reference: Oxford English Dictionary (1888–1928), Century Dictionary (1911), New Standard Dictionary (1933) and Webster's New International Dictionary, second edition (1934). In none of the definitions in question is there any reference to the associate law which constitutes an essential element of every definition of an abstract group. This law is explicitly stated under the entry "group" in the preceding edition of the last of the four dictionaries just noted and its absence in the latest edition of this work marks a step backward which counteracts some of its forward steps.

Although the commutative law in the combination of elements was explicitly recognized much earlier than the associative law, the former being explicitly noted in Euclid's "Elements" (VII, 16) while the latter received little explicit attention before the middle of the nineteenth century, group theory has taught us that much more progress can be made by assuming the associative law without the commutative law than *vice versa*. The greater part of the developments in group theory result from the consideration of elements which are assumed to obey the associative law but not necessarily the commutative law when they are combined. The term associative law is due to the most noted Irish mathematician up to the present time, *viz.*, W. R. Hamilton (1805–1865), who was also the first to emphasize the importance of this law. A. Cayley (1821–1895) was the first to mention it in connection with a definition of an abstract group, but he was not steadfast in insisting on the fact that it is an essential element of the definition of an abstract group just as the last-named dictionary noted above displayed a lack of steadfastness in this respect.

A considerable number of new mathematical definitions appear in the second edition of Webster's New International Dictionary. The selection of the terms thus defined is not always wise. For instance, we find therein an incomplete definition of the somewhat special term "dicyclic group," but the much older and more widely used term "symmetric group" does not appear at the appropriate place. One also looks in vain in this dictionary for the entries "Fermat's theorem" and "primitive root." There appears, however, therein the entry "primitive group," but the definition which follows this entry is also incomplete, since in an imprimitive group all the substitutions which omit a given letter may also form a group involving all the other letters. Such incomplete definitions are very objectionable in a work which claims to be the "foundation book of education." Many readers will probably be more surprised to find therein also an incorrect definition of such a commonly used term as "spherical excess." Under this entry it is stated that its product by twice the square of the radius of the sphere on which the triangle is drawn is equal to the area of the triangle. The word "twice" should obviously not appear in this statement.

As this is the most recent extensive revision of any one of the large dictionaries noted above and hence will probably be used in our schools and elsewhere in its present form for a long time it may be desirable to direct attention here to a few additional points which seem to be in need of reconsideration. Probably most mathematicians would agree that the name of E. Galois (1811–1832) should appear in the "Biographical Dictionary" of this work in preference to many others which appear therein, such as that of W. Chauvenet (1820–1870), for instance. In fact, many would probably have preferred to see the name of E. H. Moore (1862–1932) retained instead of that of W. Chauvenet, in case one of them had to be omitted to make room for desirable additions. The name of S. Lie in this list should be followed by the dates (1842–1899) instead of by (1842–1879). The greater part of his publications appeared after 1879.

The preceding remarks do not imply that the existence of a few inaccuracies nullifies the value of such extensive works of reference as those noted above. On the contrary, they exhibit the great difficulties involved in the onward movement towards greater and greater accuracy. As regards many points it would evidently be impossible to secure now a unanimity of views, and the brevity of statements required in a work which deals with such a wide range of knowledge as a general dictionary naturally leads to some ambiguities. It is hoped that the points noted above are sufficiently outstanding to appeal favorably to the great majority of those who may consider them carefully and that this consideration will tend to a greater independence of thought while using such works of reference. Mathematics deals to an unusually large extent with finalities as regards accuracy, but it borders on fields in which such finalities are still impossible.

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THE EFFECTS OF ZINC SALTS ON THE OXIDATION PROCESS IN PLANT CELLS

SINCE 1870, when Raulin[1] demonstrated the remarkable accelerating effect of zinc salts upon the growth of fungi, the action of this and other "stimulating" or "accessory" elements has been the subject of many

[1] J. Raulin, "Etudes chimiques sur la vegetation." Paris, 1870.

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.