If, within a few months during the spring, two-thirds of the 75 percent (0.5×10^{26} atoms) are mixed into a belt of the troposphere (for example, 45° to 60°N) containing 3×10^{27} atoms, and if the time constant for growth of concentration is roughly equal to the time constant for leakage out of the belt, an average rise in C^{14} concentration of 5 per mil is temporarily produced in the belt, and the peak concentration may attain a somewhat higher value.

Slightly elevated C^{14} concentrations, attributable to a latitudinal effect, may thus have prevailed in a belt around middle latitudes, at least during a period of the year. If the geographic position of this belt is closely related to the position of the tropopause gap or gaps, the belt has had a rather irregular course around the hemisphere.

With changing climates the position of the belt of elevated C^{14} concentration may have shifted in the past after shifts in the position of the tropopause gap. At fixed locations in middle latitudes such shifts will produce oscillations in the C^{14} activity of plant material. This may be part of the explanation of the rather sudden variations in C^{14} activity traced in tree-rings from the last 1300 years (*10, 11*). The C^{14} activity of tree-rings has been found to vary both with time and with location on the earth. The variations with time appear to be composed of short-term oscillations of 1 to 2 percent superimposed upon an oscillation having a longer period (*11*). The variations with location are up to 1 percent (*10*). The oscillations seem to be correlated with climatic phenomena.

Latitudinal variations as estimated above may have contributed substantially to the short-term oscillations in the C^{14} activity of the tree-rings, and in addition may account for the minor differences found in the C^{14} activity of plant material from different locations. Changes in cosmic ray flux, or climatically induced changes in the exchange rate of CO_2 between the ocean and the atmosphere, may likewise contribute to the oscillations occurring with time as previously proposed (*10*), but cannot account for geographical variations.

The present explanation of these oscillations may be tested by assaying series of tree-rings collected at different latitudes. The interpretation of such measurements, however, may be complicated because of the irregular, meandering course of the tropopause gap.

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Growth Inhibition of Insects and a Fungus by Indole-3-Acetonitrile

Abstract. Indole-3-acetonitrile obtained from cabbage has been found to inhibit growth of *Pyrausta nubilalis* (Hbn.), *Galleria mellonella* (L.), and *Penicillium chrysogenum*.

A broad study of the resistance of the plant host to insects and fungi is being carried forth in these laboratories (*1*), and among the plants being studied is the cabbage. Several different strains of cabbage were used in the preliminary investigation.

The outer leaves of full-grown cabbage plants were removed and dried at a temperature of 60°C for 48 hours. During the drying process a loss of 90 percent in weight was observed. The dried leaves were placed in a Waring blender and reduced to a powder which was then placed in a Soxhlet extractor. Water extraction was continued for 48 hours, and the extract was filtered and concentrated in a vacuum to give a solution representing 1 g of dry plant material per milliliter of solution. The aqueous solution was extracted with ether in a continuous extractor for 24 hours. The ether extract was washed with 5 percent potassium hydroxide and with distilled water, and then it was dried with anhydrous sodium sulfate. The ether was removed in a vacuum and the residue was chromatographed on a chloroform-silicic acid column. Elution of the column with chloroform gave an oil which on purification gave an infrared spectrum having strong absorption at 4.42 μ ($C\equiv N$). Hydrolysis of the oil produced indole-3-acetic acid. The oil showed superimposable ultraviolet and infrared spectra with an authentic sample of indole-3-acetonitrile.

Table 1. Effect of indole-3-acetonitrile on growth of a fungus and two insect species.

Indole-3-acetonitrile (mg/g medium)	Growth inhibition (%)
Penicillium chrysogenum	
0.20	100.0
0.10	66.7
0.08*	50.0*
0.05	13.6
0.02	4.0
0.01	0.0
Pyrausta nubilalis (Hbn.)	
1.40	85.3
0.70	66.4
0.45*	50.0*
0.35	44.8
0.17	31.2
Galleria mellonella (L.)	
2.00	95.0
1.00	84.2
0.50	63.3
0.25	50.8
0.12	38.4
0.06	23.1

*Calculated from dosage-response curves.

The nitrile was found to inhibit the growth of *Pyrausta nubilalis* (Hbn.), *Galleria mellonella* (L.), and *Penicillium chrysogenum*. Previously described assay methods were employed (*2*). The inhibition at various concentrations is shown in Table 1. Indole-3-acetic acid did not inhibit growth under our assay conditions.

Previously, in a study of neutral auxins in plants, Jones and his coworkers (*3*) isolated indole-3-acetonitrile from cabbage and found it to have remarkably high activity in the oat auxin bioassay.

At present, an investigation is under way to determine if field resistance variation in cabbage plants to insects is directly proportional to the concentration of indole-3-acetonitrile. Preliminary studies have shown an average concentration of 0.016 percent indole-3-acetonitrile in cabbage on a wet-weight basis. This concentration in the plant correlates well with the amounts used to obtain growth inhibition in the laboratory. Evidence for other growth-inhibiting factors in cabbage has also been obtained.

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References and Notes

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