lower pillows. The interspaces between the two pillows beyond the glassy margins are occupied by greenish chloritic material.

2. On the southern bank of the Pench river, just near the Chhindwara-Narsinghpur road bridge, 2 km SE of Singori (22°12′:79°03′30″) at 620 m MSL several irregular-shaped, roughly ellipsoidal pillow-like bodies ranging from less than a meter to 2.2 m in diam. are found. Some pillows exhibit radial cracks, otherwise concentric ring-like structures formed by comparatively medium to fine-grained minerals near the centre and glassy/pitch stone-like material near the peripheral zone. Each pillow exhibits chilled margins of shining glass/pitchstone-like material ranging from 5 to 15 cm in thickness. Gradual reduction in glass content towards central part is observed in some pillows. The basal part of each pillow is moulded over the irregular top of the lower pillows and the interspaces between these bodies are occupied by secondary silica and Zeolites.

Similar pillow lava occurrences are also recorded by the present authors near Chargaon (22°07′05″:78°58′) and Anjaniya (22°05′30″:79°00′) and in other parts of Chhindwara district.

The pillow horizon of Chhindwara area was also seen to be overlain by the medium-grained tholeiitic basalt enriched with secondary glass and opaques suggesting grading of spilitic lava to tholeiitic type. Based on available evidence, it is likely that such structures were also forced under subaqueous condition. Considering the distribution of the pillow lava in Chhindwara area along with its petrographic study, it appears that this area was also in close proximity to the sea and (or) was connected by arm of sea from the west.

4 May 1987; Revised 23 November 1987

IMMOBILIZATION OF CELL WALL DEGRADING ENZYMES BY ISOLATED HOST AND NON-HOST CELL WALLS

G. S. PRASAD*, A. R. PODILE and H. C. DUBE

Department of Life Sciences, Bhavnagar University, Bhavnagar 364 002, India.
**Department of Botany, Osmania University, Hyderabad 500 007, India.*

PLANT cell walls have high capacity to bind proteins including polygalacturonase, produced by plants and fungi[1-3]. Cooper *et al*[4] reported binding of pectic enzymes (endo-polygalacturonase and endo-pectin lyase) of plant pathogens by isolated host as well as non-host cell walls. Studies on binding of enzymes by plant cell walls have been limited only to endo-type of pectic enzymes. In the present study we have examined the ability of isolated host (pigeon pea) and non-host (tomato) cell walls to bind and inactivate exo-pectic enzymes [exo-pectin lyase (exo-PL) and exo-pectic acid lyase (exo-PAL)] and endo-xylanase of *Fusarium oxysporum* f.sp. *udum*, causing wilt of pigeon pea.

Enzyme samples, prepared from fungal cultures grown on Czapek medium containing host cell walls (pigeon pea) were examined for their activity on predetermined optimum incubation period (6th day for pectic enzymes and 12th day for xylanase). The enzyme was assayed by methods described earlier[5,6]. The hydrolytic or *trans*-eliminative cleavage of the pectic substances was identified spectrophotometrically by thiobarbituric acid (TBA) test of Neukom[7], as modified by Sherwood[8]. A colour reaction between an acid reagent solution of TBA and product of enzyme substrate reaction, gives characteristic absorption peaks for the hydrolytic and *trans*-eliminative split. A peak at 510 nm suggests the presence of a galacturonase enzyme while a peak at 547 or 550 nm indicates lyase activity. Release of reducing sugars from pectic substances suggests *exo*-enzymes activity. The enzyme that releases reducing groups from pectin is called exo-PL while exo-PAL releases reducing groups from pectic acid (sodium polypectate). The results of enzyme assays are expressed as (μmol of substrate hydrolysed/min/ml).

Cell walls were isolated from the host (pigeon pea) and non-host (tomato) plants by the method described earlier[4]. The isolated cell walls (not containing any ionically bound proteins) were hydrated by soaking them in distilled water for 5 min. Fifty mg of hydrated cell walls was added to 5 ml of enzyme samples and removed after 1 h by centrifugation. Supernatant was used for enzyme assays. The control set lacked the cell walls. Enzyme activities of the 'control' and the supernatant were compared to determine loss in activity, if any, due to the presence of cell walls. The release of bound enzymes from cell walls was achieved by adding 5 ml of 0.2 M NaCl to the centrifuged cell wall samples. The centrifuged supernatant was used to assay the enzyme activities (desorbed from cell walls on addition of NaCl). The enzyme remaining in the supernatant after removing the cell walls plus the

Table 1 *Binding of some cell wall degrading enzymes of Fusarium oxysporum f.sp. udum by isolated host- and non-host cell walls*

Enzyme	(Control cell walls) Enzyme activity*	Cell walls	In presence of cell walls: Enzyme activity	% activity*	% inhibition	After desorption with 0.2 M NaCl: Enzyme activity	% activity of the original	% activity recovered
Exo-PL	27.7	Host	12.3	44.5	(55.5)	11.3	40.8	85.3
		Non-host	13.6	49.1	(50.9)	10.7	38.3	87.4
Exo-PAL	12.6	Host	7.3	58 0	(42.0)	3.2	25.4	83.4
		Non-host	8.4	66.7	(33.3)	2.7	21.5	88.2
Endo-xylanase	78.1	Host	54.6	70.0	(30.0)	19.3	24.8	94.8
		Non-host	53.7	68.8	(31.2)	17.3	22.2	91.0

*Enzyme activities are expressed in $IU \times 10^2$ ml^{-1}.

amount of enzyme desorbed from cell walls by adding 0.2 M NaCl, gave the per cent recovery of the enzyme.

The results (table 1) indicate that all the test enzymes were bound by host-, as well as non-host cell walls to some extent. The binding of enzymes ranged from 30 to 55.5%. Exo-PL was bound maximally by both host and non-host cell walls (by over 50%). Exo-PAL was inactivated by 42% and 33% by host and non-host cell walls respectively. Endo-xylanase was inactivated by about 30% and 31.2% by both types of cell walls.

The enzyme activity lost due to binding after incubation with cell walls and the activity of enzymes desorbed from cell walls by 0.2 M NaCl (table 1) indicate that enzymes adsorbed by cell walls were not completely recovered. In the case of pectic enzymes the recovery varied from 85.3% to 88.2%; the maximum activity was recovered for endo-xylanase (90%).

The present results suggest that enzyme binding by cell walls is not limited to endo-PG only. The exo-pectic enzymes and endo-xylanase were equally amenable to binding by cell walls. No consistent difference was noted in binding of any enzymes on incubation with host-, or non-host cell walls. The release of bound enzymes by desorption with NaCl was not total (i.e. not 100%), which could be due to the irrevocable immobilization of enzymes by cell walls, or the high binding affinity of the cell walls. It could also be a function of the porosity of cell walls and molecular size of the enzymes as suggested by Knee *et al*[9].

The authors thank UGC, New Delhi for financial assistance.

24 July 1987; Revised 20 January 1988

1. Albersheim, P. and Anderson, A. J., *Proc. Nat. Acad. Sci. USA*, 1971, **68**, 1815.
2. Byrde, R. J. W. and Archer, S. A., In: *Cell wall biochemistry related to specificity in host-pathogen interactions*, (eds) S. Soheim and J. Raa, Universitets Forlaget, Oslo, 1976, p. 163.
3. Skare, N. H., Paus, F. and Raa, J., *Physiol. Plant.*, 1975, **33**, 229.
4. Cooper, R. M., Wardman, P. A. and Skelton, J. E. M., *Physiol. Plant Pathol.*, 1981, **18**, 239.
5. Gour, H. N. and Dube, H. C., *Proc. Indian Nat. Sci. Acad.*, 1975, **41**, 480.
6. Prasad, G. S., Prabakaran, K. and Dube, H. C., *Curr. Sci.*, 1987, **56**, 830.
7. Neukom, H., *Chimia (Arau)*, 1960, **14**, 165.
8. Sherwood, R. T., *Phytopathology*, 1966, **56**, 279.
9. Knee, M., *Phytochemistry*, 1978, **17**, 1257.

SOMATIC INSTABILITY IN THE POPULATIONS OF *CYPERUS CYPEROIDES* (L.) O. KUNTZE (CYPERACEAE)

D. H. TEJAVATHI
Department of Botany, Bangalore University, Bangalore 560 056, India.

CYPERUS CYPEROIDES is one of the polymorphic sedges widely distributed adapting to different geo-