevertheless can kill eggs and larvae of bivalve molluscs (Davis, 1961), kill or immobilize fishes (Westman & Compton, 1960; Butler, 1964), decrease the productivity of phytoplankton populations (Butler & Springer, 1963), and alter the tissue chemistry of clams (Eisler & Weinstein, 1967) and fishes (Eisler & Edmunds, 1966; Eisler, 1967).

This account is part of a continuing program to evaluate the impact of pesticides on marine and estuarine fauna. It reports on the concentrations of seven organochloride and five organophosphorous insecticides that kill 50 percent of three species of decapod crustaceans during a 96-hour period (LC-50, 96 h) and on the influence of temperature and salinity of the medium on pesticide-induced mortality patterns.

METHODS

Acute toxicity. — Reference standard insecticides, procured from the Entomological Society of America (Dawsey, 1964), were p, p'-DDT, endrin, aldrin, lindane, heptachlor, methoxychlor, dieldrin, malathion, methyl parathion, Phosphorin(R), and Delnav(R). A sample of DDVP was supplied by the manufacturer (Shell Chemical Co., 110 W. 51st St., N.Y.C., New York). Physical, chemical, and pharmacological properties of these compounds except Delnav(R) and Phos-

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drin(R), are presented in detail by Negherbon (1959). Similar data for Delnav(R) and Phosdrin(R) are available from the producers (Delnav(R): Hercules Powder Co., Wilmington, Delaware; Phosdrin(R): Shell Chemical Co.).

All studies were conducted at 20 ± 0.5°C under subdued artificial light. The test medium was seawater having a salinity of 240/00 and pH 8.0 pumped from an underground well (Clark & Eisler, 1964). Assay aquaria were 20-liter glass jars filled with 19 liters of test medium. Each jar was covered with a glass disc perforated with a single hole six mm in diameter. Aeration was supplied via three mm glass tubing. The dissolved oxygen content was measured periodically and ranged between 7.1 and 7.7 mg/l.

Crustaceans assayed were the grass shrimp Palaemonetes vulgaris (Say), sand shrimp Crangon septemspinosa Say, and a hermit crab Pagurus longicarpus Say. Mean length between eye and uropod, and total body wet weight of grass shrimp was 31 mm and 0.47 g; sand shrimp averaged 26 mm and 0.25 g. Hermit crabs were housed in a variety of molluscan shells, but only those from adult mud snails, Nassa obsoleta (Stimpson), were selected. Mean carapace length and total body weight of hermit crabs was 3.5 mm and 0.28 g. There was little variation in size for any of the three species of decapods; within a single species, all measurements were within eight percent of the mean. Grass shrimp, hermit crabs, and sand shrimp are common residents of Sandy Hook Bay, New Jersey, and were collected from there with a beach seine during the summer of 1964. All were held for 10 to 14 days in large (ca. 1000 liters) aquaria filled with aerated saline well water. Values for the pH (8.0), salinity (240/00) and temperature (20°C) of the test medium approximated those of seawater from the capture locale. During the acclimatization period crustaceans fed actively on chopped quahaug clams, Mercenaria mercenaria (L.).

Using serial dilution techniques, each assay jar received one ml of an acetone-insecticide solution to achieve desired concentrations; control jars received one ml of acetone. Forty-five minutes after the insecticide solutions were added, the test species were introduced into the aerated assay jars. Each species was tested separately. The total biomass per jar was 2.24 g for hermit crab (n = 8), 4.70 g for grass shrimp (n = 10), and 1.68 to 2.40 g for sand shrimp (n = 7 to 10). Results of pilot bioassays with grass shrimp indicate no loss in toxicity of any compound tested after 45 minutes in aerated seawater; also, as much as 10 ml of acetone per jar did not adversely affect shrimp during a 144-hour observation period. The procedure recommended by the American Public Health Association (1960) for evaluation of acute toxicity of wastes to fish followed.

Effect of salinity. — Test conditions, except for salinity, were identical to those described in the preceding section. Salinities in jars were adjusted to 12, 18, 30, and 360/00 by the addition of either pure sodium chloride or distilled water to stock seawater of 240/00 salinity.

Experimental animals were grass shrimp, a euryhaline species which locally are daily subjected to variations of 120/00 salinity. Groups of 75 shrimp were