the lesion is very close to the crown in a region of living pith. Under no other circumstances has suberin been found in stems wounded as late as October.

While no growth responses are possible during the colder months the dying back of wounded stems continues even through the winter. During late autumn and early spring the unprotected junctions of these dead stems with the living crown are attacked by organisms which undoubtedly enter through the open hollow stubs. This infection leads to breakdown of tissue which extends into the crown and when spring growth is resumed the plants can not wall off these diseased parts. Consequently, as early as July the central region of the crown and the upper part of the tap root have largely decayed, leaving usually only a thin shell of living tissue. Such plants may look normal during the spring, but they are definitely less able to withstand the later periods of summer drought and nearly all of them die before autumn. In a general way these difficulties are commonly related to the hardships of the previous winter, but they go back instead to autumn injuries. The considerable time that elapses in red clover between the lesions of autumn and their effects the following summer has concealed the disastrous results of late wounding.

The nature of the pith on these legumes is a determining factor both with respect to the location of wound barriers and the promptness with which they are formed. In stems having solid living pith the cicatrice is developed quickly near the wound surface under the pseudocicatrice. But if there are dead or broken portions of pith the location of the barriers is necessarily shifted and stems die back to a plane of solid living pith. This long lag between injury and cicatrization is the critical period for red clover.

Since the summer of 1934 hundreds of clover fields throughout Iowa and neighboring states have been studied not only with respect to the immediate results of wounding, but also as to ultimate effects of cutting and pasturing. It is a common practice of long standing to clip or pasture red clover during the first fall after spring seeding. Careful check on large numbers of fields shows that there is a striking correlation between fall treatment and the percentage of infected plants at intervals during the following summer. These fields were selected at random from those having fair stands of clover and for which the cultural history could be obtained. A summary of these records shows, (1), that if the fields were heavily clipped during the late autumn the proportion of diseased plants during the following summer ranged from 50 to 95 per cent., and (2), that fields if left uninjured after the first of September had only 1 to 10 per cent. of infected plants by midsummer of the following year.

Apart from the effects of lesion, clover plants frequently die as a result of "winter-killing." This is especially true if crowns are exposed either by mowing or heavy pasturage late in the season. The death of such plants is undoubtedly caused by winter hazards other than those related to wounds. Nevertheless, it can not be stressed too strongly that late cutting or pasturing not only promotes this winter-killing, due to increased exposure as a result of removing plant cover, but, even if fields survive the winter, most of the plants inevitably suffer from crown infection the following growing season as a result of their inability to heal the wounds of the previous autumn.

It is not uncommon in eastern Iowa for entire fields of red clover to live through three growing seasons, and several cases are on record of four-year-old fields. But, in all the instances investigated where fields lived more than the second summer, the plants were neither cut nor pastured after the first of September and so went into the winter with considerable ground cover and with all wounds safely healed at or above the crown level.

It seems clear from study that in this region late-season treatment, apart from certain winter hazards, largely determines the fate of red clover in a given field.

Robert W. Poulter
State University of Iowa

ROOTING NORWAY SPRUCE CUTTINGS WITHOUT CHEMICAL TREATMENT

At the New Haven meetings of the New England Section of American Plant Physiologists, held on May 12 and 13, a method was described by which cuttings of 39-year-old Norway spruce trees were successfully rooted in large numbers during the past winter. Vegetative propagation of this economic forest and ornamental species permits establishing clones with desirable growth characteristics. One of our immediate objects will be the propagation of Norway spruce trees that have a natural immunity to the spruce gall aphid.

The results of the rooting tests were based on 3,200 cuttings collected at monthly intervals from October to January, inclusive. The factors tested included (1) month of collection; (2) length of cuttings, short (5 to 10 cm) and long (10 to 20 cm); (3) cuttings with and others without a heel of two-year-old wood; (4) no preliminary treatment, standing in water 24 hours or in indole butyric acid solutions with 2.5, 5, 10, 20, 40, 60, 80 and 100 mgms of the chemical per liter. The cuttings were planted in builders' sand in an open greenhouse bench with day temperatures around 70° F. and night temperatures never lower than 55° F. Analysis of the data is based upon the examination of the bases of the cuttings 14 weeks after planting.

Detailed analysis of the influence of the several factors investigated must await subsequent publication.

The two outstanding results appear to be, first, that the season at which the cuttings are taken governs to a large degree the percentage of rooting, and second, that treatment with indole butyric acid seems to retard rooting. The greater the concentration of this chemical the more rooting was retarded. In addition, long cuttings were superior to short cuttings and cuttings without heels rooted in greater numbers than those with heels. Placing the bases of the cuttings in tap water for 24 hours prior to planting in sand retarded rooting somewhat.

Terminal and lateral twigs of lateral branches located between six to eight feet from the ground were used when making the cuttings. Best rootage was secured from plain cuttings 10 to 20 cm long made in December and planted directly in the sand bench. In 14 weeks 90 per cent. of these cuttings were rooted. Both the December and January cuttings had larger roots and more advanced top development by May 1 than cuttings collected in October or November. In May more than a thousand rooted cuttings were planted in a tree nursery outdoors and in pots so that tests of their degree of immunity to spruce gall aphids could be conducted in the late summer.

Carl G. Deuber
John L. Farrar

Yale University

PHYSIOLOGY OF THE NERVOUS SYSTEM

In his painstaking appraisal of my book, "Physiology of the Nervous System," which appeared in Science for July 7 (the anniversary of its publication), Dr. Forbes has suggested that I deliberately omitted treatment of the nerve impulse and certain basic problems of neuromuscular transmission. The statement is true and lest misconception should arise from the review, it must be pointed out that the book deals primarily with the *central* nervous system, including the autonomic division. Dr. Ralph Gerard will describe the special physiology of peripheral nerve, *i.e.*, the nerve impulse and neuromuscular transmission, in a separate monograph of this series, which will appear in the near future. This will also deal with the principles of electrophysiology.

Since Dr. Forbes likewise offers a friendly accusation of prejudice with regard to the humoral theory of synaptic transmission, may I take this opportunity of stating once again that I know of no evidence fit for critical examination that would place the liberation of acetylcholine as a *primary* event essential for synaptic transmission, in any division of the nervous system, central or peripheral. The work of Rosenblueth and Simeone cited by Dr. Forbes was published after my book had left the press. A full statement of the evidence for the electrical concept of synaptic activity will appear in a series of five papers by Drs. Gasser, Erlanger, Bronk, Lorente de Nó and Forbes in the September number of the *Journal of Neurophysiology*, which is now in the press. It seems therefore unnecessary to offer here any further defense of my position in this interesting and important controversy.

Save for those points, which might mislead the uninformed reader, Dr. Forbes's review is fair, generous and much appreciated.

J. F. Fulton

Yale University

SCIENTIFIC BOOKS

The Distribution of the Stars in Space. By Bart J. Bok, associate professor of astronomy, Harvard University. xvi + 124 pp. Chicago: University of Chicago Press, 1937. $2.50.

The editors of the *Astrophysical Journal* are currently engaged in sponsoring a series of astrophysical monographs, which are designed to bring up to date the state of knowledge in the various fields of stellar astronomy. The first volume in the series, by Dr. Bok, is a critical exposition of the information available in 1937 on the distribution of the stars in the galactic system. A truly amazing number and variety of researches have been carried out in this field during the past fifteen years. To organize and discuss critically the results of these multitudinous investigations is an imposing task, and one which the author accomplishes with clarity and dispatch.

The fundamental problem of stellar statistics is to deduce the true stellar distribution in the galaxy from observational data on the apparent numbers, brightnesses, colors, spectral types and motions of the stars. Chapter I of "The Distribution of the Stars in Space" deals with the many statistical methods, both analytical and numerical, that have been devised for this purpose. Methods for detecting deviations from random stellar distribution in any area of the sky are valuable for promoting the discovery of inconspicuous dark nebulae. With regard to the problem of the determination of space densities, Dr. Bok discusses the relative merits of analytical and numerical methods and presents strong arguments in favor of the latter procedure. Simple analytical formulae are inadequate to represent the complex variations in stellar distribution over the sky. The most serious obstacle in the path of attaining a complete understanding of the details of stellar structure is the presence of clouds of obscuring material in the galaxy. The author describes how stellar statis-