uronic acid. The purification of hemicellulases demonstrated to be present will be attempted when the hemicellulose components of the cell walls have been analysed structurally.

The fact that a single enzyme can be used to produce protoplasts from certain plants is encouraging in the search for a rigorously defined "protoplast-hybridization" methodology. The production of specific inducible lytic enzymes may also help in attaining this objective. We have observed regeneration of cell walls on protoplasts using commercial enzymes as others have^{11,15,16}, but conclusive evidence of complete cell regeneration must await the demonstration of both nuclear and cellular division.

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- ¹ Nickell, L. G., and Torrey, J. G., *Science*, **166**, 1068 (1969).
- ² Schenck, R. U., and Hildebrandt, A. C., *Crop Sci.*, **9**, 629 (1969).
- ³ Takebe, I., Otsuki, Y., and Aoki, S., *Plant Cell Physiol.*, **9**, 115 (1968).
- ⁴ Ruesink, A. W., and Thimann, K. V., *Proc. US Nat. Acad. Sci.*, **54**, 56 (1965).
- ⁵ Gamborg, O. L., and Eveleigh, D. E., *Canad. J. Biochem.*, **46**, 417 (1969).
- ⁶ Albersheim, P., in *Methods in Enzymology* (edit. by Neufeld, E. F., and Ginsburg, V.), **8**, 623 (Academic Press, New York, 1966).
- ⁷ Phaff, H. J., in *Methods in Enzymology* (edit. by Neufeld, E. F., and Ginsburg, V.), **8**, 636 (Academic Press, New York, 1966).
- ⁸ Norkrans, B., *Adv. Appl. Microbiol.*, **9**, 91 (1967).
- ⁹ Power, J. B., and Cocking, E. C., *Biochem. J.*, **111**, 33p (1969).
- ¹⁰ Smith, I., *Chromatographic and Electrophoretic Techniques*, **1**, 250 (Heinemann, London, 1960).
- ¹¹ Eriksson, T., and Jonasson, K., *Planta*, **89**, 85 (1969).
- ¹² Slettsma, J. H., Eveleigh, D. E., and Haskins, R. H., *Antonie van Leeuwenhoek*, **34**, 331 (1968).
- ¹³ Bateman, D. F., *Neth. J. Plant. Pathol.*, **74**, 67 (1968).
- ¹⁴ Karr, A., and Albersheim, P., *Eleventh Intern. Bot. Cong.*, 108 (1969).
- ¹⁵ Mishra, A. K., and Colvin, J. R., *Protoplasma*, **67**, 295 (1969).
- ¹⁶ Pojnar, E., Willson, J. H. M., and Cocking, E. C., *Protoplasma*, **64**, 460 (1967).

Biological Control of *Pistia stratiotes* L. in Western State, Nigeria

Pistia stratiotes L. is a free-floating water-weed, common on many waters in West Africa. It is capable of rapid vegetative reproduction by offshoots, and concern has been expressed over a possible infestation of the lake behind the newly closed Kainji dam on the River Niger in Nigeria where the plant is now accumulating. Our discovery of the cause of a die-back of this plant which occurs annually on enclosed and permanent waters in the Ibadan area of Western State, Nigeria, offers some hope, however, that the plant could be controlled biologically on Kainji Lake.

Systematic field observations from October 1967 to January 1969, coupled with results from experiments on the growth pattern of the plant, showed that the die-back in the Ibadan area was associated with a virus infection which reached epidemic proportions during the wet season. The sequence of events observed during this period is believed to be typical of the annual die-back.

Infected plants were rare during the dry season (November–March) and the beginning of the wet season. The infection started spreading rapidly during May, some time after the beginning of the rains, and continued until mid-July by which time no symptomless plants could be

found on any of the waters of the Ibadan area. By September most of the infected plants had died, although some were still alive. During October, at the end of the rains, a few symptomless plants reappeared and were responsible for the build-up of the dry season populations.

Infected plants were readily identifiable in the field by the deep yellowing and brittle nature of their lowermost leaves and by their less vigorous growth. The infection seems to have been spread by the widely distributed aphid, *Rhopalosiphum nymphaeae* L., which occurred on *Pistia* in small numbers during the dry season but greatly increased in numbers during the wet season when the winged forms were also dispersing. Transmission of the disease by this insect has been demonstrated experimentally in the greenhouse.

The seasonal differences in the spread and effects of the disease were attributable to the population changes of the aphid coinciding with changes in climatic conditions and, perhaps more important, with changes in the nutrient status of the water. When the aphid population was enlarging and dispersing during the early rains, growing conditions for the plant were less favourable because of the cool, overcast conditions and the dilution of the nutrients in the water by the frequent heavy rains, and plants began to show signs of mineral deficiency. In these conditions spread of the infection was rapid and the weakened plants succumbed readily to the disease. During the dry season, when the aphid population was much reduced and relatively sedentary, growing conditions were better with less overcast skies and the nutrient status of the water reached its highest levels. Changes in these conditions have been shown experimentally to affect survival and growth rates of infected plants.

The symptomless winter populations are believed to have been derived from infected plants rather than seed. There is evidence that the spread of the virus to the offshoots is relatively slow and, in the better growing conditions of the dry season, the rate of vegetative propagation outstrips infection; but here we do not yet know enough.

A somewhat similar cyclical die-back of *Salvinia auriculata* Aublet, associated with a saprophytic *Alternaria* sp. and a parasitic *Spicariopsis* sp., has been described from Lake Kariba¹. In this case circumstantial evidence suggested that the degeneration was chiefly caused by physiological-ecological factors which predisposed the plants to fungal infection.

The infection of *Pistia* does not bring complete control, only a dramatic cut-back of the population during the unfavourable conditions of the wet season. Observations suggest that the infection may be widespread in Western State, Nigeria, and, although we do not know whether it occurs elsewhere, conditions seem favourable for its existence throughout much of the forest region of West Africa. It may have caused the partial disappearance of *Pistia* from the Volta Lake in Ghana, after an initial build-up when the dam was closed; in time, it may also affect the accumulation of *Pistia* behind the newly closed Kainji dam. The climate of the Kainji area, however, is drier than that of Ibadan, and the wet season is shorter, so that the infection may consequently be less effective. If no infection appears at Kainji it would, of course, be advisable to introduce infected plants into the population to see whether some measure of control would result.

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¹ Loveless, A. R., *Ann. Appl. Biol.*, **63**, 61 (1969).