numbers were more on carapace than on abdominal segments (Figs. 1 and 2).

FIG. 1. Intestation or Balanus, *Amphitrite amphitrite* (Darwin) on the carapace of *Penaeus monodon* Fabricius.

FIG. 2. Infestation of Balanus, *Amphitrite amphitrite* (Darwin) on the abdominal segements of *Penaeus monodon* Fabricius.

The cage was stocked with prawns during September, 1977. After the monsoon rains, during the last week of December, the prawns were observed with 10 to 15 days old barnacles, which might have been released by the parents already settled in the cage. This observation confirms the view of Nair[6], who reported heavy settlement of barnacles after rain during November and December. Karandae[5] observed that low temperature during November–December favoured the breeding, releasing of the larval forms in large numbers, and their subsequent settlement on suitable substratum. Overstreet[4] reported that the prawns cultured in cages for more than three months might become sluggish during post-monsoon period and give scope for the barnacle settlement. He was also of the opinion that during ecdysis, brown prawns use a muddy sandy substratum for feeding, and deprivation of this type of bottom in the cage apparently caused prawn to moult infrequently and subsequently accumulate considerable epizoic growth on it.

In the present observation high stocking density, lack of food, prolonged rearing period (September to December) and absence of suitable substratum resulted in the irregularity in ecdysis among caged prawns, which created favourable conditions for the settlement of barnacles. Low temperature during post monsoon period also favoured large scale breeding of barnacles and their settlement. Even though the possibility of permanent establishment of barnacles seems to be remote due to frequent moulting nature of prawns, if it occurs in larger sized prawns, it may create economic problems to the prawn farmers.

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EFFECT OF LOW CONCENTRATIONS OF DDT ON THE GROWTH AND PRODUCTION OF MARINE DIATOM *SKELETONEMA COSTATUM* (GREV)

THE problem of pesticide toxcity in marine and estuarine habitats, has assumed greater importance in recent years as increasingly large amounts of pesticides are entering these environs through run off. Hence there is need for more information on the toxicity of pesticides to phytoplankton[1–4]. DDT has been shown to affect phytoplankton[1]. Even at very low concentrations, DDT was found to reduce photosynthesis and cell multiplication in diatoms[1–2]. Considering the persistence and ubiquitous distribution of DDT, its toxicity to the diatom *Skeletonema costatum* (Grev.) is investigated. The present report deals with the DDT toxicosis on the growth rate and productivity of this species of marine algae.

S. costatum, a small marine diatom[5], was isolated from water samples, of Vellar estuary and cultured in enriched sea water medium of Guillard f/2. The salinity of the medium was 30 and the cultures

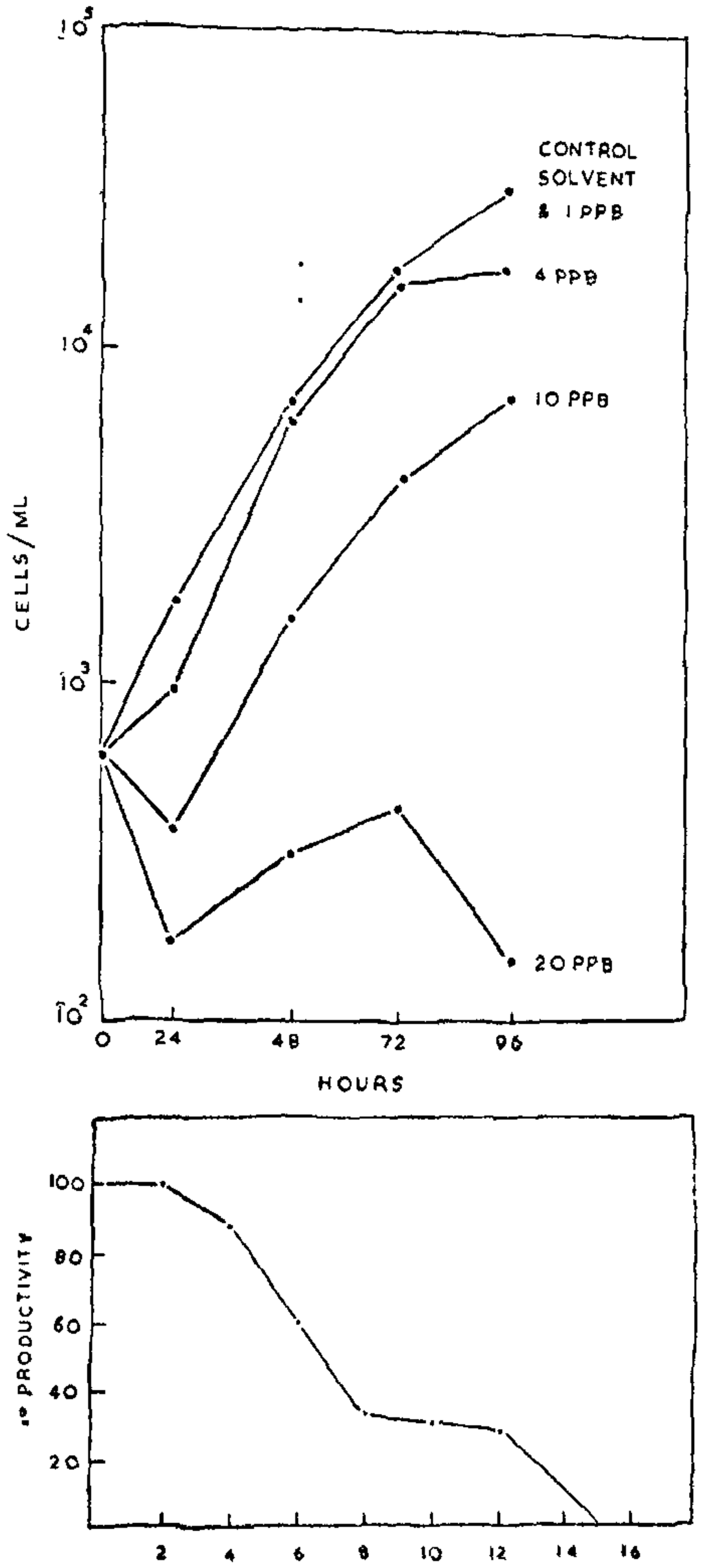
were axenic. The culture medium (100 ml) was taken in 250 ml conical flasks and was inoculated with 1 ml of stock culture. The concentration of the inoculum was on an average of $8{\cdot}1 \times 10^4$ cells/ml. The cultures were grown at a light intensity of 10,000 lux, at room tempedature (26° ± 1° C). PP'-DDT(*M/s. Hindustan Insecticide Ltd., Delhi*) was dissolved in acetone and added to the culture medium in concentrations of 1, 4, 10 and 20 ppb. Concentrations of 50 and 100 ppb resulted in the precipitation of the media and hence the results were not dependable. Aliquots of samples were taken at intervals of 24 hrs and the growth was terminated by adding Lugol's iodine solution. Counting was carried out in Utermohl's inverted microscope. Primary production was estimated at a light intensity of 15,000 lux (day light) for 12 hrs using the light and dark bottle technique[6].

The growth and multiplication of cells were identical in control, cultures that received 0·1 ml of the solvent alone and those to which 1 ppb DDT was added (Fig. 1). The average number of cells per chain was 20. Above 4 ppb, a marked reduction in cell number took place. Concentrations above 10 ppb DDT impaired the growth rates. At 20 ppb, the growth curve declined below the initial concentration in the beginning with a slight increase at 48 and 72 hrs.

Productivity was *not* affected up to 2 ppb DDT concentration (Fig. 2). Primary production started to decline above 2 ppb DDT and was completely inhibited at 15 ppb. With reference to growth, however, considerable number of cells were present even at 20 ppb concentration. Inhibition of growth and productivity was proportional to the concentration of the pesticide (Figs 1–2). The response of the diatom to the pesticide is revealed in two phases. The first phase is almost the sublethal phase in which the diatom exhibited increased growth, which was however lower than the control. In the second phase that is at higher concentrations cell division decreased rapidly and the number of the cells decreased. Partially bleached cells with broken cell walls were noted at DDT concentrations above 20 ppb. Even at 20 ppb concentration, these abnormal cells were alive for three days but on the 4th day showed signs of distintegration.

Billiet[7] reported that the nannoplanktonic flagellate *Platymonas tetrathele* cultured with crude oil emulsifiers, lost their shapes. Similar effects were noticed in the present work. The cells exposed to concentrations greater than 20 ppb lost their shape. It can be seen from Fig. 1, that higher the concentration of DDT, the lower the cell number.

It is a general ecological rule that any reduction in growth rate of a species under the minimum requirements offered, will lead to the extinction of the species.



FIGS. 1–2. Fig. 1. Reduction of cell numbers in the diatom *S. costatum* cultures at different concentrations of DDT and at different intervals of time, Fig. 2. Reduction in production rates in diatom *S. costatum* at different concentrations of DDT.

In phynoplankton, high growth rate can balance the grazing by zooplankton. Hence it can be inferred that pestidide pollutants shift the production/con-

sumption balance in the ecosystem. Further it is suggested that *S. costatum* may be taken as an indicator species in poullution monitoring studies.

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DDT IMPACT ON ASPARTATE AND ALANINE AMINO TRANSFERASE ACTIVITY LEVELS IN THE LIVER OF FROG, *RANA HEXADACTYLA*

Introduction

THE organochlorine insecticide (DDT) was known to be a neurotoxicant affecting peripheral sensory organs and nervous system[1], by inhibiting the acetylcholinesterase activity[2]. It also inhibits the microsomal ATP phosphorylases[3], and Mg^{++}, Na^{+}, and K^{+} dependent ATPases as well as actomyosin ATPases of nerves and muscles[4–6]. DDT also causes the depletion of carbohydrate reserves, the loss of body weight and a general increase in blood amino nitrogen content[7,8]. The depletion of carbohydrate reserves and increase in blood amino nitrogen content indicate the possible involvement of transferases. In the present investigation an attempt has been made to study the *in vitro* effects of DDT on the enzymatic systems involved in the amino acid metabolism of liver of frog, so as to assess the specific role of this insecticide on transamination reaction systems.

Materials and Methods

The liver of frog, *Rana hexadactyla* was excised after pithing the animal and 10% (W/V) homogenate was prepared in 0·25 M sucrose solution at 5° C. The extract was centrifuged at 2,500 rpm for 15 minutes to remove cell debris and the supernatant was used for the assays of aspartate and alanine aminotransferase activities. The activities were estimated by the method of Reitman and Frankel[9] as given by Bergmeyer[10]. The activities were expressed as μ moles of sodium pyruvate formed/mg protein/hr.

The free amino acid levels were estimated by the method of Moore and Stein as given by Colowick and Kaplan[11]. Sucrose soluble and insoluble proteins were estimated by the method of Lowry *et al*[12] with folin phenol reagent.

Experimental tubes received 0·01 to 0·1 ml containing 2 to 20 μM of DDT in addition to the contents of reaction mixture, whereas control tubes received distilled water in the place of DDT (as per the method described by Desai *et al.*[13]).

Results and Discussion

The results obtained with control and experimental (preincubated with DDT) homogenate preparations from frog liver indicated that the protein content showed a continuous increment as the concentration of DDT increased from 2 to 20 μM (Table I). Similar increase in protein levels was observed by Cappan and Nicholls[14], and it is also suggested that DDT and polychlorinated biphenyls cause the induction of drug-metabolizing enzymes in liver and cause marked changes in the protein synthetic machinary[15,16]. The preincubation of liver homogenates with DDT resulted in changes not only in the total protein level but also in the soluble and structural fractions. The variation in the levels of sucrose soluble protein is presumed to indicate the variation in the general solubility of denaturation of protein which could correspondingly reflect in the structural protein level. To varify this aspect the ratios of soluble/structural proteins were determined and a decrease in the ratio showed a lesser solubility, greater denaturation while an increase in the ratio showed an elevation in the solubility and lesser denaturation. When compared to the control, the experimental homogenates, in general showed increased soluble/structural ratio with increase in DDT concentration in the incubation mixture showing an elevatory tendency of proteins to solubilize. Thus the DDT pre-incubation alters the denaturation patterns in addition to proteolysis.

The preincubation with DDT showed a general drop in the level of FAA with the increase in the concentration of DDT (Table I). Hence it is presumed that the free amino acids might have been mobilized for the synthesis of proteins. Earlier *in vivo* and *in vitro* studies have shown that the increased synthesis of microsomal protein after the addition of DDT depends on an increased incorporation of amino acids into microsomal proteins[17–20] and the present investigation adds credence to the above statement. Since FAA content was found to decrease in the experimental tissue homogenates, it was felt desirable to study the possible involvement of aminotransferase reacting systems in the mobilization of free amino acids.