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Auxin Gradient Theory of Abscission Regulation

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Abscission of leaves, flowers, and fruits is known to be accelerated or retarded by many factors, including light intensity, photoperiod, temperature, water, mineral nutrients, carbohydrates, auxins, oxygen, carbon dioxide, anesthetics, mechanical injury, disease, insects, and senescence.

Several hypotheses and theories concerning the regulation of abscission have been advanced. Each has emphasized some important factor in abscission, such as turgor (*1*), nutrient balance (*2*), leaf-fruit ratio in fruit abscission (*3*), acidity (*4*), and hormone-ethylene balance (*5*). Few consider all known factors; none are adequately comprehensive. These hypotheses and theories will be analyzed in a forthcoming article (*6*). This paper reviews some aspects of the physiology of abscission and describes an auxin gradient theory of the regulation of abscission.

In an investigation of auxin in beans, Shoji *et al.* (*7*) found the concentration of auxin in the leaflets (distal to the leaflet abscission zone) approximately three times the concentration in the leaf stalks (proximal to the abscission zone). Shortly before the leaflets abscised, the auxin concentration in the leaflets fell, but in the leaf stalk it remained unchanged. This suggested that the auxin gradient across the abscission zone is a factor in the regulation of abscission. A similar but more extensive investigation in cotton has confirmed these results (*8*).

In excised leaflet abscission zones of beans, abscission was accelerated by the application of auxin to the proximal side of the abscission zone (*9*). This was confirmed in excised abscission zones of cotton (*10*) and in greenhouse beans (*11*). In *Coleus*, auxin transported from young leaves accelerated abscission of debladed petioles below the leaves (*12*). These observations further support the idea that the auxin gradient is a regulator of abscission.

Additional support is given by the auxin relationships of other factors affecting abscission: oxygen,

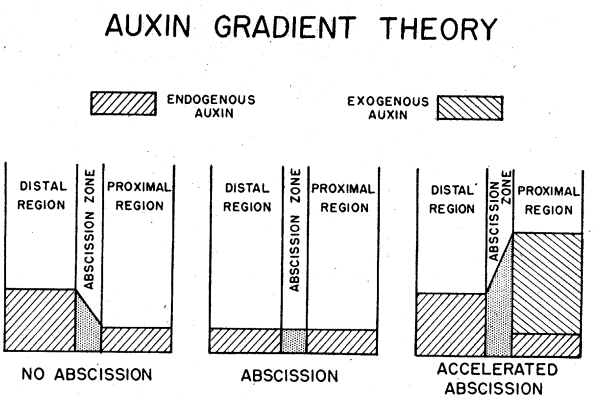

Fig. 1. Relationships between the auxin gradient across the abscission zone and abscission. Based on Shoji *et al.* (*7*) and Addicott and Lynch (*9*).

which accelerates abscission, is required for auxin inactivation (*13*); under oxygen deficiency, abscission is retarded and auxin increased (*14*). Chemical defoliants lead to a rapid decrease in leaf auxin (*8*, *11*). Ethylene, which also accelerates abscission, decreases auxin in some species (although not in others) (*15*). Injury by disease or insects may reduce auxin; for example, the fungus *Omphalia* defoliates coffee, apparently through the production of an auxin-inactivating enzyme (*16*). Zinc deficiency, which often accelerates abscission, decreases auxin (*17*).

On the basis of this and other evidence (*6*), the following theory is proposed: Auxin is the principal endogenous regulator of abscission; its gradient across the abscission zone regulates onset and rate of abscission. Abscission does not occur with auxin gradients characteristic of healthy, mature tissue: with high auxin distal to the abscission zone and low auxin proximal to the abscission zone. Abscission occurs after a fall in the ratio of distal to proximal auxin. Abscission is accelerated when the gradient is reversed. Figure 1 shows these relationships. There is evidence of positive correlation between the auxin gradient and the rate of abscission (*10*).

Application of auxin to an intact plant frequently does not retard abscission (*18*), and may even accelerate it (*19*). On the basis of this theory, such results would be expected if applied auxin were translocated or inactivated as rapidly as it is absorbed, not enough remaining distal to the abscission zone to maintain a retarding gradient. If auxin accumulated on the proximal side of the abscission zone, the reversed gradient would accelerate abscission.

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Communications

Educators Sampled from an Undefined Population

"The most neurotic, as a class, are the scientists and our experience has been that biologists as a group exhibit more picayunish tendencies. . . . Professors of petroleum geology and other highly specialized engineering subjects sometimes seem to be plain downright ornery," writes Robert C. Cook, editor of the recently published 16th edition of *Who's Who in American Education* (*1*), on the second page of prefatory remarks referring to his editorial contacts with various educators during a period of 26 years. *Who's Who in American Education* is a companion volume to *Leaders in American Science,* concerning which Branson (*2*) has commented adversely. Perhaps *Who's Who in American Education* has certain characteristics that tend to disrupt the careful scientist's emotional balance and thereby lead to "neurotic," "picayunish," and "ornery" behavior.

Branson concluded that, because of errors and omissions, *Leaders in American Science* would have been more appropriately entitled "Some Americans Interested in Science." As a sequel to his note, we have attempted to estimate the coverage of *Who's Who in American Education.* There are five possible ways in which a person might be treated: current listing, including photograph (CP); current listing, no photograph (C); name listed, but reference made to a previous volume—that is, entry not up to date (L); name listed, but reference made to *Leaders in American Science* (LAS); not listed at all (N).

How fully are various populations of prominent professors of education, educational psychologists, and psychologists represented? First, we searched for the names of the 15 full professors working primarily in the department of education of the University of Wisconsin who do not have major administrative responsibilities. *Who's Who in American Education* does not list 12 of them (80 percent) at all; for two we were referred back to volume XIV (1949–50); only one person (7 percent) has a current listing, without photograph.

According to official records (*3*), there were 210 fellows of the division of educational psychology of the American Psychological Association on 1 Jan. 1954. They fall into the five categories outlined: CP, 7; C, 36; L, 22–15 (vol. XV), 6 (vol. XIV), 1 (vol. XII); LAS, 0; N, 145. Thus, only 43 entries, or 20 percent, are current. We cannot discern any basis for inclusion and exclusion. Such widely known professors as Yale's Carl I. Hovland, Duke's G. Frederic Kuder, Columbia's Irving Lorge, and Ohio State's Sidney L. Pressey are omitted altogether.

A third suitable population seemed to be the 207 members of the American Educational Research Association (*4*) who are full professors of education or closely allied fields, such as educational psychology and science education, and who do not have major administrative assignments. *Who's Who in American Education* gives current listing to 54 of these (26 percent), 18 with photographs. The 1953–54 AERA president, Guy T. Buswell, does not appear at all.

Last, we looked for the names of the 30 presidents of the American Psychological Association who were living when the 16th edition of *Who's Who in American Education* went to press, from O. Hobart Mowrer in 1954 to Robert S. Woodworth in 1914 (*5*). There are current listings for only four of them, or 13 percent.

From these searchings among prominent educationists and psychologists, it seems probable that, aside from listing an unstated percentage of certain types of school administrators described in its preface, *Who's Who in American Education* samples no definable populations of "educators." Despite the editor's assertion that "Volume Sixteen should contain the names of almost all of the superintendents of school systems in cities of 25,000 or more population," the two we sought (for Atlanta and Madison) were missing. Appearing in the volume are some classroom teachers ("You may be sure that any classroom teacher included in this volume was listed because he or she has been recommended by a responsible educator"); college teachers of all ranks, in nearly every conceivable field, and from many types of institutions; administrators at practically all levels; and noninstitutional educational workers of many types.

In his preface the editor complains that it is hard to locate the names and addresses of members and officers of various organizations, but this is certainly not true of the four populations we investigated. For example, all current members of the AERA are listed each year in the December issue of the *Review of Educational Research,* a widely circulated journal. Members of the American Psychological Association