investigations. Green plants almost invariably contain small amounts of zinc and it is probable that this element is essential for their best growth, although it is toxic, except at very low concentrations. The discovery in recent years of the extremely beneficial action of zinc salts on peach, orange, pecan and other trees affected with various types of little-leaf has opened new fields for study of this problem.

In presenting this note, we wish to call attention to several recent scattered publications on the specific action of zinc on cell metabolism.

It seems significant that several workers have arrived independently at the conclusion that zinc salts are intimately concerned with the processes of oxidation in the cell and with the transformation of carbohydrates in the plant.

Miss Colley[2] showed that zinc had more influence in promoting the growth of aerobic bacteria (*Pseudomonas tumefaciens*) in narrow test-tubes than in relatively shallow layers of liquid in Erlenmeyer flasks. Thunberg[3] published three admirable papers within the past year in which he showed that zinc salts produced a remarkable acceleration of oxidation processes when added to the extracts of certain seeds. Ganassini[4] believes that inorganic and organic basic zinc salts and zinc hydroxide may behave in alkaline medium as oxidative agents like the oxidases and peroxidases.

It is well known that the plant obtains a large part of the necessary energy from the combustion of sugars. Not all the energy obtained from this oxidation is used for growth. A portion, which we might term the "overhead," is used for the maintenance of the plant organization. The work of Javillier[5] indicated that zinc regulates the consumption of sugar in the cell. He thought that it diminished the amount of energy required for maintenance with a corresponding increase in the amount available for construction.

Confirmatory evidence on the relation of zinc to the consumption of sugars has been afforded by Haas.[6] He has shown: (1) that orange leaves affected with the disease known as mottle-leaf contained more reducing sugars than unaffected leaves; and (2) that the sugar content of mottle-leaf cuttings previously dipped in a zinc-lime-water mixture diminished more rapidly than that of mottle-leaf cuttings grown under similar conditions without any application of zinc.

The authors of this note have shown that the metabolism of cells of mottled orange leaves is profoundly altered. The pathological symptoms observed are related to an accumulation of suboxidized metabolic substances and a destruction of chlorophyll. The stromata of the plastids are often rich in fat globules and deficient in starch grains. The suboxidized metabolic substances were largely droplets of phytosterol. It is possible that sugars were converted into lipids instead of being oxidized to furnish energy to the cells. However, the normal course of metabolism in this type of leaf cell was resumed after the trees had been sprayed with a dilute solution of zinc sulfate. Chlorophyll was produced and starches and sugars utilized for the energy of the active leaf.

We have outlined recently the way in which zinc salts may promote oxidation through their action on sulfhydryl compounds.[7] This idea has been supported by Giroud and Bulliard's[8] demonstration of the specific action of zinc in stabilizing the nitroprusside color reaction of glutathione. We were able to show:

(1) An accumulation of zinc in the meristematic cells of buds and in the palisade cells of leaves.

(2) Renewed activity in the leaf cells as a result of the application of very dilute solutions of zinc sulfate as a spray.

(3) Accelerated growth of new shoots on trees subsequent to the application of zinc salts.

We can only hope that investigations in progress in various laboratories may afford information on the rôle of zinc which is greatly needed at the present time.

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## PLIOCENE ANTELOPES OF THE PRONGHORN TYPE

THE phylogeny of the Antilocapridae and reported species giving rise to *Antilocapra americana* has been a subject of considerable interest to paleontologists. The work of W. D. Matthew on the *Merycodus* of Miocene and Pliocene age, and that of J. C. Merriam[1] on *Illingoceros* and *Sphenophalos* from the Pliocene, has increased considerably our knowledge of the probable line of descent of *Antilocapra americana*. The

[2] Mary W. Colley, *Amer. Jour. Bot.*, 18: 266–287, 1931.

[3] T. Thunberg, *Kungl. Fysiograf. Sällskapets I Lund Förhandlingar*, Bd. 4, Nr. 18, 1934; *Skandinavischen Archiv. F. Physiol.*, 69: 247–254, 1934; *Lunds Universitets Årsskrift*, *N. F.* Avd. 2. Bd. 30, Nr. 13, 1934.

[4] D. Ganassini, *Arch. Ist. Biochim. Ital.*, 3: 131–138, 1931.

[5] M. Javillier, *Ann. Inst. Pasteur*, 22: 720–727, 1908.

[6] A. R. C. Haas (paper in press).

[7] H. S. Reed and J. Dufrenoy, *Hilgardia*, 9: 113–141, 1935.

[8] A. Giroud and H. Bulliard, *Protoplasma*, 19: 381–384, 1933.

[1] J. C. Merriam, *Univ. Calif. Pub. Bull. Dept. Geol.*, 5: 22, 319–330, December, 1909; *Univ. Calif. Pub. Bull. Dept. Geol.*, 6 (Part 1): 2, 21–53, 1920, and 6 (Part 2): 11, 1911.

writer's attention was called by Merriam to a very interesting paper by E. H. Barbour and C. B. Schultz[2] in which they describe a new genus and species, *Proantilocapra platycornea,* Barbour and Schultz, from the Lower Pliocene in Cherry County, Nebraska. However, no comparison or reference to the closely related genus *Sphenophalos nevadanus* Merriam was made. *Proantilocapra,* as figured, shows morphologic characters close to those of *Sphenophalos.*

The horn-cores as to size, attitude in relation to orbit and frontal and in cross-section are much like those of *Sphenophalos.* The latter differ in being bifurcate, a character common to *Sphenophalos* from the Great Basin Province.

The occurrence of the new genus *Proantilocapra* in the Lower Pliocene of Nebraska adds important data in solving this problem.

In the original description and occurrence of *Sphenophalos,* Merriam discussed the systematic position of the genus and recognized, in the then available material, characters that indicate a close relationship to the pronghorn antelopes.

Specimens of the same species collected later in other Great Basin localities of middle and earlier Pliocene studied by Furlong[3] confirmed this view.

A more detailed report on the new genus *Proantilocapra* by Barbour and Schultz and other representatives of the same species will be welcome.

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## CONCERNING REASONING

THE twenty-four canaries fly freely in the laboratory. One of them, Billie Burke, alit on the top of the window shade, slipped, slid down between the window and the shade, came out at the bottom, parachuted to the concrete floor. That accident the canaries have many times each day, but Billie was unlucky, caught her wing and broke it. There have been three injured wings in the seven years, but this wing healed badly and the bird will never fly.

While she was convalescing I put her water and food near her on the floor. The others have their food on the top of the zinc-top table. She disliked eating down there alone, and the first realization I had of the bad healing was seeing her pathetically inadequate efforts to spring to the top of the table. This spring was with her legs. She did not use her wings at all. The spring carried her in the beginning to a height of three or four inches, later to a height of seven or eight.

Presently it occurred to me to build her a spiral staircase of sticks around the one table leg, the sticks two inches apart. This I did at night. All the next day she paid no attention to the sticks. The other canaries paid no attention either, at least did not regard the staircase as a way to the top of the table, though they might perch on a stick or hop up two or three. So the second morning I decided to put out Billie's water but not her food. I watched all day for something to happen. Nothing did. Toward evening I tied leaves of lettuce to the ends of the sticks. Still nothing happened. The other canaries ate on the top of the table where they were used to eating, and Billie stayed on the floor and did not eat. Nevertheless, the third morning when I arrived at the laboratory she was on the top of the table, and from then on has lived most of her life on the top of the table.

But in a week or two I began to realize that even this was not satisfactory. Birds like to sleep high, and nights when they were all getting ready you could see Billie cock her head to watch the others. Therefore, what I did now was find a small tree, stripped it of all but a few of its upper branches, mounted the tree on the end of the table, tacked a staircase of sticks around the trunk, and in thirty seconds she was perched at the top! I had no experimental intention, of course. I was only wanting to get her up there, and there she was. It had taken her two days to see how to get to the top of the table, and thirty seconds to see how to get to the top of the tree. Yet the ladder round the tree in general appearance was certainly sufficiently different from the ladder round the leg of the table. How she originally got to the top of the table I do not know. It may have been by a succession of blunders, or it may have been blunder plus recognition, as is the more likely, considering that there were nine steps. But assuredly it would seem that she recognized the essential characteristic of her first experience, and used it instantly to a new end.

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# SPECIAL ARTICLES

## GRAVEL CUSPS ON THE CALIFORNIA COAST RELATED TO TIDES

WHILE living in Santa Monica during the winter of 1933–34, the writer became interested in the triangular masses of gravel and cobbles, called "cusps," which were found on the beach at the mouth of Santa Monica Canyon. It was observable that these cusps were subjected to great variation in size and number.

[2] E. H. Barbour and C. B. Schultz, *Amer. Mus. Nov.,* No. 734, pp. 1–4, August 3, 1934.

[3] E. L. Furlong, *Carnegie Inst. Wash. Publ.* 418, pp. 27–36, 1931.