cells contain increasing amounts of glucose-6-phosphate and succinate dehydrogenases. Dannenberg *et al.*, using histochemical methods in vitro, showed the latter enzyme to be active in the alveolar macrophage (*10*).

In preparations of lungs from three animals associated with deficient production of pulmonary surfactant (chickens, frogs, and dogs 1 week after pulmonary artery ligation) the large enzyme-rich alveolar cells were lacking or absent (Fig. 2). Compared to lungs from dogs, lungs from chicken or frogs have lower surface activity as determined on the surface balance (*15*), although bubbles obtained from chicken lungs appear to have normal stability (*16*). Morphologically, the osmiophilic lamellar bodies of mammalian alveolar cells are absent in amphibian lung (*17*) and are present only in restricted areas of avian lung, but not in the air-capillary epithelium (*18*).

That the large alveolar cells are rich in enzymes of oxidative and synthetic metabolism, and that their absence correlates with diminished pulmonary surface activity lend further support to the concept that they are sites of elaboration of alveolar surfactant. Since these enzymes are located in the mitochondria, the findings also correlate with evidence that the synthesis of fattty acids by the lung is most active in the mitochondrial fraction (*19*).

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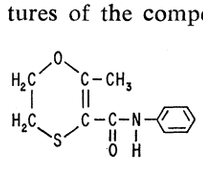
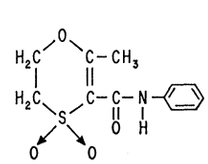
Systemic Fungicidal Activity of 1,4-Oxathiin Derivatives

Abstract. *Treatment of pinto bean and barley seed with 1,4-oxathiin derivatives gave disease control by systemic fungicidal action of such pathogenic fungi as* Uromyces phaseoli *and* Ustilago nuda. *The two chemicals, D735 and F461, were highly specific and selective against the pathogens without injury of the hosts.*

Two compounds, 2,3-dihydro-5-carboxanilido-6-methyl-1,4-oxathiin (D735) and its sulfone analog (F461), were tested for fungicidal activity and found to act systemically against several fungus species when used as foliar sprays or for treating soil or seed. The structures of the compounds are



D735



F461

These chemicals (*1*) appear to be particularly effective in controlling plant pathogenic fungi such as wheat leaf rust, *Puccinia rubigo-vera tritici* (Eriks) Carleton; bean rust, *Uromyces phaseoli typica* Arth.; loose smut of barley, *Ustilago nuda* (Jens.) Rostr. and *Rhizoctonia solani* Kühn. In general, various analogs showed no, or considerably less, fungitoxicity; that is, the free carboxylic acid and its esters and *N*-alkylamides were quite ineffective.

Table 1. Loose smut control of barley caused by *Ustilago nuda* in field experiments with seed treatments of 1,4-oxathiin derivatives at three dosages.

Treatment	Chemical (% by wt)	Seed heads (total No.)	Seeds infected	
			No.	Percentage
D735	0.125	745	14	1.9
D735	.25	723	5	0.7
D735	.5	701	0	.0
F461	.125	736	107	14.5
F461	.25	718	90	12.5
F461	.5	693	62	8.9
None		656	114	17.5

Compared with protectants relatively little progress has been made in the development of systemic fungicides (*2*), and there are numerous reviews on this subject (*3*). We now describe the systemic fungicidal activity of compounds D735 and F461 against bean rust and loose smut.

Seeds of pinto beans, *Phaseolus vulgaris* (l.), were treated with D735 and F461 by tumbling the finely ground chemical with the seed in a glass jar, 0.25 percent of chemical by weight of seed being used. The seeds were planted in 4-inch pots in the greenhouse, and then the separate sets of plants were inoculated, at 1- and 2-week intervals, with uredospores of bean rust, *Uromyces phaseoli.* Bean plants grown from untreated seeds were included in the test. Both chemicals effectively controlled the development of rust symptoms on the primary bean leaves when inoculated 7 days after planting. At this interval D735 gave 99 percent and F461 100 percent disease control. In the 2-week interval between planting and inoculation, F461 gave 99 percent control on the primary leaves and 96 percent on the trifoliolates, whereas D735 failed to control rust on any of the leaves. In these tests the untreated plants had an average of 12 pustules per square centimeter. One can speculate from these results that the sulfone is the more stable form in the plant.

Foliar disease control was obtained by seed treatment without causing injury to the plants. Both materials are fairly water soluble (D735 approximately 170 parts per million and F461 approximately 1000 parts per million) and appear to be readily translocated in the transpiration stream (xylem) to the site of the pathogen. Similar disease control was obtained by foliar

treatments with each chemical 72 hours after inoculation of the plants or by soil treatment at planting time and subsequent inoculation of the bean foliage with uredospores.

Both materials were tested in the field for their effect against loose smut of barley caused by *Ustilago nuda*. Barley seed variety 'Larker,' known to be infected with the loose smut fungus, was treated in glass jars with 0.125, 0.25, and 0.5 percent of chemical by weight of the seed. The seeds were planted in the field 8 April 1965 in duplicated 10-meter plots. About 2 months later on 18 June the effect of the seed treatment was noted by counting the smut-infected and the healthy seed heads in each plot (Table 1). In this experiment the sulfide D735 was highly effective in controlling the systemic loose smut disease. The oxidized form F461 was moderately effective.

The above experiment was repeated in the field during the 1965 growing season, and the initial findings were confirmed. None of the plants grown from treated seeds showed any signs of injury at any of the three dosages.

We conclude that 1,4-oxathiin derivatives are a new class of truly systemic fungicides which selectively control plant diseases without adversely affecting the host. Of particular interest is the fact that these chemicals control systemic diseases such as those caused by *Ustilago nuda*.

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A Permian Productoid Brachiopod: Life History

Abstract. *Spine arrangements on silicified specimens of* Waagenoconcha abichi *(Waagen) from the Khisor Range of West Pakistan suggest that the juvenile shell attached itself to a foreign object, and that the adult shell lay on its ventral valve in the substrate, anchored and stabilized by a dense corona of long slender spines around the ventral visceral disc.*

The ecology and living habits of many extinct species are difficult to determine because of the absence of critical features in much fossil material. For this reason the life histories of many groups of fossil brachiopods have remained matters for speculation. Recently, however, intensive searches for silicified shells, and large-scale programs of etching them from limestone, have begun to produce specimens of sufficiently high quality that the living habits of some of these ancient forms can be interpreted more confidently.

The productoid brachiopod *Waagenoconcha abichi* (Waagen) has been known from the Permian Productus Limestone of the Salt Range, West Pakistan, and of its trans-Indus extension, the Khisor Range, for almost 90 years (*1*), largely on the basis of specimens that had been freed by natural weathering or by cracking of the rock. These specimens exhibit numerous low tubercles, with hollow ends, that were interpreted as the bases of thin recumbent spines (*1*, *2*). Noetling's (*3*) illustration of a ventral valve, partly weathered from the rock, showed that some of the spines are long and thin and that at least some are not recumbent but almost perpendicular to the shell surface. The arrangement of spines over most of the shell surface remained unknown, and the living habits of the animal could be deduced only by analogy with other productoids (see *4*).

Several small blocks of argillaceous limestone, showing evidence of silicified brachiopods, were collected from the topmost beds of the Middle Productus Limestone on the west side of a broad valley that opens just north of the village of Kotla Lodhian in the Khisor Range (*5*). Decalcified in hydrochloric acid, these blocks produced many valves and a few complete shells of *W. abichi* having almost all spines intact. The shells provide several lines of evidence that permit interpretation of the life habits of the species.

A few small disarticulated ventral valves retain the spine arrangement of early youth. The indented apex of the beak and the presence of two or three pairs of convergent apical spines imply that the young shell was attached to some foreign object that suspended it above the substrate, or perhaps stabilized it at the level of the substrate. Similar attachment has been reported for the young of several groups of productoids (*2*), and one species is reported to have remained attached by the apex throughout its life (*6*). *Waagenoconcha abichi* was not observed attached to any fossilized object, but the blocks contained silicified specimens of several kinds of bryozoans, many hundreds of sponge spicules, and a few specimens of another kind of spiny productoid, any of which could have provided seats for the settling of larvae and for the attachment of spat. Moreover, the larvae may have attached themselves to some kind of vegetation; marine algae abounded during the Permian (*7*).

Larger juvenile shells have the apical spines broken off; the venter bears regularly spaced, thin, short, surface spines that probably helped to stabilize the shell in the substrate after it had broken free from its earlier attachment (*8*). These delicate spines did not form clusters and were therefore probably easily broken by any disturbance of the shell.

Upon attaining a length of about 20 mm the shell put out a dense brush of spines around the ventral margin, many of which became almost 30 mm long but less than 0.5 mm thick (see cover). The next subsequent one or two laminae of growth also produced dense growths of similar spines that grew downward toward the first group, contributing greatly to the number of spines concentrated at one level and undoubtedly greatly strengthening the cluster (Figs. 1 and 2).

Subsequent growth laminae produced no anchoring spines but instead put out short and delicate spines that grew at an angle dorsally, diverging strongly from the last group of anchoring spines. The abrupt transition from large tubercles, which were the bases of the anchoring spines, to the small tubercles produced by surface spines on the trail, was considered to be a primary distinction of the genus *Waagenoconcha* (*4*), although heretofore the nature and arrangement of the spines themselves were unknown.