β-cells. The β-cells synthesize and store insulin. It is therefore likely that the concentration of glucose in these cells will be lower than elsewhere in the body. A specifically low concentration of glucose in the β-cells may, in view of the above results, account for the selectivity of alloxan for these cells.

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## The Attempted Dehydrogenation of 3,4-Disubstituted Thiolanes[1]

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We have subjected 3,4-thiolanediol and its diester and diethyl ether derivatives to dehydrogenation procedures in an attempt to prepare the corresponding thiophene analogs. Thiolane itself has been dehydrogenated to thiophene in 32% yield, using platinized charcoal at 400°, and in 18% yield with nickel sulfide on alumina at 350° (*1*); in each case the remainder of the material was converted to hydrogen, hydrogen sulfide, olefins, and alkanes. Passage of thiolane vapors through a "red-hot" glass tube is reported to give traces of thiophene (*2*). The syntheses of thiophene and its homologs from hydrocarbons and sulfur probably involve thiolane intermediates which subsequently undergo dehydrogenation (*3*), and sulfur and thiolane under pressure do give small yields of thiophene (*4*).

DL-1,4-Dichloro-2,3-dihydroxybutane (*5*) was cyclized to 3,4-dihydroxythiolane (*6*) with sodium sulfide. The latter was converted to the diacetate and dibenzoate esters. The diacetate was also prepared by cyclizing DL-1,4-dichloro-2,3-diacetoxybutane (*5*). 3,4-Diethoxythiolane was prepared by a slight modification of the method of Patterson and Karabinos (*7*).

The four substituted thiolanes were heated with sulfur under dehydrogenating conditions with and without solvents. When short reaction times were employed, most of the starting material was recovered unchanged. Under more vigorous conditions decomposition occurred, with the concomitant evolution of hydrogen sulfide. Similar results were obtained using platinum on charcoal as the dehydrogenating agent. Neither of the diesters was attacked by chloranil.

In a series of vapor phase runs, solutions of sulfur and the dibenzoate or the ether were passed under nitrogen pressure through a tube packed with "noncatalytic" fused alumina balls[4] and maintained at temperatures varying from 450° to 525°. Decomposition occurred in every case. Attempts to split out two molecules of acid from the diester by pyrolysis in the absence of sulfur (*8*) were also unsuccessful.

We believe that dehydrogenation took place during these various experiments, and that the substituted thiophenes then decomposed. The instability of 3,4-dihydroxythiophene has been mentioned by Fager (*9*) and by Turnbull (*10*). The ethoxy, benzoxy, and acetoxy substituents would tend to increase the susceptibility of the thiophene nucleus to degradative attack because of their action in increasing the electron density in the ring.

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## The Response of Two Species of Pine to Various Levels of Nutrient Zinc[1]

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The effect of a lack of nutrient zinc on the growth of a number of forest tree species has been reported by several workers (*1–4*). In general, the symptoms of all the species studied have been quite similar, being subsumed under the heading of little-leaf or rosette disease. These names are quite descriptive, since the affected trees usually exhibit diminished bud growth, reduction of leaf size, and chlorosis of varying degrees of severity. The symptoms are also concordant with the known effect of a lack of zinc in reducing the auxin level of the deficient plants. Although naturally occurring zinc deficiencies have been

[1] This work has been assisted by a grant from the Tennessee Corp.

demonstrated to exist in citrus and tung trees in California and Florida and in pecan trees in Georgia, the only known reference to a natural deficiency in pine trees was reported for *Pinus radiata* in Australia (*1*). Subsequent studies performed on seedling plants of this species growing in culture solution established the need of zinc for healthy growth (*5*). The deficiency symptoms of the seedling plants were similar to those observed on trees growing in zinc-deficient soil and included diminished bud growth, shortened needles, and varying degrees of chlorosis.

It has been reported that a serious deterioration of shortleaf pine (*Pinus echinata* Mill.) and to a lesser extent loblolly pine (*Pinus taeda* L.) was prevalent throughout the Piedmont region (*6*). This deterioration, which became known as the little-leaf disease, occurs extensively on shortleaf pine, and to a lesser extent on loblolly pine when associated with shortleaf pine. The little-leaf disease is regarded as a systemic disturbance that causes a gradual reduction of the growth of all the aboveground parts of the affected tree. Needle length decreases from a normal of 3–4 in. to a minimum of 1 in., or even less in very acute instances. Growth of new shoots declines from a length of 7–12 in. to a minimum of 1 in. or less. Reduction of growth is accompanied by a gradual increase in the degree of yellowing, reaching a definite chlorosis in the acute stages of the disease.

Although the symptoms of the trees affected with the little-leaf disease are similar to those reported for the zinc-deficient trees of *P. radiata,* the writer is unaware of any published reports of the effect of zinc on the growth of either loblolly or shortleaf pine. Such a study was undertaken and will be reported briefly.

A sufficient quantity of seeds of both loblolly and shortleaf pine were stratified in dishes of moist sand and placed in a refrigerator maintained at 3° C for a period of 2 months. They were then planted in acid-washed quartz sand and after 2 months were transplanted to especially prepared containers.

The plants were grown in 2-liter Pyrex beakers that had previously been painted on the outside with a coat of black asphaltum, followed by a layer of aluminum paint. To permit drainage a small hole was bored in the bottom of each beaker, and a piece of Pyrex wool placed over the hole. Fine quartz sand was washed with concentrated sulfuric acid and rinsed with Pyrex-distilled water. The sand was then placed in the beakers and washed with a 1 : 1 solution of hydrochloric acid, followed with a thorough rinsing with Pyrex-distilled water. Cardboard tops, impregnated with paraffin and punctured with several small holes, were used as covers for the beakers.

Nutrient solutions were prepared and purified separately, 5 liters at a time, in 6-liter flasks. "Major" nutrients were prepared, using the methods of Arnon (*7*) and Stout and Arnon (*8*), in which molar solutions of the salts were used. The nutrient solutions and distilled water used in the experiments were tested frequently by the dithizone test, as described by Stout and Arnon (*8*), and found to contain less than 1 part in 10 billion of trace metals. A trace supplement, which consisted of boron, .5 ppm; copper, .02 ppm; manganese, .5 ppm; and a .5 % iron solution, was used. Concentrations of zinc of .000 ppm, .001 ppm, .01 ppm, and .1 ppm were used.

One plant of loblolly and one plant of shortleaf pine were planted in each of four beakers in each of the four concentrations. It was considered that by having the two species growing in the same containers there would be less likelihood of fortuitous results. The containers were saturated with nutrient solutions twice a week, and the plants watered with distilled water in the intervening time. The plants were allowed to grow in an unshaded greenhouse for approximately a year.

At the end of the year there was a great difference in the response of the two species. All the loblolly seedlings were still alive and growing, although the growth response showed a definite effect of the various concentrations of zinc. The plants in the minus zinc series were about half as tall as the plants in the high zinc series, had shorter needles, and exhibited some chlorosis. The plants growing in the two intermediate concentrations of zinc exhibited some diminution of terminal bud growth, some reduction of needle extension, and a slight chlorosis when compared with the controls.

The shortleaf seedlings growing in the minus zinc series were all dead at the end of 8 months. They had made practically no growth, the needles were very short, and the plants exhibited extreme chlorosis. The .001 ppm series contained three dead and one weakly living plant at the end of one year. The plants had lived a few months longer than those in the minus zinc series and had made slightly more terminal bud growth, but they also showed failure of needle extension and severe chlorosis. In the .01 ppm series only one of the plants was dead, but the remaining seedlings exhibited diminished bud growth, greatly reduced needle extension, and severe chlorosis. In the high zinc series the plants were vigorously alive and exhibited normal healthy growth.

It will be noted in Table 1 that, although the height growth of loblolly shows a definite relation to

TABLE 1

EFFECT OF VARIOUS CONCENTRATIONS OF NUTRIENT ZINC UPON THE GROWTH IN LENGTH (IN CM) OF LOBLOLLY AND SHORTLEAF PINE SEEDLINGS

| | Concentrations of zinc in ppm | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | .000 | | .001 | | .010 | | .100 | |
| | Shortleaf | Loblolly | Shortleaf | Loblolly | Shortleaf | Loblolly | Shortleaf | Loblolly |
| | 10 | 23 | 11 | 23 | 10 | 28 | 28 | 28 |
| | 5 | 22 | 10 | 24 | 17 | 28 | 28 | 44 |
| | 3 | 20 | 8 | 23 | 14– | 32 | 30 | 35 |
| | 5 | 18 | 11 | 27 | 14 | 30 | 26 | 36 |
| Av | 6 | 21 | 10 | 24 | 14 | 30 | 28 | 36 |

the effect of various concentrations of zinc, there was fairly good growth in the low zinc series. However, there was practically no growth of shortleaf pine in any concentration below the control.

These data clearly indicate that in addition to *P. radiata,* both loblolly and shortleaf pine require zinc at approximately .1 ppm for continued normal growth. In addition, there appears to be a marked difference in the nutrient requirements of loblolly and shortleaf. The symptoms of zinc deficiency produced in both species closely resemble those described for the little-leaf disease that has been reported to affect shortleaf and to a lesser extent loblolly in the Piedmont area (*6*). As to whether the little-leaf disease is in truth a zinc deficiency this experiment is not designed to answer. It may be that the disease is caused by factors such as fungi, nematodes, poor aeration, etc., which affect the absorption of zinc, with consequent production of zinc-deficiency symptoms.

Perhaps the most striking result of the experiment is the establishment of such great differences in the response of the two species to the various levels of zinc. The difference is of such magnitude as to suggest a basic difference in various physiologic processes. More extended investigations are currently in progress; they will deal not only with the effect of other nutrient elements but also with the effect of the presence or absence of mycorrhiza.

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# *Comments and Communications*

## Scientific Documentation through Cooperation

SOME comment should be made on the note by Jacques Avias on "International Organization of Scientific Documentation Based on Legislation" (SCIENCE, **115**, 250 [1952].) It happens that my fields of special study (paleontology and stratigraphic geology) are the same as those of M. Avias, and, like him, I am concerned with the problem of effective dissemination of knowledge in our subjects.

M. Avias would have laws forbidding scientific work to circulate unless accompanied by cards of standard size with abstracts in specified languages, unless special cards are deposited with specified international agencies, and so on. I find the thought of such coercive legislation very repugnant, and more than a little frightening. It would be unfortunate were our colleagues in other scientific fields left with the impression that bibliographic conditions in paleontology are so chaotic that such bureaucratic authoritarianism is warranted. The actual conditions are not ideal, but they are not thoroughly bad.

The geological (including paleontological) literature pertaining to North America, in its broadest sense, is listed in annual bibliographies with analytical indices, published by the U. S. Geological Survey and available to all at a very small cost. These bibliographies are amazingly complete, and are published as promptly as could be expected: the volume for a given calendar year appears during the next year, and commonly during the next summer.

For the literature of the rest of the world one must look farther, and coverage is not so perfect, but I think that comparatively few papers escape notice in the *Bibliography and Index of Geology Exclusive of North America,* published annually by the Geological Society of America, Schindewolf's *Zentralblatt für Geologie und Paläontologie* (happily again appearing regularly, with admirable reviews), or the *Bulletin analytique,* the geological parts of which are reprinted in an annual volume by the Société géologique de France. Besides these inclusive listings, almost all countries have some agency publishing summaries of work of more local interest, such as the annual review of Swedish papers, which appears as part of the *Förhandlingar* of the Geologiska Föreningen i Stockholm. By consulting half a dozen sources (surely not an impossible task for a research worker), well over 90% of all papers in geology and paleontology will be found. For papers dealing with paleontology, abstracts and analyses are found in *Biological Abstracts* and the *Zoological Record,* as well as in the *Zentralblätter.* Coverage here may be described as good, although improvable and improving.

This result has been accomplished through no armament of laws, but by the geologists and paleontologists of the world working together through their professional societies, or through looser organizations like *Biological Abstracts.* No statute demands that copies of books or journals be sent to editors, although no doubt the editors are pleased, and their work is lightened, when this is done. I do not believe we need be ashamed of what has been accomplished bibliographically by free cooperation and informal zeal.

Granted that a worker may thus learn the titles of almost all papers in his field, does he then need the batteries of especially trained translators and the implied miles of filing cabinets in Paris (presumably in