cytological controls in autotetraploid varieties. It also indicates that polyploid material is hampered not only by chromosomal instability but also by changes at the genome level connected with unexpected genic changes.

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Production of Pectic Enzymes by *Phytophthora infestans*

PECTIC enzymes have been shown to be produced *in vitro* by many plant pathogenic fungi, and evidence has been presented which suggests that they may play a part in the mechanisms of infection of the host plant[1]. Most work has been concerned with relatively non-specialized facultative parasites. Little is known about obligate parasites, for which the only record is of polygalacturonase production by germinating uredospores of *Puccinia graminis tritici*[2], and the difficulty of obtaining uredospore suspensions in axenic culture makes this work somewhat suspect. *Phytophthora infestans* shares certain features in common with obligate parasites, showing a high degree of host specificity[3], has much more exacting nutritional requirements *in vitro* than most facultative parasites[4,5], and forms haustoria[6]. The processes of germination *in vitro* appear similar to that of many obligate parasites, as zoospores readily germinate on a wide range of natural and synthetic media but do not readily continue growth to form actively growing colonies[7]. Thus the following observations on the ability of *Phytophthora infestans* to produce pectic enzymes may be of some interest.

An isolate of race 4 was grown in a range of natural and synthetic media. The basal medium contained in g/l.: potassium dihydrogen phosphate, 0·5; $MgSO_4.7H_2O$, 0·25; asparagine, 1·0; yeast extract, 5·0; thiamine, 0·001, and additions were made as shown in Table 1. The *p*H was adjusted to 5·5 before autoclaving. After 14 days' growth, the culture filtrates were tested for pectin methyl esterase (PME), exo- and endo-polymethylgalacturonase, exo- and endo-polygalacturonase[8,9], and tissue macerating activity using potato tuber disks[10]. The results are given in Table 1. A further seven isolates (two of race 4, one of race 1 and four of unknown race type) were grown in medium *F* and the culture filtrates tested for PME and macerating activity as before, and for polygalacturonase activity by the cup-plate technique[11]. Again PME was the only enzyme activity detected.

Table 1. PECTIC ENZYMES PRODUCED BY AN ISOLATE OF RACE 4

Medium	Pectic enzymes: PME	Pectic enzymes: Polygalacturonase complex	Pectic enzymes: Macerating activity
A 'Birds Eye' french beans	+	−	−
B Potato stems	+	−	−
C Potato tubers	+	−	−
Synthetic media (basal medium with additions as shown in g/l.)			
D Glucose 25 g	+	−	−
E Apple pectin 10 g	+	−	−
F Glucose 25 g + apple pectin 10 g	+	−	−

+, Enzyme activity demonstrated. −, No enzyme activity demonstrated.

The failure to detect polygalacturonase activity of any kind conflicts with the results of Grossmann[12], but it is possible that these are inducible enzymes only produced under conditions which were not provided in these experiments. The absence of macerating activity was not unexpected as the host's tissue is not macerated *in vivo*. Tissue disks infiltrated with culture filtrates did not go brown, and were not killed because the cells could still be plasmolysed and deplasmolysed, and so the toxicity usually associated with macerating activity was also not present[13,14]. The only enzyme activity which could be demonstrated in any filtrate was PME. This was produced in media both with and without pectin, and so behaved as a constitutive enzyme. This would suggest that it may also be produced *in vivo* and play some part in the mechanisms of infection.

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Mechanism of Fluid Exudation from Isolated Maize Roots

IT is commonly believed that salts are secreted into the xylem vessels of isolated roots by some mechanism involving metabolic energy and that the concomitant water movement is driven by the osmotic pressure gradient between xylem sap and the external medium. In particular, House and Findlay[1] have found quantitative support for this process in maize roots. These workers considered that the exudation from the basal ends of isolated roots was described by:

$$J_w = L_p RT[C_s^x - C_s^0] + \varphi w^0 \qquad (1)$$

where J_w (cm³ exuded per cm² of root surface area per sec) is the fluid exudation rate, $L_p RT(C_s^x - C_s^0)$ is the net osmotic water flux from the external medium into the root and φw^0 is net water flux independent of any osmotic gradient. This latter water flow might possibly be analogous to that found in many animal epithelial preparations bathed in identical salines. In equation (1), L_p (cm/sec atm.) is the osmotic permeability or, more correctly, the hydraulic conductivity of the roots to transverse water flow, R the gas constant, T the absolute temperature, C_s^x (mole/cm³) the osmolarity of salt (for example, potassium chloride) in the exudate and C_s^0 the osmolarity of salt in the external medium. The observed difference in salt concentration ($C_s^x - C_s^0$) is likely to depend not only on the net salt flux into some compartment, like the xylem, but also on the rate of water entry into this region.

Several investigators[2-4] have proposed essentially similar descriptions of water flow to equation (1), but apparently there has been no quantitative support for this relation under steady-state conditions apart from our investigations[1]. The purpose of the experiments reported here was to test equation (1) by examining the relationship between J_w and L_p for isolated maize roots.

Grains of maize (*Zea mays*, white horse tooth) were soaked and germinated as previously described[1]. Primary roots were excised from 4- or 5-day-old seedlings which had been pretreated with a solution, π_1, containing 0·1 mM calcium chloride and 1 mM/l. potassium chloride, for 24 h before the experiment. The basal end of each root