remains to be determined whether this reduction results from a removal of nutrients from the incubation medium by the replacement technique or from an accelerated leakage of spore material induced by this technique.

Since cogermination of *P. funerea* with the 3 fungi mentioned above does not reduce the carbohydrate or amino acid content of the bathing solution (table 3), the reduction of the germination rate in *P. funerea* could possibly be due to the presence of germination inhibitors. Observations of a similar nature are summarized in the review paper by Allen[15]. pH changes do not seem to be of significance as the pH stays within the range of 6.5–7.5 which completely overlaps with the optimal range for germination.

Mycelial extract (ME) of *Papulospora* sp. stimulated spore germinating and germ tube extension of *P. funerea* significantly. This was perhaps due to the presence of some growth promoting substances in ME; a similar effect was observed previously by us[6,7], in studies of induced growth and colonization of *P. funerea* in metabolites of *Papulospora* sp. *Nigrospora sphaerica* and *Epicoccum* nigrum were found to stimulate spore germination and germ tube extension to some extent, possibly by increasing the nutrient level in the external fluid (table 1) containing the spore mixture.

These findings suggest that nonparasitic phylloplane fungi may antagonize foliar pathogens by creating nutrient shortage or producing inhibitory substances on leaf surfaces in an ecological niche. It should be remembered, however, that these experiments apply to an in vitro situation and may not necessarily hold true in vivo.

Table 3. Effect of spore exudates of different phylloplane fungi on the spore germination and germ tube extension of *P. funerea*

Name of fungi	Percent spore germination (g) and germ tube extension (gt, µm) at different intervals of time (h)							
	6		12		24			
	g	gt	g	gt	g ± SD		gt ± SD	
Water control	30	90	80	210	85	0.8	280	10.8
Alternaria alternata	23	40	35	80	46	3.7	120	5.4
Aspergillus flavus	10	10	15	20	18	2.9	33	1.4
Aureobasidium pullulans	20	46	65	110	70	2.6	160	5.1
Cladosporium cladosporioides	20	65	68	115	90	2.1	200	3.2
C. herbarum	25	80	75	180	100	0.0	260	5.3
Curvularia lunata	20	30	35	38	40	2.9	43	2.6
Epicoccum nigrum	35	60	56	115	90	1.7	300	4.8
Fusarium oxysporum	0	0	26	10	30	2.3	23	2.1
Nigrospora sphaerica	25	40	60	160	90	2.0	296	7.7
Papulospora sp. (ME)	60	120	100	280	100	0.0	–	
Penicillium oxalicum	0	0	20	10	28	1.6	20	2.1
Phoma hibernica	0	0	33	30	45	1.5	58	3.6

ME, Mycelial extract.

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Electrical impedance of daminozide- and calcium-treated McIntosh apples

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Summary. Daminozide [butanedioc acid mono-(2-2-dimethylhydrazide)] applied in the field reduced the electrical impedance of McIntosh apple fruit at harvest and after storage. Vacuum infiltration with calcium chloride ($CaCl_2$) increased the impedance whether fruit were treated with daminozide or not.

Bioelectric tests have been used to evaluate many characteristics of plants or plant organs such as frost hardiness in woody ornamentals and trees[2], virus infection[3], and fruit senescence[4]. Impedance is one bioelectric test often applied because of the ease of measurement and its apparent correlation with pathological and physiological changes. Electrical impedance of peaches has been shown by Weaver and Jackson[5] to increase until fruit reach the ripe stage after which it declines. Golovkin and Tsvetkov[6] used impedance as an indication of the change in the permeability of apple membranes at reduced temperature. Greenham[7] demonstrated that the impedance of bruised apples was lower than those not bruised, and Sacher[4] referred to the use of impedance as a measurement of senescence and, indirectly, cell permeability.

Looney[8] suggested that daminozide could influence respiration through maintenance of membrane integrity in apples. Unduragga and Ryugo[9] found that permeability of almond seedlings was increased by daminozide treatment and proposed this permeability change was effective in

reducing respiration. Calcium has been implicated in maintaining membrane integrity[10] and also influence respiration and ethylene production[11].

Previous results from the 1977–78 season indicated that the impedance of McIntosh apple fruits was reduced by field treatment with daminozide. This paper reports on the effects of field applications of daminozide, followed by dipping in $CaCl_2$ or exposure of the fruits to high CO_2 treatment, on the impedance of McIntosh apples of the 1978–79 harvest season.

Materials and Methods. McIntosh apple trees were field-treated with daminozide at 3 kg/ha applied as a 5 X concentration spray on August 2, 1978. Fruit were harvested on September 5, 19, and 26, 1978 and placed in storage at 1 °C. 1 week after harvest, samples were vacuum infiltrated with $CaCl_2$ (4% w/w) for 3 min at approximately 380 mm Hg. The control samples were infiltrated similarly with tap water. Further samples were exposed to an atmosphere of 3% O_2 and 10–15% CO_2 for 2 weeks at 0 °C. After storage for 47 and 175 days in air at 1 °C, the samples were warmed to room temperature prior to evaluation. Analyses of daminozide at harvest were performed as described previously[12] and calcium analyses of selected samples by atomic absorption spectrophotometry. Impedance was measured by the techniques and equipment of Weaver and Jackson[5] except that a hollow collar around the rubber stopper prevented juice from the fruit short-circuiting the current between the electrodes. 2 impedance measurements at 250 Hz were made on each of 10 fruit within each of the 3 replicates per treatment. Measurement of respiration and ethylene production were performed as described previously[11].

Results and discussion. Calcium content (dry weight basis) of vacuum-infiltrated apples was increased by the treatment (0.14% Ca in treated vs 0.07% in control) and the daminozide content of the treated fruit ranged from 4 to 12 ppm fresh weight, with lower concentrations in fruit harvested later. Impedance was generally higher in fruit harvested later, and also increased during the first 47 days in storage (table 1). Between the 2 storage periods, the impedance increased clearly only in the calcium-treated apples of the first 2 harvest dates. There was a general decrease over time in storage in the fruit from the September 5 and 26 harvests, but with little change in the fruit harvested on September 19. Impedance measurements indicated a difference in the fruit harvested on September 19. In a post-storage period of 7 days in air at 20 °C the impedance generally decreased in the fruit for that harvest and increased in fruit of the other two harvests (data not presented). These effects may be related to the ripening pattern of the fruit as influenced by time and calcium: daminozide treatments, but further work is needed to clarify the response.

It is clear that the impedance was reduced by daminozide treatment and increased by calcium treatment. The lack of statistical interaction between daminozide and calcium treatment indicates that the calcium treatment increased daminozide-treated and nontreated fruit quantitatively similarly although the means for the water, CO_2 and dry treatments appear similar to the overall means for the daminozide-treated fruit. Another interpretation is that the calcium treatment reversed the effect of daminozide in lowering impedance. If impedance is related to permeability as has been suggested[6] with the lower impedance reflecting increased permeability, daminozide seems to have an effect on apples similar to that proposed by Undurragga and Ryugo for almond seedlings[9] rather than the maintenance of membrane integrity proposed by Looney[8].

Calcium would have an effect opposite to that of daminozide because it tends to maintain membrane integrity[10]. However, it is difficult to explain the similar effect of calcium and daminozide in reducing respiration and ethylene production (data not presented) by control of membrane permeability if their effects on membrane permeability, as measured by impedance, are opposite. Because the ethylene synthesizing system may be located in the cell-wall-cell-membrane complex[13] it could be useful to clarify this discrepancy. The lack of effect of water infiltration suggests that the increases in impedance due to calcium treatment are not due to dilution, decreased impedance due to water present or to some physical effect of the solution uptake. Because free ions would tend to decrease impedance[3] it is apparent that the $CaCl_2$ was either fixed or taken up in the cells because impedance increased upon $CaCl_2$ treatment. The lack of effect of high CO_2 treatment on impedance, despite a reduction of respiration rate and ethylene production by CO_2 (data not presented), suggests

Impedance (ohms $\times 10^4$) at 250 H_z of McIntosh apples field-treated with daminozide (+D), plus pre-storage vacuum infiltration with 4% $CaCl_2$ and water, and high CO_2 treatment

Treatment	Harvest date September 5	September 19	September 26
After 47 days in storage at 1 °C			
+D	2.62* (2.09)**	2.72* (2.49)	2.89* (2.58)
−D	2.76 (2.30)	2.86 (2.67)	3.06 (2.80)
$CaCl_2$	2.84[a]***	2.97[a]	3.17[a]
Water	2.69[b]	2.72[b]	2.92[b]
CO_2	2.62[b]	2.75[b]	2.90[b]
Dry	2.61[b]	2.74[b]	2.92[b]
After 175 days in storage at 1 °C			
+D	2.50*	2.73*	2.60*
−D	2.77	3.01	2.88
$CaCl_2$	2.98[a]***	3.25[a]	3.20[a]
Water	2.50[b]	2.77[b]	2.66[b]
CO_2	2.53[b]	2.74[b]	2.53[b]
Dry	2.52[b]	2.71[b]	2.58[b]

* Differences between + and − daminozide within harvest date and storage period significant at $p = 0.5$ using F. test. ** Values at harvest in parentheses. ***[a–b] Means within 1 harvest date-storage period followed by different letters significantly different using Duncan's Multiple Range Test at $p = 0.05$.

impedance is not necessarily directly related to these responses, nor to the retention of firmness usually obtained and the increased permeability reported at high CO_2 concentrations[14].

There is evidence that daminozide application may result in disorders in apples[15] and another report (in preparation) will discuss the association of daminozide concentrations and breakdown apparent in these fruit. It is possible that the effect of daminozide in increasing permeability, thus potential breakdown, is often present but not revealed unless the conditions inducing senescence occur. It is also certain that the effect of daminozide upon permeability and any latent effect upon physiological breakdown, is concentration dependent. Although permeability changes may occur as one physiological effect of daminozide, breakdown may occur only if the concentration is higher than commercially recommended or other conditions induce senescence.

It is obvious that daminozide-induced disorders would be associated with membrane breakdown and cellular disorganization which would result in decreased impedance[4], although which is cause and which effect is not clear. On the other hand, calcium is known to maintain membrane structure and function, and cellular integrity[10], and in so doing presumably decrease the incidence of disorders in apples as it has been shown to do[16].

Research is continuing to relate impedance to physiological and physical changes in apple fruit.

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Persistence of infradian body weight cycles in castrated dormice *(Glis glis)*

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Summary. Male dormice were castrated at 2 phases of their infradian body weight cycles. No consistent changes were found in cycle period, amplitude, or absolute weights of the dormice following castration. Unlike other mammals, body weights of dormice appear unaffected by castration. Although both body weight and reproductive condition vary on an infradian basis, the changes in body weight appear to be programmed independently from changes in gonadal function.

In both natural and controlled environmental conditions, dormice *(Glis glis)* show endogenous cycles in body weight which are several weeks to a couple months long[2]. These infradian cycles have been confirmed in many independent studies[3-7]. Reproductive condition in male dormice has been shown to vary with the body weight cycle[8]. The control mechanisms of these cycles are not known. It is well documented that gonadal hormones influence body weight in mammals, including rodents, ungulates, carnivores, and primates[4]. Hence there may be a causal relationship between the body weight and reproductive cycles in dormice.

In general, orchiectomy causes a decrease in body weight[9]; exceptions to this include the golden hamster and Mongolian gerbil in which orchiectomy causes an increase in body weight[10]. Among the rodents that show a weight decrease after orchiectomy, several species (e.g. Djungarian hamsters[11] and hedgehogs[12] are similar to dormice in that they show body weight cycles in conjunction with reproductive cycles. In rodents which show body weight cycles, reproductive competence is typically associated with low body weights[13]. In dormice, however, reproductive competence appears to be associated with the high body weight phase of their infradian cycles[8]. In this respect, dormice resemble Djungarian hamsters rather than the other rodents which show body weight cycles. If dormice are like Djungarian hamsters in their response to orchiectomy, then orchiectomy should result in a decrease in body weight[14].

Castration has also been shown to affect circadian cycles. In male mice, gonadectomy results in a lenghtening of circadian cycles[15]. If the dormouse body weight cycle is dependent on the circadian system, then castration might also alter the period of this infradian cycle.

To determine whether the body weight cycle is dependent on the presence of gonadal hormones, male dormice were castrated at either the high weight phase or the low weight phase of their body weight cycles.

Methods. Animals were obtained from a dealer in France (STACEL). For at least 60 days prior to castration and for the duration of the experiment, they were maintained at 21 ± 3 °C on a 12:12 h light/dark cycle. They were provided with nesting material and given food (ground Purina chow) and water ad libitum, with the exception of 2 animals which were initially given the same food in pellet form and later switched to ground chow (figure). Animals were kept individually in cages measuring $19 \times 22 \times 37$ cm and weighed weekly to the nearest gram. 10 adult males selected on the basis of showing clearly defined body weight cycles (> 20 g amplitude), were bilaterally castrated under