evaporated off to obtain IV (1.4 g) as thick oil. I.R.(Neat): 1725, 1700, 970 cm^{-1} (Found: C, 63.50; H, 8.20. $C_9H_{14}O_3$ requires C, 63.52; H, 8.23%).

9-Hydroxy-Δ^2-decenoic acid (V)[12]

The above compound (IV, 2.5 g) in dry ether (10 ml) was condensed with CH_3MgI. The resultant product (V) obtained as liquid (2 g) was purified through a column of neutral alumina in ether. I.R.(Neat): 3250, 1700, 970 cm^{-1}. (Found: C, 64.42; H, 9.63. $C_{10}H_{18}O_3$ requires C, 64.51; H, 9.70%).

9-oxo-Δ^2-decenoic acid (IV)

The above carbinol (2 g) in a mixture of dry acetone (15 ml) and benzene (20 ml) was heated at 80° for 8 hr with a solution of aluminium tert. butoxide (3.4 g in dry benzene). It was then cooled and treated with 10% H_2SO_4 (10 ml). On workup with benzene, VI was obtained as solid (1.2 g) and was cyrstallised from methanol m.p. 53–55° (lit[7]. 53–54°). The purity of the compound was tested by TLC. I.R.(KBr): 1725, 1700, 970 cm^{-1}. Its 2,4 DNP derivative has m.p. 126–128° (lit[7]. 127–128°) (Found: N, 15.34. Calcd. for $C_{16}H_{20}N_4O_6$: N, 15.40%).

The authors express their grateful thanks to Dr. T. P. S. Teotia, Director, Dr. B. B. Khanna, Head, Chemistry Division and Prof. J. N. Chatterjee, Head, Department of Chemistry, Patna University for their interest.

11 September 1982; Revised 16 November 1982

1. Wigglesworth, V. B., *The principles of insect physiology*, ELBS and Chapman and Hall, London, 1972, 609.
2. Kennedy, J., McCorkindale, N. J. and Raphael, R. A., *J. Chem. Soc.*, 1961, **3**, 3813.
3. Sisido, K., Kawanisi, M., Kondo, K., Morimoto, T., Saito, A. and Hukue, N., *J. Org. Chem.*, 1962, **27**, 4073.
4. Barbier, M. and Lederer, L., *Compt. rend*, 1960, **251**, 1135.
5. Eitler, K., *Ann.*, 1962, **658**, 91.
6. Jaeger, R. H. and Robinson, R., *Tetrahedron*, 1961, **14**, 320.
7. Vig, O. P., Vig, A. K., Grewal, M. S. and Gupta, K. C., *J. Indian Chem. Soc.*, 1975, **52**, 543.
8. Tsuji, J., Masaoka, K. and Takhasi, T., *Tetrahedron Lett.*, 1977, 2267.
9. Subramaniam, C. S., Thomas, P. J., Mamdapur, V. R. and Chadha, M. S., *Indian J. Chem.*, 1978, **16B**, 318.
10. Dzhemilev, U. M., Balezina, G. G. and Tolstikov, G. A., *Chem. Abstr.*, 1980, **93**, 185693 q.
11. Reuter, James M. and Solomon, Robert G., *J. Org. Chem.*, 1978, **43**, 4247.
12. Butler, C. G., Callow, R. K. and Chapman, J. R., *Nature.*, 1964, **201**, 733.

RESPONSE OF CYANOBACTERIAL NITROGEN FIXATION TO INSECTICIDES

B. D. KAUSHIK AND G. S. VENKATARAMAN
Division of Microbiology, Indian Agricultural Research Institute, New Delhi 110 012, India.

AGROCHEMICALS such as herbicides, fungicides and insecticides are either stimulatory or inhibitory or neutral to cyanobacterial growth and nitrogen fixation[1]. A greater understanding of the impact of a wide range of these chemicals is necessary to appreciate their environmental bearing on the ecology of these organisms, particularly under improved soil and crop management svstems.

The present communication deals with the effect of BHC (γ-1,2,3,4,5,6-hexachlorocyclohexane), Carbofuran (2,3-dihydro 2,2-dimethyl-7-benzofuranyl methyl carbamate) and Phorate (O,O-diethyl-S-ethyl thiomethyl diphosphate) on the chlorophyll *a* synthesis and nitrogen fixation in five cyanobacterial forms, two of which belonging to *Hapalosiphon* (*H. fontinalis* ARM 363, *H. welwitschii* var. *vaginatus* ARM 364), two to *Westiellopsis* (*W. prolifica* ARM 365 and ARM 366) and one to *Calothrix* (*C. braunii* ARM 367). The recommended field doses of these insecticides are 1.5 ppm for BHC, 0.5 ppm for carbofuran and 1 ppm for phorate.

The algae, originally isolated from saline-alkali soils[2] were grown in nitrogen free Fogg's medium[3], supplemented with A_5 solution[4]. The cultures were incubated at 30° C under 2000 lux. The nitrogenase (N-ase) activity was measured in terms of acetylene reduction[5,6] using a Nucon Model GLC 5500 with a Porapak R column. Acetylene, equal to 10% of the total volume was injected and the vials were incubated for 90 min at 30° C under 2000 lux. The reaction was terminated by injecting 0.1 ml TCA (50%) and the gas phase was analysed for ethylene.

For examining the effects of insecticides, 2 ml of algal suspension from an exponentially growing culture were inoculated into 100 ml flasks containing 25 ml Fogg's nitrogen free medium. The pesticides were added to give a final concentration of 1, 10 and 100 ppm. Chlorophyll *a* (Chl *a*) synthesis was measured spectrophotometrically at the end of 14 days' growth in terms of the absorption of methanol (90%) extract.

TABLE 1

Total chlorophyll a (mg/25 ml culture)

Insecticides (ppm)	*H. welwitschii* var. *Vaginatus* ARM 364	*H. fontinalis* ARM 363	*W. prolifica* ARM 365	*W. prolifica* ARM 366	*C. braunii* ARM 367
Control	0.074	0.095	0.069	0.153	0.631
BHC					
1	0.075	0.090	0.064	0.165	0.461
10	0.072	0.105	0.076	0.178	0.331
100	0.052	0 065	0.047	0.259	0.104
Carbofuran					
1	0.088	0.094	0.069	0.299	0.530
10	0.080	0.093	0.065	0.177	0.552
100	0.030	0.096	0.034	0.118	0.109
Phorate					
1	0.073	0.090	0.064	0.161	0.438
10	0.071	0.082	0.059	0.181	0.323
100	0.027	0.059	0.052	0.104	0.077

(Values average of triplicates.)

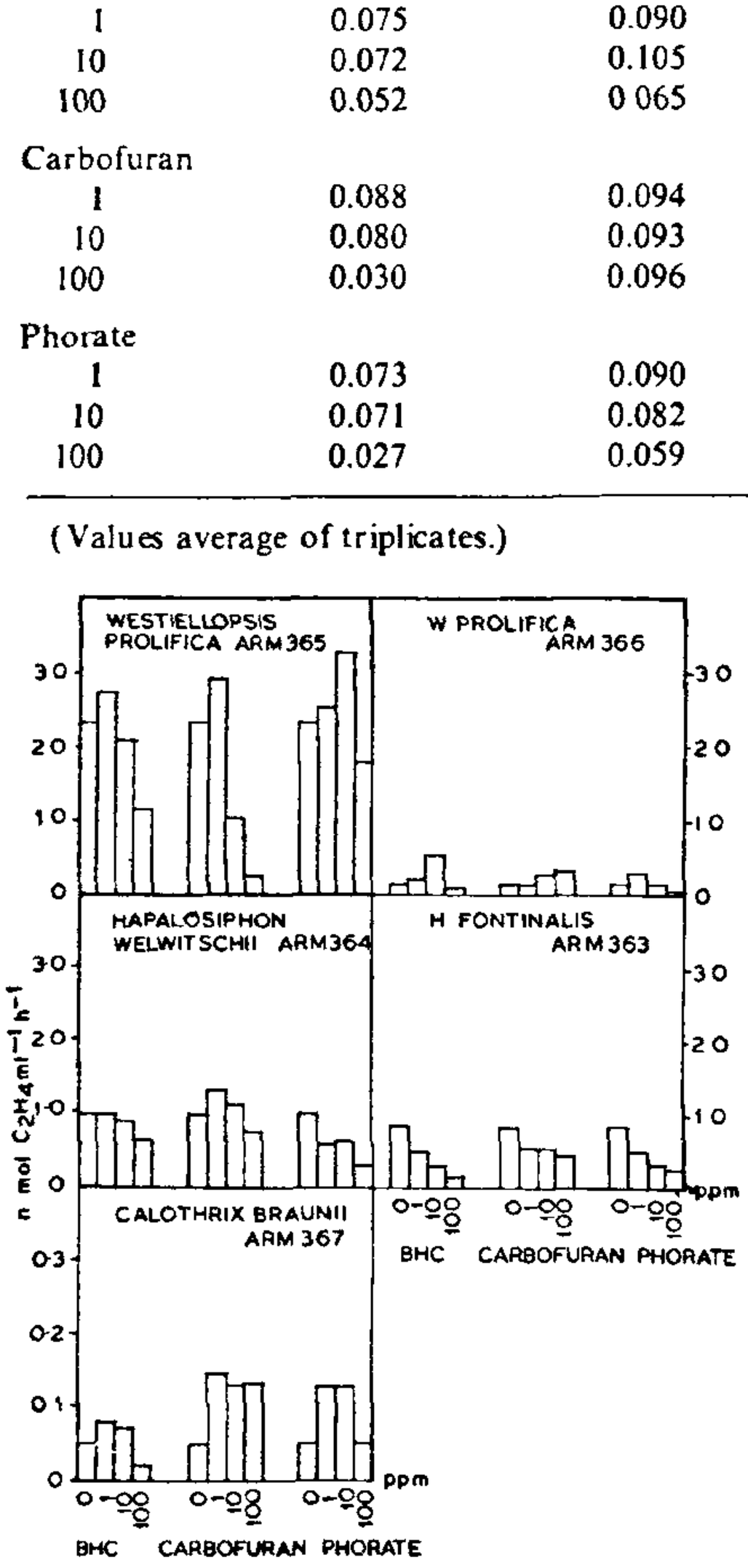

Table 1 and figure 1 summarize the Chl *a* content and Nase activity respectively. BHC, carbofuran and phorate showed no adverse effect on Chl *a* synthesis in *H. welwitschii* var. *vaginatus* upto a concentration level of 10 ppm, although at 100 ppm level they were inhibitory. However, in *H. fontinalis* BHC at 10 ppm, Carbofuran upto 100 ppm and phorate upto 10 ppm had no adverse effect. The two strains of *W. prolifica* ARM 365 and ARM 366 showed differential responses to the three insecticides in terms of Chl *a* synthesis. While 10 ppm of BHC and carbofuran showed no adverse effect, 100 ppm had an inhibitory effect. However, increasing concentration of phorate above the level of 1 ppm was inhibitory. On the other hand an appreciable increase in Chl *a* content was observed in ARM 366 upto 100 ppm of BHC, 10 ppm of Carbofuran and Phorate. Chl *a* synthesis in *C. braunii* ARM 367 was adversely effected with increase in concentrations of all the three insecticides.

The influence of insecticides on Nase activity showed wide variation. While 1 ppm of BHC did not affect the Nase activity in *H. welwitschii* var. *vaginatus*, about 40% inhibition was observed with phorate this concentration level. On the other hand Carbofuran up to 10 ppm exhibited marked stimulation on nitrogen fixation. About 50% reduction in the Nase activity was observed in *H. fontinalis* even at 1 ppm level of all the three insecticides. In *W. prolifica* ARM 365, a pronounced enhancement in the Nase was observed at 1 ppm of BHC and carbofuran and upto 10 ppm of phorate. At 100 ppm level the Nase activity was reduced by 25% with phorate, 50% with BHC and 87% with carbofuran (figure 1). The Nase activity of

ARM 366 also showed a stimulation upto 10 ppm of BHC and 1 ppm of phorate. Higher concentrations of these two insecticides had an inhibitory effect. Unlike ARM 365, ARM 366 showed increased Nase activity in presence of carbofuran even upto 100 ppm. A similar response to carbofuran was observed in *C. braunii* ARM 367 also.

The present investigation shows that (i) insecticides such as BHC, carbofuran and phorate affect differently the pigment synthesis and Nase activity, (ii) they are either stimulatory or inhibitory or had no effect depending upon the type and concentrations used, (iii) different genera respond differently and there is an inter and intra-specific strain variation and (iv) recommended field doses of these insecticides do not generally affect the biological activity of these organisms.

16 September 1982; Revised 29 November 1982

1. Metting, B., *Bot. Rev.*, 1981, **47**, 195.
2. Subhashini, D. and Kaushik, B. D., *Aust. J. Soil Res.*, 1981, **19**, 361.
3. Fogg, G. E., *Ann. Bot.*, 1949, **13**, 241.
4. Arnon, D. I., *Am. J. Bot.*, 1938, **25**, 322.
5. Stewart, W. D. P., Fitzgerald, G. P. and Burris, R. H., *Proc. Natl. Acad. Sci. USA*, 1967, **58**, 2071.
6. Stewart, W. D. P., Mague, T., Fitzgerald, G. P. and Burris, R. H., *New Phytol.*, 1971, **70**, 497.
7. Mckiney, G., *J. Biol. Chem.*, 1941, **140**, 315

ANNOUNCEMENTS

FIFTH REGIONAL CONGRESS ON GEOLOGY, MINERAL AND ENERGY RESOURCES OF SOUTHEAST ASIA (GEOSEA V)

The fifth Regional Congress on Geology, Mineral and Energy Resources of Southeast Asia will be held at Kuala Lumpur, Malaysia, during April 1984.

Original papers on the following topics are invited: General Geology, Regional Geology, Sedimentology, Palaeontology Stratigraphy, Mineralogy/Petrology, Tectonics/Structural Geology, Economic Geology, Marine Geology, Engineering Geology, Petroleum Geology/Energy Resources, Geochemistry/Applied Geochemistry, Geophysics/Applied Geophysics, Environmental Geology, Geohydrology, Quaternary Geology, Geomorphology, Geochronology and others. *Abstracts of papers intended* for presentation at the Congress must be submitted to the Organizing Secretary as soon as possible, preferably before November 1983, for consideration of acceptance for presentation. Papers presented at the Congress will be considered for publication by the Society's Editorial Board in a special volume after the Congress. Papers are to be in English.

Further information may be had from: The Organizing Secretary, GEOSEA V, Geological Society of Malaysia, c/o Department of Geology University of Malaya, Kuala Lumpur, MALAYSIA.

HERPETOLOGISTS' LEAGUE AND THE SOCIETY FOR THE STUDY OF AMPHIBIANS AND REPTILES

A joint meeting of the Herpetologists' League and The Society for the Study of Amphibians and Reptiles. Universities of Utah, Salt Lake City, Utah, 7-12 August 1983. *For further information please write to* Prof. John M. Legler, Meeting Chairman, Department of Biology, University of Utah, Salt Lake City, UT 84112, U.S.A.

FELLOWSHIP OF THE ROYAL SOCIETY, LONDON

Dr. S. Chandrasekhar of the Raman Research Institute, Bangalore (India), has been elected a Fellow of the Royal Society of London in recognition of his outstanding contributions to the physics of liquid crystals.