gle-shock stimulation of the olfactory bulb, parts of the pyriform lobe, and parts of the thalamus, with latencies (2.5 to 8.0 msec) greater than the latency of the response to direct stimulation (less than 1.0 msec). Propagated spikes preceding the dipole wave were always seen on stimulation of the olfactory bulb and sometimes on stimulation of the pyriform lobe.

It seems clear that a burst of propagated spikes is responsible for transient activation of the dipole in response to single-shock stimulation; "spontaneous" activity might be due to continual trains of spikes reaching the prepyriform cortex along the same paths as spikes evoked by single shocks. Olfactory sensory stimulation evokes spikes in the lateral olfactory tract as well as oscillating potentials in the prepyriform cortex (*3*); pain induces the same oscillating potentials in that cortex (*4*). These findings are interpreted to mean that the e.m.f. of the dipole lies in the prepyriform cortex, but that the "controls" of the e.m.f. lie elsewhere in the rhinencephalon and thalamus.

The pattern of current postulated to occur during formation of the corticonuclear dipole is fundamentally similar to that thought to occur during saltatory conduction (*5*) (Fig. 1, *a, b, c*), but with this major difference: during saltatory conduction the site of e.m.f. moves to successive nodes of Ranvier, whereas during field conduction the site of the e.m.f. spreads in directions normal to the direction of conduction. During saltatory conduction in a nerve, the inflow and outflow of axonal current occurs through membrane areas of approximately equal size, but during field conduction the net somatodendritic current appears to pass through the axon tip. Since dendrites have more surface area than axons, the current density at the axonal tip may exceed the density at the dendritic surface. The possibility arises that the periaxonal *current density* may be "amplified" to levels capable of influencing surrounding neurons, in the same way as electrical stimuli delivered to the brain by means of electrodes (*6*). Certain anatomical peculiarities of cortical neurons lend credence to this possibility: the surface projections on the "feathered" dendrite (which would provide a large factor of amplification); myelinated axons purportedly without nodes of Ranvier (which would provide insulated conductors); and free endings (which in this view would not require a chemical transmitter for activation of surrounding cells).

The prepyriform cortex appears to be the site of an electromotive force capable of forming an oscillating current field in the basal forebrain nuclei. The control of the field appears to reside in structures adjacent to the prepyriform cortex. It is suggested that to the extent that rhinencephalically induced currents influence neuronal activity in the basal nuclei, a transfer of information can take place from the cortex to the nuclei without the mediation of propagated spikes (*7*).

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7. This investigation was supported by a fellowship (BF-6317-C) from the National Institutes of Health, U.S. Public Health Service.

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Phenology of Lilac Bloom in Montana

Studies of periodic biological phenomena in relation to the environment, often referred to as phenology, are being made throughout Montana in order to learn more about climate and its relation to agriculture. In the spring of 1956, the Montana Agricultural Experiment Station, in cooperation with the U.S. Weather Bureau and local garden clubs, began a survey of various stages of development of the common purple lilac (*1*). This plant was selected for observation because it is widely grown throughout the state and can be easily identified and because the timing of its various developmental stages appears to be dependent on the "thermal" environment. The "thermal" environment of the plant, as the term is used here, is a physiological concept. Although plant development increases with higher temperatures (within limits), the relation is by no means linear. Furthermore, other factors, such as radiation, wind, humidity, and so on, contribute to the rate of over-all development and to some other physiological responses of the plant. It is this total environmental complex, usually well represented by temperature measurements, which is designated "thermal" environment.

Questionnaire cards were sent to 327 Montana climatological observers by state climatologist R. A. Dightman, requesting information on the following three stages of floral development of the common purple lilac; date of first bloom, peak of full bloom, and final withering of the lilac bloom. The information requested was received from 123 weather observers. In addition, similar data on the lilac and other plants were reported by garden club members, mainly from the larger communities throughout the state.

Some plants that develop through their various stages of maturity without being greatly affected by the natural variations of photoperiod or soil moisture can be used as integrators of the "thermal" environment and thereby can serve as climatic indicators. Hence, indicator plants which are widely distributed and available for observation may be considered "measuring sticks" of *local* climatic differences.

This use of available plant indicators for purposes of learning more about the natural environment can prove to be of particular value to agriculture because local climates often determine success or failure in growing different varieties of agricultural crops.

Since weather observations are made only at widely scattered points, little is known about local climates on individual farms. Also, within similar climatic areas, (so designated on the basis of available weather information), considerable differences in plant development are often found because climatic variables not measured at the climatological stations—variables such as solar radiation, wind, humidity, and the daily course of temperature—are disregarded in the climatic classification. Because of the expense of measuring all important climatic elements and of increasing the density of the climatological network, the phenological approach to understanding regional and local climates may have an important role to play in climatology.

Phenological data are of value not only as climatic indicators; they can be utilized in many other ways. For example, observations on developmental stages of various agricultural crops serve as a basis for scheduling farm operations, even though the agricultural crops observed may not be well adapted as indicator plants. Phenological data can also help in revealing basic information about plant-environmental relationships, since weather effects are often closely linked to their concurrence with particular stages of crop development.

The lilac bloom survey conducted throughout Montana in the spring of 1956 has provided useful information about the climate and plant development in this state. The dates of bloom were plotted on maps, and "late" and "early" areas were determined. Statistical analysis of the information indicates that latitude and elevation were significantly correlated with dates of lilac bloom. It was found that the season was retarded about 1 day for every 20 miles of northward distance. The bloom was also about 1 day later for every 100-foot increase in elevation in the mountainous areas.

As more information is accumulated in subsequent surveys, analyses will be made to determine the relation between weather measurements at the climatological stations and plant development.

Figure 1 shows the periods when lilacs came into bloom throughout Montana in the spring of 1956. In "early" areas, indicated by horizontal lines, lilacs bloomed before 20 May. Areas with no lines were intermediate, with bloom beginning between 20 and 25 May, and the areas of slanted lines were last, with the onset of bloom coming after 25 May. Due to the scarcity of reports from areas above 5000 feet and to the great influence of the irregular terrain at these altitudes, this initial analysis does not extend to higher elevations.

Two large early-blooming areas are shown on the map, one in the east-central part of the state and the other in the far western valleys. Earliest reports of bloom dates came from Hardin (elevation 2895 feet), in southeastern Montana. A number of reports of early bloom also came from the north-central part of the state, including locations in and near Great Falls and Highwood and the towns of Chinook and Dodson.

Lilacs bloomed late in the northern communities bordering on Canada, in the northeastern section near North Dakota, and in some of the mountain valleys of the western section. Latest reports of bloom dates came from Elliston (elevation 5075 feet), in west-central Montana.

Figure 2 shows the duration, in days, of the period between the beginning and the end of the lilac bloom. Lilacs remained in bloom less than 14 days in the areas where there are horizontal lines and more than 20 days in regions covered by slanted lines. This map tends to reflect the weather which occurred during the blooming period, and it could provide a basis for understanding relationships between weather and plant development.

For the state as a whole, it required an average of 7 days for the lilacs to advance from opening of first bloom to the date of peak of full bloom and 9 days to develop from peak of full bloom to the end of bloom. The highest station reporting lilac bloom was Lima, in southwestern Montana, with an elevation of 6265 feet, and the lowest station to report lilac bloom was Hinsdale, in the northeastern section, which has an elevation of 2170 feet.

A number of countries have well-organized phenological networks and are effectively utilizing such information in their agricultural planning. It is interesting to note that phenological observations have been made in Europe from the mid-18th century up to the present time, whereas very little has been done in the United States to obtain phenological information on a regional basis.

In 1957 phenological reports are being obtained from individual farmers throughout the state as well as from the climatological observers and garden club members who cooperated last year. Since lilacs are not available for observation purposes in some parts of Montana, an alternate indicator plant, the large common *Caragana* (Siberian pea), is also listed for this year's survey. The *Caragana*, a yellow flowering perennial, completes its various stages of bloom at about the same time as the lilac. Study of the additional reports now being received will permit greater detail and accuracy in the charting and statistical analyses of the phenological information.

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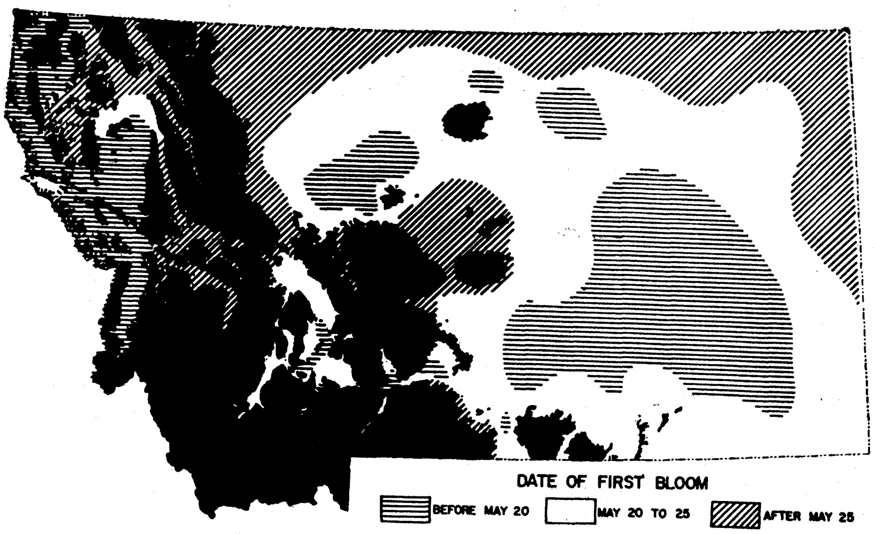

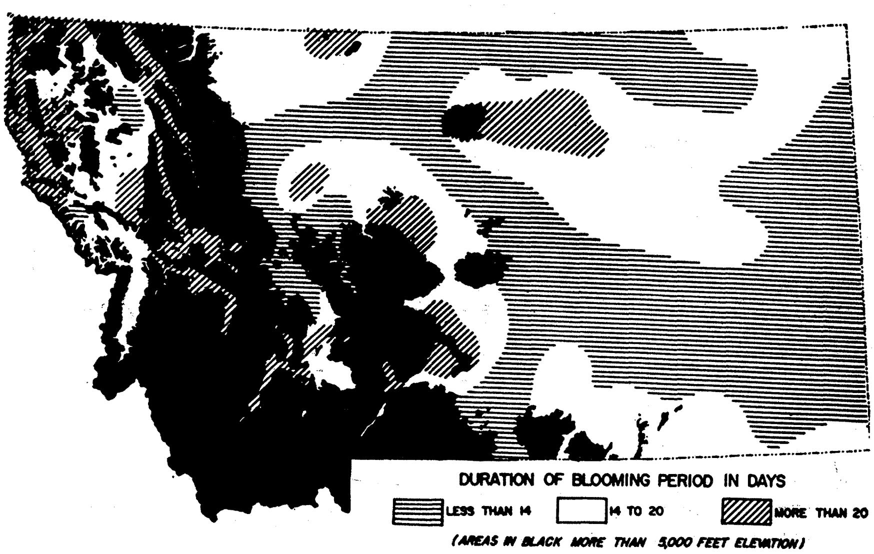

Fig. 1 (Top). Periods when lilacs came into bloom in Montana in 1956. Fig. 2 (Bottom). Duration of the period of bloom.

Note

1. This survey was made possible through the cooperation of R. A. Dightman, state climatologist, U.S. Weather Bureau, and of V. E. Iverson and H. N. Metcalf, Horticulture Department, Montana State College.

7 October 1957

Relation between Size of Neurons and Their Susceptibility to Discharge

Neurons in the central nervous system differ widely in the size of their cell bodies. Even in relatively homogeneous groups of cells, such as motor neurons, the differences in volume and surface area are considerable. The functional significance of these variations in size is not known. It is, of course, a well-established fact that the voltage required to