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Division of Horticulture

PRUNING

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INTRODUCTION

The Department of Botany in cooperation with the Division of Horticulture, has prepared this treatise on pruning, Dr. Atwood of the Department of Botany preparing the chapter on Plant Physiology as Related to Pruning.

The Division of Horticulture has been working for a number of years on research problems related to pruning. As this work is in the preliminary stages, it will be a number of years before a complete report can be made. However, in the various papers in this bulletin we are presenting a few of the facts which we have been able to determine, coupled with observations that have been made in various fruit-growing districts.

C. I. LEWIS,
Chief, Division of Horticulture.

PLANT PHYSIOLOGY AS RELATED TO PRUNING

By W. M. Atwood, Associate Professor of Botany

For the orchardist most correctly to deal with the problems confronting him, it is necessary to have a clear idea of the complicated "living machinery" upon which he is dependent for profit or loss. It is worth while to know how the tree removes from the soil the substances it needs; how it manufactures its food, and finally how both the complicated food materials and water are distributed and used by the tree. The knowledge of a few facts of this nature is the necessary foundation upon which is being built the successful practices of the practical fruit grower of today.

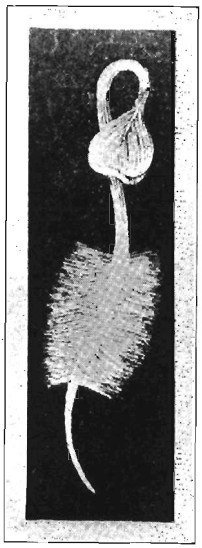

Figure 1. Seedling of radish showing root hairs. (After B. M. Duggar, "Plant Physiology." Macmillans.)

If the finest terminal roots of most living plants be carefully examined there is found on their surfaces a fuzzy growth resembling fine hairs. As the root is the region in which the plant absorbs the water and minerals of the soil, it is evident that this absorbing region of the root—the root hair region—must tremendously increase the absorbing area of the root. Figure 1 shows a young root with the root hair zone well developed. These fine outgrowths of the root enable it to get into very intimate contact with the finest soil particles which contain necessary minerals and which are surrounded by films of soil-moisture that become available to the plant. The necessity of carefully guarding the root hair region of trees from injury so far as is possible is emphasized by the behavior of any young tree upon transplanting. Figure 2 shows the way in which a twig of a pine tree was affected by transplanting. It is evident that in transplanting, the tree loses a large percentage of the finer roots, and hence of the most active water-absorbing tissues. The region where the needles were so no-

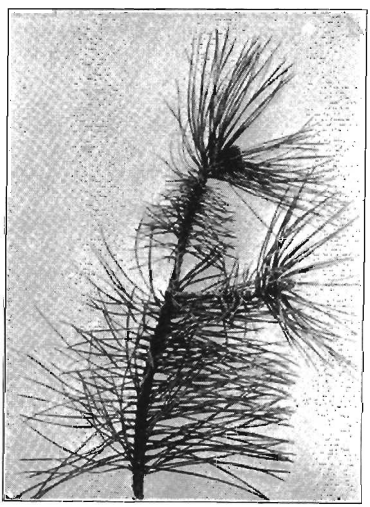

Figure 2. Effect of transplanting upon water supply. The short needles produced after transplanting. (After B. M. Duggar, "Plant Physiology." Macmillans.)

ticeably shortened, is the region which developed immediately following transplanting and before the pine had been able to develop new water-absorbing root tissues. It thus becomes perfectly clear why the orchardist when purchasing trees from a nursery never leaves a large leafy top after first setting out the young tree. Temporarily the young tree is less able to supply its leaves with water than previous to its removal from the nursery. The judicious cutting back of the top for a little while enables the tree soon to develop its root system back into balance with the top.

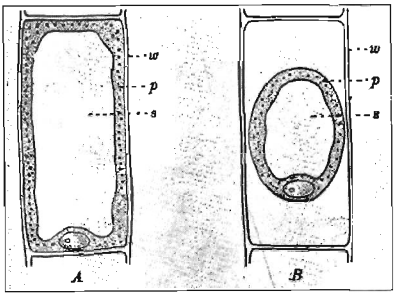

Figure 3. Root Cells. "A," in normal condition; "B," Cell deprived of its normal water. (After Bergen and Davis, "Principles of Botany." Ginn & Co.)

The root hairs do not absorb water from the soil as a sponge or a blotter takes up water when placed in a wet place. If a root hair is examined under a microscope we find that inside the thin outer wall there is a lining of the jelly-like living substance called protoplasm which is present in all animals and plants wherever there is life. Water tends to be taken into the root hair by a force called osmosis. When pure water is separated from the cell substances by the thin film of protoplasm, we find that the water can readily enter but the substances within the hair cannot get outside of the protoplasm. The law of osmosis is that when two liquids of different density are separated from each other by protoplasm which permits the passage of the less dense only, the less dense liquid moves in through the protoplasm into the more dense liquid. There would be no object in here explaining this water intake if it did not help to make clear the reason, at least in part, for the unfavorable effects of alkaline soils upon plants. Figure 3 shows at "A" a root cell which is in normal condition. If such a cell is surrounded by a soil sufficiently alkaline, water instead of moving into the root, tends to move in the opposite direction—that is, it moves out of the root, leaving a collapsed living cell as shown at "B." It is thus possible for a tree to be unable to get needful water in too alkaline a location even though moisture be abundant. Fortunately soils of this character are not common.

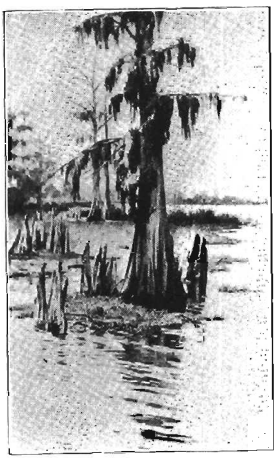

Figure 4. A swamp enduring tree, the Cypress, (*Taxodium distichum*, Rich.) Note the root projections of "knees" above the water surface. (After Bergen and Davis, "Principles of Botany." Ginn & Co.)

Before following water from the root hair region in its journey over the tree, one more point must be mentioned. Root hairs

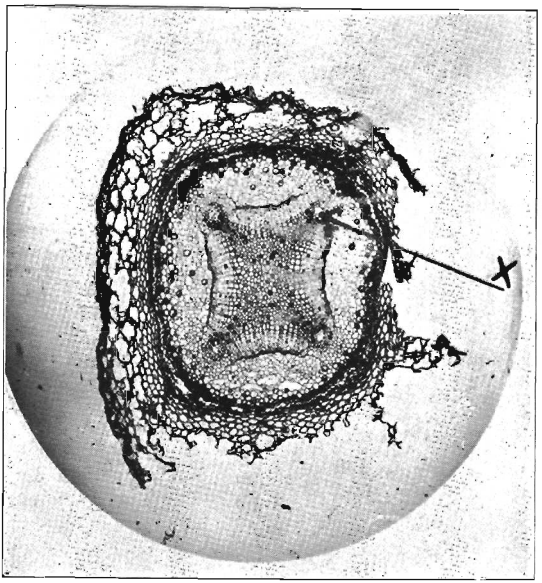

Figure 5. Cross section of a young pine root. (*Pinus Strobus*, L.)

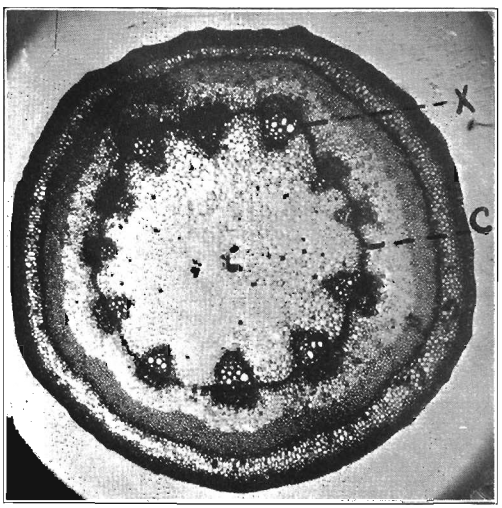

Figure 6. Cross section of young stem of "Pipe Vine." (*Aristolochia Sipho*, L'Her.)

to perform their work of water intake properly, must have a certain amount of air in the soil. If the soil be too wet or "water logged," injury results to the tree because of the unfavorable conditions imposed upon the root. Only a few trees such as the Cypress (Fig. 4), are adapted to meet such an excess of water about their roots. The significance of this fact in orchard cultivation and drainage is clear.

If we cut a thin slice across a root, we are able to see towards its center the water-carrying vessels which take the water absorbed by the root hairs and carry it up to the stem. Figure 5 shows at X the water-carrying region of a young pine root, while Figure 6 shows at X the region in a young vine stem through which the water travels after leaving the root. We can also see in this cross cut of the young stem the cambium region at "C." The cambium is practically the only region in which any of our orchard trees develop so as to produce increase in diameter of the stem. As this is the only growing region it becomes evident that two grafted stems unite only at this one region, the cambium; hence the care which the orchardist exercises in making the two cambium regions come together.

The cambium lays down new wood each year, the latest wood always of course being the outer layer. The rings we often see running about the stump of a freshly hewn tree are the product of this yearly activity of the cambium.

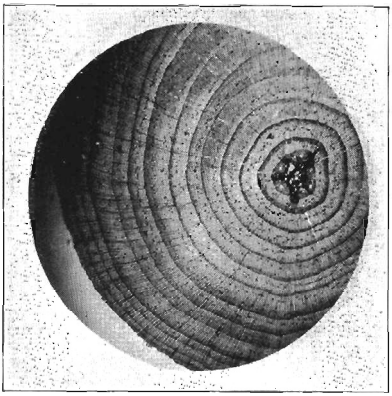

Figure 7. Cross section of the stem of the Redwood, (*Sequoia sempervirens*, End.)

Figure 7 illustrates the yearly rings of a stem, but if we would see more clearly just the cause of the ringed appearance of the wood, we find it necessary to magnify the wood at the region of one of these rings. This wood or water-carrying tissue, as illustrated in Figure 8, is composed of water ducts or cells. The wood laid down in the late summer is much more dense, as shown at "A," while the early summer wood is more porous and open as we see at "S." This is partly explained by the fact that the water demands upon the tree are greater in the spring in proportion to the water-carrying tissues present, than later in the summer. The wood of the horticultural varieties as walnut (Fig. 9) or the cherry (Fig. 10) shows the difference in spring and late summer wood a little less conspicuously than figure 8.

If we follow the ascent of the water up the stem, the two points of destination most of interest perhaps are the buds and the leaves. Only in so far as water absorption from the root and water transfer through the stem is in normal condition can the young buds far up on the twigs open or perform their work. In the leaf we find the source of the majority of all the food which

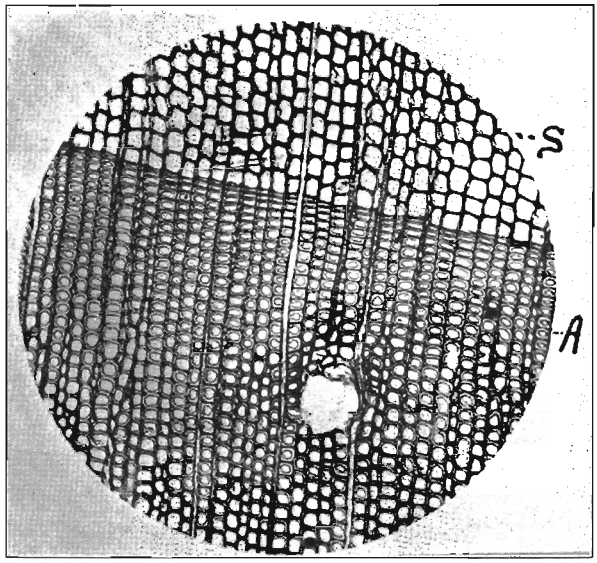

Figure 8. Magnified section of wood of the Pitch Pine. (*Pinus resinosa*, Ait.) "A," late summer wood; "S," early summer wood.

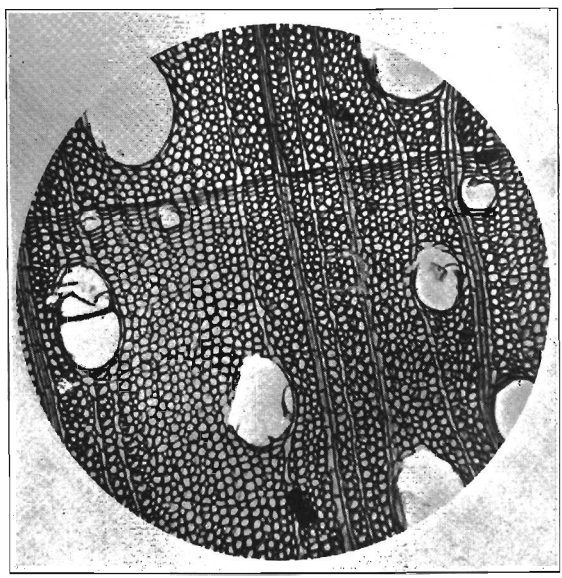

Figure 9. Magnified section of the wood of Walnut. (*Juglans nigra*, L.)

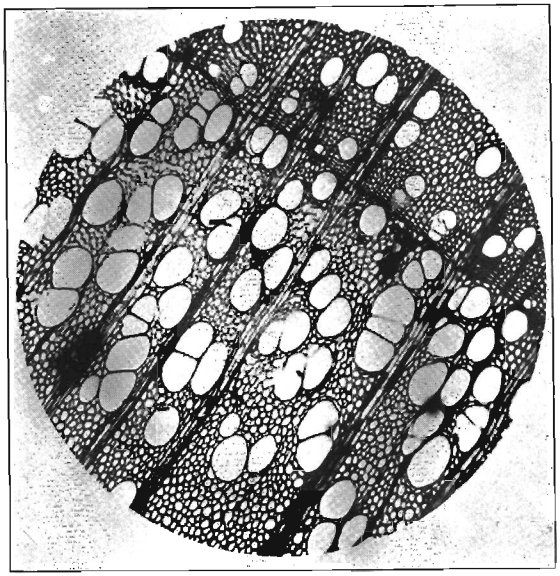

Figure 10. Magnified section of the wood of Cherry. (*Prunus serotina*, Ehrh.)

the plant produces and which enables the tree to grow or produce fruit. A very small proportion of the woody tissues or of fruit tissues are due to the so-called "foods" of the soil, but the large per cent is derived from true foods

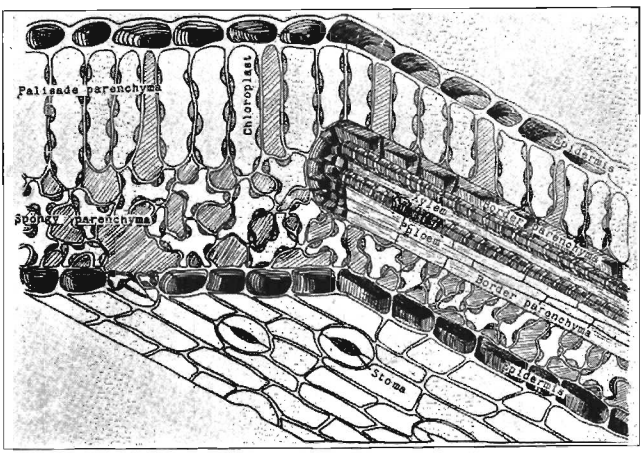

Figure 11. Diagram of the cut edge of a leaf to show the regions contained. Magnified. (After Stevens, "Plant Anatomy.")

laid down in the leaves. This makes clear the great injury to an orchard resulting from any factor which reduces the leaf area of the tree beyond certain safe limits. If we cut across a leaf and then look at the exposed edge much magnified, we see something like the diagram of Figure 11. The green coloring of plants is particularly abundant in the leaf, and is located especially in the upper portions of the leaf which are marked "palisade." On the under surface of the leaf will be seen little openings, one of which is marked "stoma." Through these openings the air has access to the interior of the leaf. The carbon dioxide present in the air in small amounts, combines with moisture present in the leaf, under the influence of sunlight in the region of the green coloring bodies found in the leaf palisade tissue. The result is plant food in the form of starches and sugars. These air openings or stomata are present on the lower surface of an apple leaf to the extent of about 24,000 per square inch. Figure 12 shows such stomata photographed from the under side of a leaf.

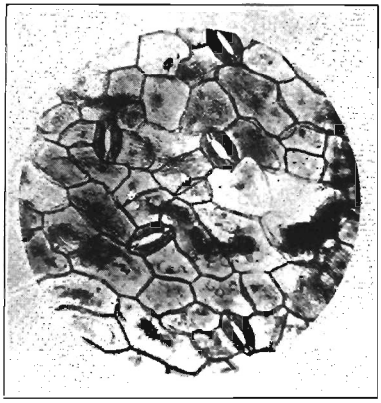

Figure 12. Photomicrograph of stomata on the under side of a leaf. (After F. E. Lloyd, "Physiology of Stomata.")

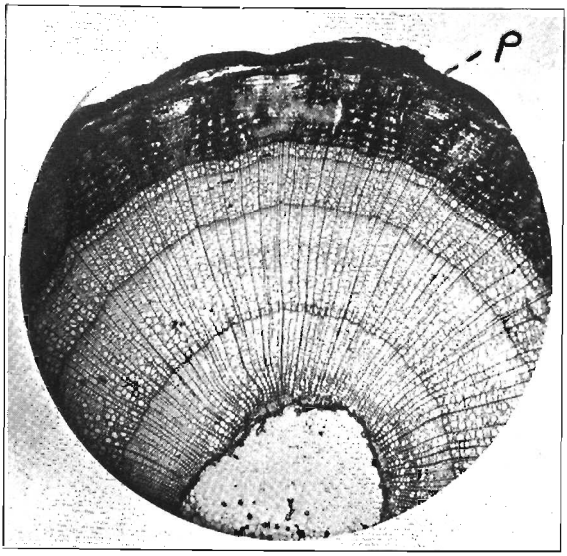

Figure 13. Magnified section of the wood of the Linden or Basswood. (*Tilia Americana*, L.) "P," the food carrying regions of the inner "bark."

The food laid down or manufactured in the leaf is distributed over the tree through certain regions of "food ducts" which are located in the inner "bark." Thus in Figure 13 we see in the cross cut of a basswood limb that the woody or water-carrying tissues are surrounded by certain regions of the "bark" (P) which are responsible for the distribution of food to the tree. It is a familiar fact that wounded animal tissue requires abundant food materials to repair and rebuild the injury. The food is supplied by the blood. In the case of plants, the food stream is distributed more slowly through the bark. It thus is evident that in removing a limb entirely, if the cut is made parallel and close to the surface from which the limb arises, the wound will be in the best position to intercept the food materials passing down from the

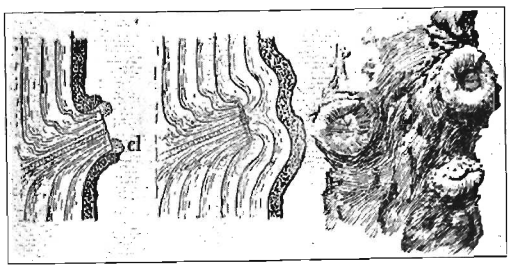

Figure 14. Section of a stem to show the method of healing after removal of a branch. (After Curtis, "Nature and Development of Plants.")

leaves through the inner "bark." See Figure 14. For similar reasons heading back is usually to a side limb rather than cutting to a bare stub.

From the above facts it should be evident that the growth and thrift of a tree is dependent upon various factors, among which we must include the fertility of the soil, the water supply about the roots, their condition and development, the care with which the soil has been cultivated, and the character of the leafy top of the tree. The objects which are aimed at in pruning are always more effectively attained if, at the same time that the top is being artifically altered, we bear in mind the various other conditions which surround the tree, of which we have spoken above, and which are often sufficiently effective to modify or do away entirely with the beneficial effects of the most "artistic" pruning unthinkingly practiced.

The application of these conditions to the problems of pruning in Oregon will be more clearly brought out by the portions of this bulletin which follow.

THE STUDY OF FRUIT-BUDS

E. J. KRAUS

If the fruit-buds are regarded as the actual fruit manufacturing machinery of a tree, it is necessary to know something of where they are located, how and when they are formed, and how they should be treated. For convenience, they may be classified according to their particular location on the tree; namely: terminal buds (on shoots), axillary buds (on shoots), and those borne on spurs. The terminal fruit-buds are those which are at the very tip or terminus of a shoot. In certain varieties of apples, such as Jonathan, Gravenstein, Newtown, and others, and in some varieties of pears, notably the Bartlett, Winter Nelis, and Angouleme, much of the first crop of fruit-buds is borne terminally on shoots. The axillary buds are also borne on one-year-old wood, but on the sides of the shoots instead of at the tips. The third class of buds, those borne on spurs, which are really nothing more nor less than very short branches, are borne either singly, or in aggregations of twos, threes, or many. Generally they are developed first from either one- or two-year-old wood, though at times from that which is older. They develop either from single terminal buds, as is general in plums and prunes, or from one to several lateral buds, as in apples and pears. Depending upon variety and environmental conditions, these annual increases in length may vary from a fraction of an inch to several inches, with the result that the older spurs may be very compact, or loose and spreading. In some instances large spurs consist of as many as forty or fifty buds on more or less

Figure 15. Bartlett pear twigs showing at *a* numerous axillary buds; *t* terminal buds; *f* a fruit-spur which bloomed last year but set no fruit and from which vigorous side branches have grown; at *b* fruit-spurs which bore fruit last year and are producing blossoms this year at *S*.

angled branches. A fruit-spur, then, may be a single short branch bearing one or a few fruit and leaf buds, or a large aggregation of such branches which arise from one another.

The proportions of the several classes of fruit-buds vary greatly according to the kind and variety of fruit. In the peach, particularly, all the fruit-

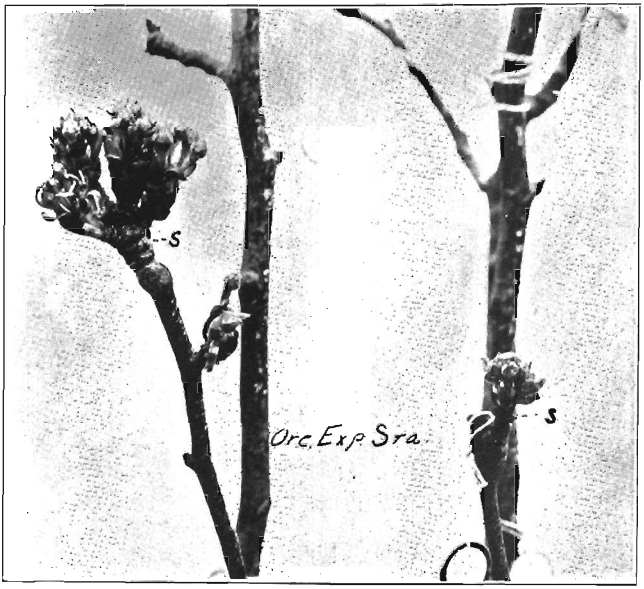

Figure 16. Bartlett pear. At *S* fruit-buds produced laterally from a spur which bore last year.

buds are axillary and borne on one-year wood. Some of the annual branches are so short that they might be regarded as spurs, perhaps, though the proportion of buds borne on such spurs, as compared to the total number on the tree, is small. In this particular class of fruits the fruit-buds, which usually contain one or sometimes two flowers, are borne singly on one side or the other of the leaf-buds, or in pairs with a leaf-bud between them. They are usually more numerous toward the tips of the branches, though when the trees have been properly kept open to admit light and air they are plentiful on the smaller laterals and scattered well along the branches, except at the bases of the larger ones. In the plum and prune, fruit-buds are borne both on one-year shoots and on spurs. Most Japanese varieties have large quantities of axillary buds, much as has the peach, except that frequently there are more than two at each node. The number of axillary buds on one-year-old wood in the case of the common varieties of prunes should be regarded as small as compared with those on spurs, though one-year-old spurs are often prolific bloomers. .The sweet cherry has its fruit-buds either on spurs or as axillary

buds on one-year-old wood. If the one-year branches are of any considerable length, it is worthy to note that the fruit-buds on them are borne near the base, or at least the basal one-half. Apples and pears may be considered together, since the methods of fruiting are similar. The fruit-buds are borne on spurs, as axillary buds, or terminals on one-year wood. Varieties vary greatly in this regard. Some have a large proportion of their fruit-buds on one-year wood, especially while young, while others bear very few such buds, having practically all, except a very few terminals, borne on spurs which sometimes are present on one-year wood. Attention is called to the fact that, normally, the axillary fruit-buds are borne near the tips of the branches instead of the base, just the reverse of the condition prevailing in the sweet cherry.

In apples and pears it is frequently objectionable to have fruit borne at or near the tips of long one-year branches, because such branches are bent

Figure 17. Winter Nelis. Fruit branch taken from an old tree. Note that the greatest number of fruit-buds are borne on vigorous new wood produced by thinning out old spurs. The old unpruned spurs bear mainly leaf-buds.

with the fruit and become misshapen, are swayed with the wind, and thus bruise not only the fruit they bear, but all in the immediate vicinity, and tend to bring the fruit to the very outside of the tree, so that even a light load is apt to cause breaking. Yet it is undesirable at times to remove all such fruit-buds, because they may constitute a large proportion of the entire crop. If it were possible it would be of much greater advantage to have them borne on short laterals so that they might be saved to produce fruit. Such a con-

dition actually can be brought about, especially with young trees, through a method of early summer pruning, whereby some of the branches, instead of being allowed to grow normally, are headed back sufficiently early in the season to allow laterals to spring from them and develop terminal and even axillary fruit-buds.

The amount of pruning to be done in winter on any variety of fruits so as to produce the maximum number of fruit-buds depends upon so many factors that no specific recommendations can be made. Two facts must be observed, however, when dealing with normal apple or pear trees of average vigor, and, in a general way, all other deciduous tree fruits. First, if a large amount

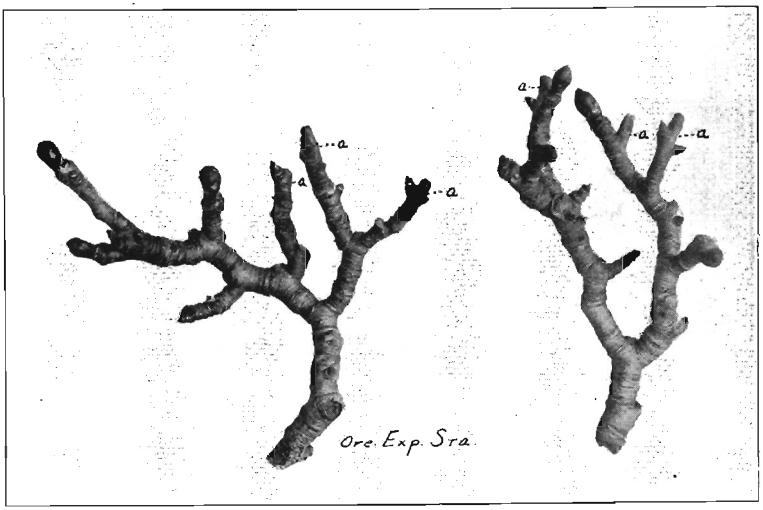

Figure 18. Bartlett pear. Old spurs which have been blooming annually but setting a very small number of fruits. At *a* spurs which bloomed but set no fruit, some of them again producing fruit-buds the following season.

of wood is removed in heading back a one-year-old branch, lateral branches, and not fruit-buds, will be produced from the remainder. Second, if the heading back is very slight, fruit-buds may and are apt to be produced, but they are likely to be borne near the cut, with the result that below them few or none of the buds will break and long barren spaces on the branches will exist. It is a safe rule to bear in mind, that the greatest influence is felt in the vicinity of a pruning cut. Thus, if a long branch is cut back severely, the greatest growth response will come near the point of cutting, though there will be some response throughout the whole limb. Or again, if a dense or tall pear tree, for example, has the top cut back without a thinning out or cutting back of the remaining branches, the first or greatest response will be near the cut. This principle is of importance in pruning very old trees in which masses of spurs have been formed, but which are not producing

annual, profitable crops. Annual crops of bloom are produced but the crop of fruit is light, and what is produced is often inferior. In such cases it would be better to remove some spurs entirely and thin out others in order again to bring about a vegetative response directly within the remaining spurs themselves rather than to take out many large branches or merely to cut

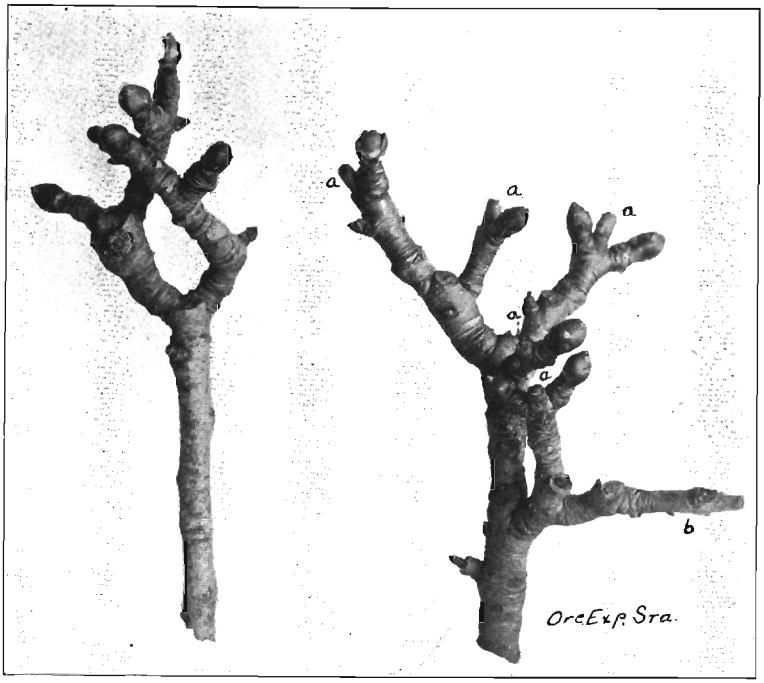

Figure 19. Bartlett pear. Old spurs which have set an average number of fruits in previous years. At *a* spurs which bloomed but set no fruit, again producing fruit-buds for the following year. At *b* the same except no fruit-buds produced.

back the top or saw off the ends of all large limbs. Such a spur pruning may not be advisable each year, but will serve as an occasional rejuvenating means. The removal of some branches will probably be necessary in conjunction with the spur thinning, and of course the removal of all dead wood is essential. The main point to be emphasized, however, is this: there will be less unbalancing of the trees, and more real stimulation to fruit production if the cutting is distributed rather than more or less localized. Figure 18 represents part of two very old spurs. They have been producing fruit-buds and flowers for many years, but have matured but few fruits, due to a lack of vegetative vigor. Figure 20 shows a portion of a spur which had been thinned and shows a strong, almost too vigorous vegetative response, as a result,

while Figure 22 illustrates how these vegetative shoots again become strong fruit spurs in the course of two or three years.

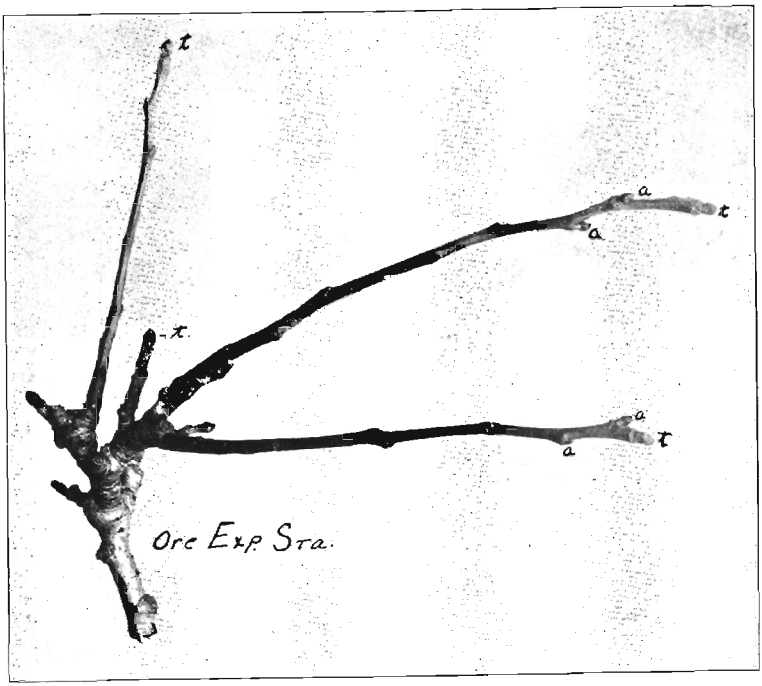

Figure 20. Bartlett pear. Vigorous vegetative response from thinning spurs; terminal fruit-buds at *t*; axillary fruit buds at *a* on one-year shoots.

In this connection attention is called to those lateral branches of moderate length which bear terminal fruit-buds and are frequently abundant in young trees just coming into bearing. If not excessively long, say not over twelve inches, it is the best policy not to remove the terminal bud, since if it is left to remain the chances of having the lateral buds on such a branch develop into fruit-spurs are much greater than if the branch is headed back. Even if fruit does not set from such a bud, the beneficial effect is greater if it is not removed. Of course, if the branch is excessively long and limber, head it back. Frequently, in pears and in many varieties of apples, such laterals of from three to eight inches in length, if left alone become the first really productive areas of the tree, but are ruined if removed or heavily cut back. This statement is in no way intended to discourage the practice of shortening in or heading back those more or less numerous lateral, vegetative branches which frequently grow in large numbers in the lower inner portions of young trees. In fact, there is reason to believe that if some of these branches are

allowed to remain and are cut back to three or four inches in length they can be developed into early and valuable fruiting wood.

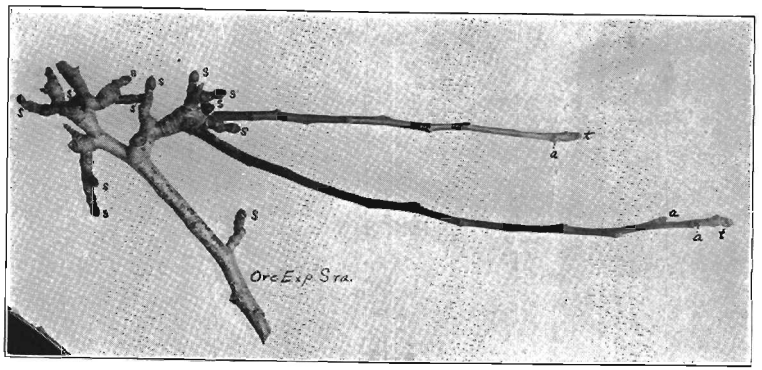

Figure 21. Bartlett pear. A good vegetative response from thinning the spurs. Note the numerous fruit-buds at *S* on spurs which did not break into long branches; terminal buds at *t* and axillary fruit-buds at *a* on one-year shoots.

The time or season during which fruit-buds are formed is a matter worthy of consideration. The practice of summer pruning largely hinges on such a knowledge because if the pruning is done at one season of the year, and is to have an immediate effect, sufficient time must be allowed for fruit buds to develop during the part of the season which remains. The amount of cutting that may be permissable early or late in the season is entirely different. Early summer pruning may, and sometimes should, be heavy to bring about a vegetative response, while a late summer pruning must be light in order that a heavy vegetative response may be avoided. Too late a summer pruning may fail of its purpose absolutely, either by forcing worthless vegetative shoots or causing leaf buds to start which do not have sufficient time for reorganization into fruit-buds. Roughly speaking, trees have a growth period and a dormant period, though in fact, certain changes are going on throughout most of the dormant period. Changes take place within a bud and determine whether it will become a leaf or fruit-bud in the apple or pear as early as the latter part of June and proceed throughout the summer and fall. The very beginnings of fruit-buds are also visible as late as the latter part of August, so that apparently there is actual differentiation of buds occurring throughout the summer. Usually this differentiation takes place first in the buds on the spurs, then those in the axils of the leaves, and finally in the terminals. Depending on conditions, the order may vary, depending on the vigor and growth of the shoot, especially among the terminals. In fact, the order may be reversed, or they may form at about the same time. With minor exceptions fruit-buds for these particular fruits go into the winter in practically the same state of development. But slight advance takes place during the early part of the dormant season. Later, numerous microscopic

changes go on and these, in late winter and early spring, occur even more rapidly, until finally the swelling of the buds becomes very evident and blooming follows in course of time. Knowing the period at and during which fruit-bud formation takes place, one is better able to modify orchard practices so that the best possible conditions for their development can be brought about. Such buds are influenced by many conditions other than pruning, such as moisture, light, air and food, but it is the former means with which this discussion is most concerned.

The relation or balance which seems to exist between the so-called vegetative or growth tendencies and the reproductive or fruit-producing powers

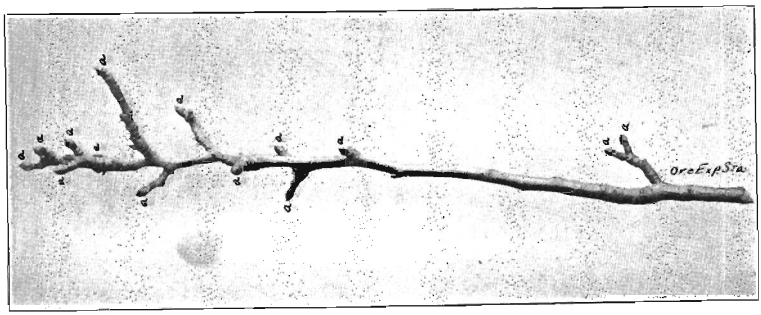

Figure 22. Bartlett pear. A vigorous shoot, produced from an old spur which has been pruned, now in a healthy productive condition. Note the numerous fruit-buds present.

of a tree is a delicate one and can be brought about or maintained only by the careful observation of each individual tree and its response to any treatment given. Suffice it to say that it is easily possible to have too many fruit-spurs or fruit-buds in a tree; so many in fact that the energies of the tree appear to be used up merely in the production of bloom, and such fruit as may be produced is inferior both in size and quality, as previously pointed out. The aim must be to produce or maintain, not the greatest possible number of spurs, but the most efficient fruit-spur system, which means that the spurs shall be evenly distributed throughout the whole tree, that there shall be ample room between and among them, and that they be healthy and vigorous. The same ideas as outlined for fruit-spurs hold true for the fruit-buds of the peach. While the total number of fruit-buds produced might be greater on an unpruned tree, and it is true that large numbers of them are lost from winter pruning, yet it is better to remove some branches entirely and to shorten back others and admit light and air into the tree to strengthen the remaining buds and maintain proper vegetative condition than to allow it to spread out and lose practically all its lower and interior fruiting area and produce only at the ends of the branches toward the outside.

Finally, then, it is necessary that a careful study be made of the fruit-bud producing habits of any variety under any given set of conditions. There are localities in which trees tend to produce an excess of fruit-buds when

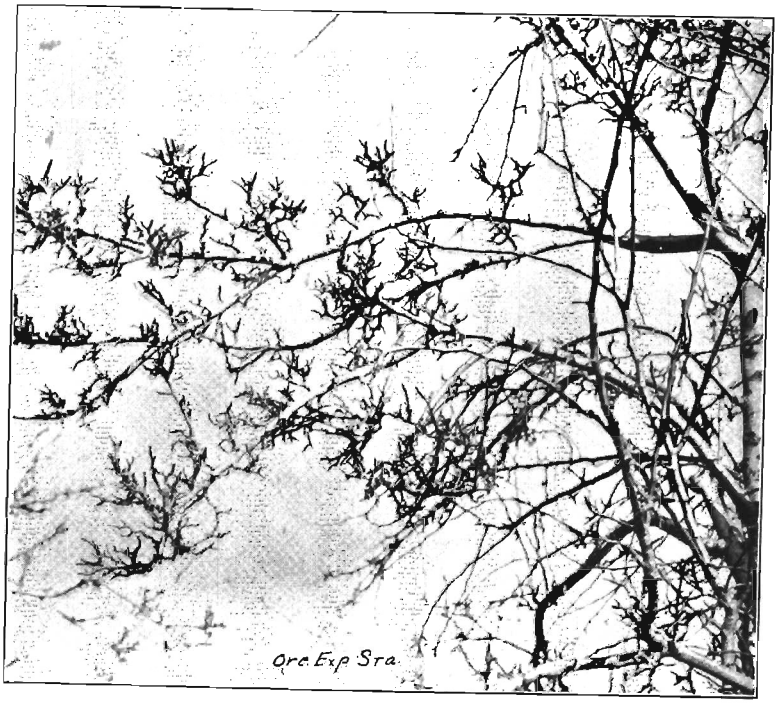

Figure 23. Large branches from an old Bartlett pear tree. Numerous fruit-spurs but very light vegetative growth.

compared with the production of vegetative shoots and care must be exercised in pruning that the ideal relationship be maintained by either a heavy heading back or thinning out. Again the tendencies may be in the opposite vegetative direction, and unless great care is exercised the trees are unproductive or do not come into bearing for many years. In such cases great caution in heading back must be exercised, and frequently methods of control other than pruning must be resorted to. The question of annual bearing of varieties is of great importance to every fruit grower. It would be a difficult task to make all varieties of apples annual bearers, since if it is not a characteristic of any variety so to bear special methods of pruning or culture would be required to change the entire constitution of the tree. On the contrary some varieties will bear annually, even under the most adverse conditions. Generally speaking those varieties which produce fruit-buds liberally on one-year wood, either as axillaries or terminals, come into bearing younger, and are more likely to bear annually than those which bear on spurs exclusively. It should not be overlooked nor forgotten that while it may be normal for spurs to bear only during alternate years, such is by no means always

the case and blooms and even fruits are often produced each successive year for a number of years. This is notably true of several varieties of pears, especially the Bartlett, which like the Wagener and Jonathan apples is an excellent example, also, of a variety which produces an abundance of axillary and terminal fruit-buds. The following table, based on a range of average Oregon conditions, will serve to give information concerning the more common varieties of apples and pears.

TABLE I. RELATION OF POSITION OF BLOOM TO BEARING IN THE COMMONER VARIETIES OF OREGON APPLES AND PEARS.

Apples	Bloom on terminals	Bloom on axillary buds	Annual bearers
Variety			
Arkansas	None	None	No
Baldwin	Some	Some	No
Bellflower	Rarely	Few	No
Ben Davis	Abundant	Many	Yes
Gravenstein	Many	Few	Yes
Grimes	Many	Rare	Yes
Hyslop	Many	Many	Yes
Jonathan	Many	Many	Yes
King	Few	Rare	Yes
McIntosh	Few	Few	Yes
Newtown	Some	None	No
Rome	Some	Very few	No
Spitzenberg	Few	Rare	No
Transcendent	Many	Many	Yes
Wealthy	Many	Many	Yes
Winesap	Many	Many	Yes
Pears			
Anjou	Few	Very few	No
Angouleme	Yes	Yes	Yes
Bartlett	Yes	Yes	Yes
Bosc	Some	Very few	Nearly
Clairgeau	Yes	Yes	Yes
Comice	Few	Few	No
Howell	Yes	Yes	Yes
Winter Nelis	Yes	Yes	Yes

PRUNING YOUNG TREES

C. I. Lewis.

Many orchardists growing young trees have been disappointed with the results they have obtained from pruning. While these disappointments may be due. on the one hand. to a lack of knowledge of some of the fundamental principles underlying pruning, on the other hand, we believe that a very large percentage of the dissatisfaction is due to the fact that the grower has been expecting too much from pruning alone, and has failed to realize the great importance of other orchard practices, such as irrigation, tillage, and the maintenance of soil fertility.

No matter how skillfully we prune for fruitfulness, unless we have such soil conditions as to furnish sufficient food and moisture at the right time to develop good, strong buds, we should not expect to secure satisfactory results. Again, we must realize that soil, elevation, and climate, are factors which have a very close relation to pruning. Likewise, the variety question is always to be taken into consideration. For example, the pruning of Jonathans in Southern Idaho, at an altitude of 2,000 feet, on a silt loam, is an entirely different problem from that of pruning Yellow Newtowns in Western Oregon on a heavy soil at an elevation of 100 feet. While the fundamental principles underlying the pruning of these two trees may be the same, the application of these principles to the two may be radically different.

We need, first, to form a clear understanding of what these principles are, and second, to study more closely than we ever have in the past the application of these principles to our individual orchards.

The Three Types of Trees

There are three types of trees grown here in the Northwest: the so-called open, globe or vase-shaped tree, the center leader type, and the modified leader type.

In the vase or open tree three to five branches are chosen to form the framework of the tree; any tendency of a branch to assume the lead is suppressed; no leader being allowed to grow, each of the three to five branches is given equal prominence in the tree. This tree was borrowed from the French and has been modified in this country to suit our special needs; for example, in parts of the Middle West and in California the tree is allowed to carry a large number of laterals, summer pruning or shearing being employed to force out more laterals so as to shade the branches from sun scald. A dense compact tree is the result. Here in the Pacific Northwest we seldom use the term "globe" or "vase," but almost always call it the open tree. Instead of shearing to produce shade, our growers prune out and keep the tree open to admit more light. The general framework, however, of the California and Oregon types is the same. Our orchardists claim that the advantage of the open tree is that it allows more light to enter the tree, thus causing a better coloring of the fruit; and second, it produces a tree that is broad and spreading and easy to keep low headed. The objections to this tree are: first, that it is

generally structurally weak, the scaffold branches issuing at one point, thus making weak crotches, and if one branch breaks out the tree may be ruined; second, this type of tree is used too generally, as it is not adapted to all varieties under all conditions that are found here in the Pacific Northwest.

The so-called leader tree has been used largely in the East on the Atlantic Seaboard, and is used somewhat on the Pacific Coast, especially in British Columbia. There are a few orchards here in the Pacific Northwest where the growers believe the leader to be the best type. With the leader tree, the center branch is always allowed to have the ascendancy, and the tree grows more or less to the true pyramid. The growers obtain very large trees. It is very difficult, however, to keep them low headed, and to keep them open, but they are probably stronger trees, there being less breakage from this type of tree than from the so-called open tree.

The third type of tree is the modified leader. In this type we start the trees exactly as though we were going to grow the center leader, but, beginning from the second to the fifth year, the leader is suppressed. The advantages of this type of tree are that it allows us to space the branches well, to build strong crotches and main scaffold limbs, and at the same time allows us to keep the tree relatively close to the ground. This type of tree is growing in favor where it has been tried throughout the Northwest.

We would caution the growers, however, that with any of these types of trees, weak trees or strong trees can be built, and also that very bushy or open trees may be attained with any one of the three systems.

The type of growth of trees in your locality may determine to a certain degree what system you should use. For example, we wouldn't grow the Wagener ordinarily as an open type of tree. It is rather an upright grower for a few years, but later becomes a feeble grower. On the other hand, we should not think of growing varieties like the Tompkins King or Northern Spy as center trees. They shoot up too straight, are too big, and are too hard to control. The Yellow Newtown is too often pruned as a typical open tree, and on light soils becomes very weak when twelve or fifteen years of age. A modified leader, or in some cases even the old-fashioned leader, would be better with the Yellow Newtown. On the other hand, on some very strong loams, the Yellow Newtown can be handled very satisfactorily when grown as an open or globe-shaped tree, provided we take a little care in spacing the branches carefully the first two or three years.

The Height of Head

The height of head is only a relative term. One man would say that 30 inches was a low-headed tree; another man would say that this was extremely high. The Pacific Coast grows low-headed trees. We have found by experience that these are the easiest to care for, that they are the most economical for thinning, harvesting, spraying, and pruning, and that we can shade the trunks and main scaffold limbs better with this type of tree, than with a high-headed tree. In parts of the Inland Empire they often head their trees very low, about eight or nine inches. Many of the Jonathans in the Rocky Moun-

tain district, and in certain portions of Idaho, Eastern Oregon, and Washington, are headed in this way and are giving satisfactory results. Under such conditions they must protect the trees as much as possible against sunscald. However, in Western Oregon we would consider 20 to 25 inches a better height of head. Many growers have felt that about 20 to 25 inches is the proper height for apples and pears. Peaches should be headed very low; as low as they can be grown. Cherries should be headed at about 25 inches. Prunes should be headed at about 30 to 35 inches. We used to believe that walnuts should be headed very high, 7 or 8 feet, and no laterals allowed to grow the first few years, but we are finding this was a mistake, and that about 35 inches will make a splendid head for walnuts.

Season for Pruning

Here in the Northwest, in speaking of seasons for pruning we generally only consider two seasons; namely, the winter and summer. We receive many letters in regard to early fall or late spring pruning. There is no question but that in the Northwest, where mild winter conditions prevail, winter pruning may be done safely most years at any time when the trees are dormant. In those sections of severe winter conditions, we would advise delaying the pruning as late as possible before the growth starts in the spring. Very rarely would we advise fall pruning in the Northwest, unless one has such a large acreage that it is going to be impossible to complete it unless the pruning is commenced early in the season. If it becomes necessary to prune trees in the fall or very early winter, we would suggest that the growers prune the older trees first, leaving the younger trees for the last pruning. We would caution against pruning trees when they are frozen, and would advise delaying pruning until freezing weather is over. Much heart rot and dieback has resulted from pruning frozen trees. It is possible to prune trees somewhat even after they come out fully in the spring. This is especially true with peaches, and will be discussed in another section of this article.

As regards summer pruning, this is becoming of such interest and importance, that we shall treat it under a special head.

Three Lessons to Learn in Pruning Young Trees

There are three great fundamental underlying principles connected with the pruning of young trees. You might say that there are three lessons, and that if these are mastered the problem of pruning young trees becomes rather simple, but unless they are mastered it is difficult to develop strong, well-balanced young trees.

Lesson 1. *To choose and space the scaffold branches.*

If you grow an open or modified leader type of tree, four or five branches are what we recommend. If you grow the typical leader tree it does not make as much difference, as from year to year new branches are added. We prefer here in Oregon the four- or five-branched tree. While it may be true that the three-branched tree will produce three branches that average larger in diameter than if four or five are allowed to grow, nevertheless, we feel that

the three-branched tree is a dangerous one; that it is structurally weak; that if you lose one of the three branches, you have practically a ruined tree; whereas, with four or five scaffold limbs, you can lose a branch and still balance the tree in such a way as to save it. The first lesson then is to choose four or five well-spaced branches, having them issue in a whorl around the tree, if possible, and having them as far apart as they can be conveniently spaced. The farther apart they are spaced, the stronger and better will be the trunk and the better the tree obtained. To do this, you must not neglect the tree as soon as it is headed, but must watch it very carefully the first month or two after it is set out. It will be necessary to rub certain undesirable buds off, to remove certain undesirable branches, or possibly to suppress from time to time certain branches which tend to run away with the tree. By observing these simple rules you can build a stronger tree. It is for this reason that we often advocate that instead of cutting the treee at 20 inches at the time it is set, cut it 25 or 28 inches, and then space the branches from as near the ground as you can get them up to the top of the trunk. However, if you cut the trec at 25 or 28 inches, and then go away and leave it you will often find all the branches will develop near the top of the trunk and the tree will be weak. It is only by careful watching that the extra increase in height of head can be made of any material advantage.

Lesson 2. *To keep main branches or sections of the tree properly dominant.*

If one branch tends to grow at the expense of the rest of the tree the weaker branches gradually become side branches to the two or three remaining stronger branches. If proper pruning is done this can be obviated. We find that the average pruner does one of two things. He may be among the group that cuts the tree level across the top, so he has a plane surface. This will never build a strong, well-balanced tree, because in doing this you pay no attention to the relation of one branch to another. The second group of pruners is apt to cut the weakest wood most and the strongest wood the least. They have heard that the more we cut the wood the more it grows; therefore, if wood is weak and we cut it back it will grow stronger. It is true that the more a tree is pruned back as a whole while dormant the more will be the resulting growth; that heavy heading in of a tree means a heavy after growth. This, however, has to do with the trees as a whole and has little to do with the relation of one branch on a tree to another. If you have a strong branch in close proximity to a weak branch the best way to strengthen the weak branch is by cutting back the strong. The development of the weak branch will be in proportion to its leaf and branch area; if there is a large amount there will be a heavy demand on the sap, and the weak branch will develop. By limiting the branches and leaves on the strong branch you restrict its growth; as a result the following year there will be less discrepancy between the development of the two branches and a continuation of the practice should lead to a balance between the two. The heading back should be done, then, not so much from the point of view of the tree as a whole, but from the point of view of the relation of the branches to each other.

Cut the strongest branch the hardest; cut the second branch in vigor not quite so much; the third in vigor still less, until you come to the weakest branch, which should be cut the least. It is only by suppressing the strong branches, limiting the number of leaves and buds that they have, that you can possibly hope to encourage the weaker branches. If you wish to grow a modified tree, or leader-type tree, the only difference we would make in this pruning would be that we should choose one branch for a leader and not cut it back quite so heavily as we should with the open tree, simply letting it have enough of a lead to maintain that position. Other than that we should prune all the branches the same as directed. We can do a great deal of so-called corrective pruning. That is, we may have a tree four or five years old, and notice that two of the scaffold branches are weaker than the rest of the tree: consequently, we would like to encourage these two branches to grow stronger and larger. To do this, prune these two very lightly, and prune the other parts of the tree more heavily and thus encourage the two weaker branches.

Lesson 3. *To avoid the sharp-angled, equally-balanced crotches.*

If we examine the average scaffold branch of a tree carefully, from the time it leaves the main trunk up to its last year's growth, we shall observe that it has been developed much along this order. The first year the branch was cut back it forced out a number of laterals. All the laterals except two were removed. These two were cut equally and in most cases were not spaced very far apart. The next year on each one of these two the same treatment was repeated. Two branches were chosen and these were cut equally. The result is that the branches all over the tree are in pairs, of equal strength, and form very sharp forks. Now, this makes a weak branch, one which will break very easily, as the stress and strain all come at very critical points; namely, at the numerous balanced crotches. To avoid this condition of a tree, treat each one of your main branches as a leader. This means that when you choose two branches, at the first you will choose them as far apart as you possibly can, and second, in pruning these, you will cut one harder than the other. Thus one will become a leader and the other a side branch. If you continue this, the whole branch becomes a strong leader, with a great many side branches, which distribute the strain in such a way as to reduce the breakage to a minimum.

Classes of Non-bearing Trees

For convenience of discussion, we may divide the young or non-bearing trees into three classes: First, those trees from one to four years of age. This is the formative period, the body-building period, of the young tree. Second, the period from four to seven years of age. I have called this the critical age. It is a transition period from the body-building, on the one hand, to the heavy-fruiting on the other. With Yellow Newtowns, Baldwins, Winter Nelis, Comice, and many others we could mention, the pruning at this time will determine to a very large degree the fruitfulness of the trees for a number

of years to come. The third class or group of trees are those from seven to twelve years of age, which have reached the bearing age, but as yet have not borne a commercial crop. Before taking up the details of pruning these three classes of trees, summer pruning and its relation to such trees may be considered.

Summer Pruning as Adapted to Young Non-bearing Trees

During the past two years we have heard much about summer pruning, and with many summer pruning has become a fad, and some expect marvelous results. While summer pruning is not new, it is true, however, that it has

Figure 24. A young Yellow Newtown apple tree before and after summer pruning. Photograph taken August, 1912.

been more generally used the past few years than formerly, and like everything that is just coming into general practice, is being overdone. Many people are expecting too much from summer pruning.

Let us consider first the summer pruning for our young trees during the form-

ative period, that being the ages from one to four. In many cases not much pruning will be done during the first summer of the tree's life, as the trees often do not make very much growth the first season, but where they do make a vigorous growth and make it by the middle of June or early July it will often be found to advantage to head the trees at that time, cutting them back just about the same way that you would cut them back the following spring. That is, if you have a long terminal growth, 12 to 30 inches in length, cut it back to the point where you desire to force out new laterals for the future body building of the tree. Now, you may have a tree that is running to one or two branches at the expense of all the others. It would be well to pinch back these strong branches, so as to hold them back for the time being and thus encourage the weaker branches to grow. By the second year nearly all these trees can be greatly benefited by summer pruning. This may come any time from the latter part of May up to the middle of July, generally about the middle of June. It consists of cutting back the rank terminal growth so as to force out the laterals and allow them to make a good growth and become hardened before fall. In this way you will gain a whole year in the framework of your trees. A good practice to follow with such trees is to do most of the heading back in June and most of the thinning out in March or April, or whenever the winter pruning is done. However, should the trees after they are pruned in June make such a rank growth that they need some topping back again the following spring, you should by all means do so. In nearly all cases it will be advisable to do some topping back of the terminals, or else the terminal bud will incline to continue this growth, producing a long leggy branch. If no topping is done on these shoots in spring it will be necessary to give them a heavy heading back in summer, to prevent their becoming too long before producing desirable laterals. You should remove from these young trees, during the summer time, any undesirable growth, branches which you know will never be of any value to the tree and are growing at the expense of some branch which should be developed. We would caution, however, against the too strenuous thinning out of young trees. We are of the opinion that we have overdone the thinning out of lateral branches.

This pruning which is given to these young trees, while it does not as a rule directly induce fruitfulness, will tend to bring the trees up to the critical period in much better condition than otherwise, since it tends to balance the tree; and since it distributes the pruning over two periods of the year, it eliminates the necessity for very vigorous pruning which so many growers give trees. The heavy winter pruning given young trees serves as a stimulus and often causes too much vegetative growth.

Some growers are opposed to summer pruning on the grounds that such pruning weakens the tree, that it is devitalizing, that it is unwise to remove any of the leaves as they are the "lungs," and manufacturing organs of the tree. We feel that it would be only in very extreme cases that summer pruning would ever be devitalizing, and certainly not where one makes the single summer pruning as already recommended. Such pruning in some cases might give increased vigor; in others very little difference will be noted;

Figure 25. A three-year-old Lambert cherry tree before and after summer pruning early in July.

while in still others the growth may be modified to the extent that there is less vegetative growth, but even in the last case there is modification rather than devitalization. The result of a single summer pruning as recommended for these young trees is not so much a question of vigor as it is a question of change in direction of growth or energy. The clipping back of the terminal, forces the growth into desirable new lateral framework rather than into a useless additional terminal growth. There are cases where frequent summer pruning at short intervals during the summer has a tendency to check or dwarf a tree; for example, in growing dwarf trees we must not only have a dwarfing stock but we must practice frequent pinching back of shoots. Again, we have seen walnut trees dwarfed by removal of all lateral growth for a period of years. These last two cases, however, are extreme and represent excessively frequent pruning. The greatest danger of devitalizing young trees does not come from a single summer pruning, but rather from allowing too heavy bearing of young trees.

We shall now consider summer pruning as related to our second class of trees; namely, those from four to seven years of age. These trees have now gone through their formative period and should have good trunks and scaffold limbs, and should be approaching that period when they can begin to bear

Figure 26. At left: A vigorous five-year-old Wagener tree pruned in July. Photo taken in October. Note that there has been a vigorous response of new shoots averaging fully one foot in length as a result of the summer pruning.
At right: A five-year-old Wagener apple tree of less than average vigor pruned in July. Photo taken in early October. There has been practically no growth response as a result of the pruning.

heavy crops. We shall modify summer pruning for these trees, as compared with the younger trees. In this case we are to work with the idea of trying to induce fruitfulness directly if possible. The pruning will generally come considerably later with these older trees. There is no definite time to set. We recommend, however, that the pruning be done at the time the terminal buds are forming on the ends of the shoots. You will note the leaves are beginning to get larger on the ends of the twigs, and if you will look closely you will see that the terminal bud is forming. At that time, which in the Willamette Valley, for example, is generally about the middle of July, we cut back the terminal growth, cutting it back to the point where it is desired to force out new laterals for another year's growth. The cutting at this time seems to cause a thickening of the branches, probably an accumulation of tissues around the buds, and with some varieties, probably, will lead to direct fruiting the following season. With others, however, it will simply tend to keep the trees in balance, and probably encourage earlier fruiting than would otherwise be true. That is, your results may come in two or three years rather than in one year. If this pruning is done at about the right time very little secondary growth will take place, and what does

Figure 27. At left: A five-year-old Yellow Newtown apple tree which was pruned the previous summer. Note length of shoots which resulted from summer pruning.
At right: Same tree as shown at left after winter pruning. Note that the pruning has been light. This tree is reaching the critical period when it should commence to bear. Heavy pruning might keep it from bearing.

will naturally be very small. Of course, we realize that in many cases these trees four to seven years of age do not harden up until late in September or even in October, and then it would be too late to do any pruning to advantage. Even though summer pruning with these trees might not lead to an increase in fruiting the following summer, it would be a distinct help in keeping the trees in balance, and in eliminating the excessive cutting which might otherwise be necessary the following spring.

We shall consider for just a moment the trees which are from eight to ten or twelve years of age, which should be in fruiting but have never borne. These trees have almost always been over-stimulated. They have been over-pruned, over-tilled, over-irrigated; they have had some one stimulus or a combination of stimuli given them which results in forcing rank wood growth, producing heavy large leaves, but little or no fruit. The remedy is to remove the stimulus, whatever it may be, and prune several times a year.

Summer pruning for such trees will come probably more about the time you should prune the very young trees; that is, along in June. At each time when the terminal growth has reached such a length that you can see it is going to become excessive, it should be cut back and the trees thinned out

somewhat, and the following spring a little more thinning and pruning out could be done to advantage. The application of summer pruning to these trees should be largely merely a distribution of the pruning over two periods, thus avoiding an excessive pruning. Only in very rare cases could you expect direct results from such pruning. Results will come indirectly in bringing the trees back to their normal balance. It often becomes necessary to reduce the amount of tillage or irrigation given such trees and in cases where the growth is abnormally excessive it is sometimes found advisable even to check this by growing crops between the trees, such as hay or grain.

Applications of the Principles of Pruning to the Young Trees

At the time the tree is given its first pruning we should definitely settle the question of height of head. Most growers, after they have headed the tree, pay no more attention to it until the following spring when they are ready for the second pruning. We believe in many cases, however, this is a mistake. It will be found very advisable in May and June to go through the orchard and look over the young trees carefully. At this time certain very small shoots or buds should be rubbed off. If one branch is growing

Figure 28. At left: A five-year-old Wagener apple tree which was summer pruned in July. Photo taken the following January. Note the amount of after growth indicating that the tree was pruned at about the right period. A splendid type of modified leader.
At right: Same tree after winter pruning. Note the light amount of wood which has been removed in thinning out; almost no heading back.

at the expense of all the others, it can be suppressed, and one can do very much the first year to start the tree in the proper way, and to put it in better condition for the second year's growth. It is only in rare cases that it will be advisable to give the trees a systematic summer pruning the first year, because it will be only occasionally that the trees will make a sufficiently rank growth to warrant such pruning. Many young trees do not make much top the first year; they are building roots and getting firmly established. In cases, however, where they have made a strong growth, it is suggested that the trees be summer pruned, and just as soon as they have made sufficient growth so that new laterals can be formed to advantage, you should pinch back these shoots, provided this pruning can be done not later than the middle of July and preferably in June. These laterals should be cut back to stubs from 8 to 15 inches in length, depending, of course, upon the vigor of the branch. One can make the mistake, however, of pinching them back so hard as to force the new laterals too near the main crotch, and thus make a very close, heavy crotch which will pile up in years to come.

Since few trees can be summer pruned the first season, we shall consider the tree the second spring, as one which had received no such pruning. One should choose definitely the type of tree to be grown; either the open, the leader, or the modified leader tree. If the tree was summer pruned, that question should have been settled at the time of pruning. If you grow the leader or modified leader you will choose one branch to maintain the lead, and will prune this in such a way that it can maintain such a lead. If you decide to grow the open tree, you should choose the four or five branches and space them as far apart as possible, and cut these back according to their strength, cutting the strongest branches the most and the weakest ones the least. One will then have five main branches with a few laterals on each one. It is customary to remove all these laterals. By the middle of June the young tree should have made a sufficient growth to allow for summer pruning. Each branch should be pinched back so as to leave it from 8 to 15 inches long, cutting according to vigor, always suppressing the stronger.

By the following spring each of the original five main scaffold limbs will have from one to a dozen lateral or additional branches. It is customary to remove all but one from each main branch so that when the tree is pruned there will be ten branches on the tree where there were five before. A great deal of care should be used in selecting these new branches. The two branches on each scaffold limb should be spaced as far apart as possible. Of course, avoid the choosing of laterals which will tend to grow in toward the center of the tree. Then in cutting these two laterals avoid cutting them equally. Choose one which will grow as a leader for the branch and do not cut this back quite as heavily as you do the second branch which you will suppress more heavily in order to make it grow as a side branch and not as a main branch. In this way you will get rid of the weak crotch which is one of the fundamental principles to remember in pruning trees. This second summer these trees should be so well established that by June you can give them a second pruning. Each one of these branches that you left on the tree has

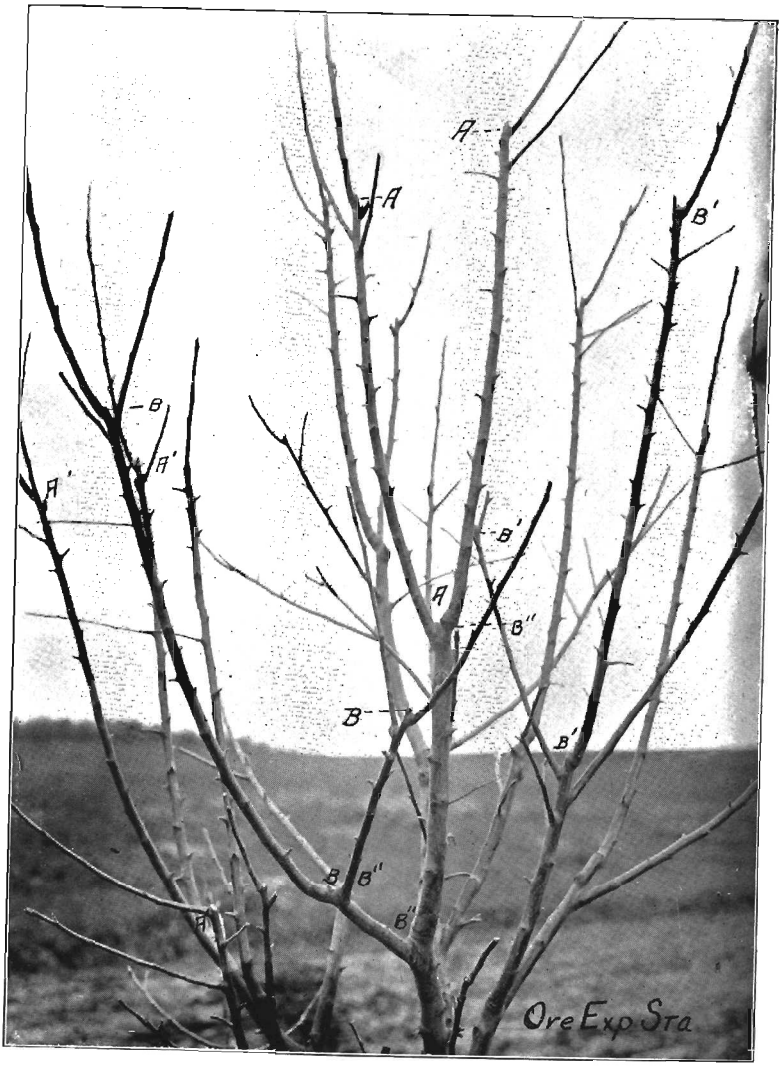

Figure 29. Balance in pruning. Note at *AA* equal cutting has resulted in nearly equal strength of branches; at *BB* unequal cutting has resulted in completely destroying such balance making a stronger crotch.

grown 15 or 18 or in some cases as much as 30 inches or even more in length. We would advise, instead of letting them go the entire summer, that whenever they have made sufficient growth, they be cut back in order to force

Figure 30. An example of unequal growth. Branch *A* is growing at the expense of the other branches in the tree and should be suppressed.

out a new set of laterals. The following spring in all probability about all the pruning you will have to do will be a little thinning out here and there, and in case the laterals which come out as a result of the pruning in June have made a very vigorous growth and are getting too rangy, you will have to cut them back somewhat, although it will only be in extreme cases that you will have to practice much cutting on these branches. Moderate clipping back is often advisable to prevent the terminal bud from continuing growth and producing long willowy growth. So you continue this pruning right along for two or three years, never leaving as a rule more than about two branches where you had one before.

At the beginning of the fourth year I would suggest a modification of the pruning. It is coming time now to let down on the heavy pruning. If you practice as severe pruning as you did the first four years, you are constantly going to force the tree into wood. Many growers thin out the laterals excessively, force an enormous terminal growth, and cut back this terminal growth vigorously, thus forcing out new laterals. We believe that too many growers make a mistake by pruning too vigorously at this time. It would be to advantage to leave more lateral wood than most growers leave. Just how much is advisable to leave in all cases is very hard to say, because we have not worked out definitely just what is the relation of shade to the formation of fruit spurs or fruit buds. Until that can definitely be worked out it won't be possible to give very explicit directions, but we would rather let the tree grow a little brushy, because after it comes into bearing this excess wood can very easily be thinned out. The summer pruning now changes from the former early summer pruning and should now be done at the time the terminal buds form, rather than early in June as already described under summer pruning. The rule then with trees from four to seven years of age, is simply to cut back the terminals sufficiently so they will not run away with the tree, and just thin out so that the tree does not become too dense. More pruning than this we would not recommend. We feel that if this is followed there will be a tendency for young trees to come into bearing earlier than they otherwise would.

The amount of pruning that trees which have just come into bearing will stand will, of course, vary tremendously according to their vigor. The soil they are on, the climate, and the variety, should all be taken into consideration. As shown in the chapter on The Study of Fruit-Buds there is a great difference in the bearing habits of trees. The amount of pruning which regular bearers like Jonathan, Wagener, Winesap, Grimes, etc., will stand, will vary considerably as compared to the pruning that Yellow Newtown, Northern Spy, Baldwin, Tompkins King, or varieties which have their habit of growth, will stand. As a general rule, the growers of Yellow Newtown on the heavier soils of the State are making a mistake with their young trees. In almost all cases they are over-pruning, and are cutting their trees so hard that whatever tendency the trees might naturally have to bear are directed into other channels.

The directions given so far have been written chiefly from the point of

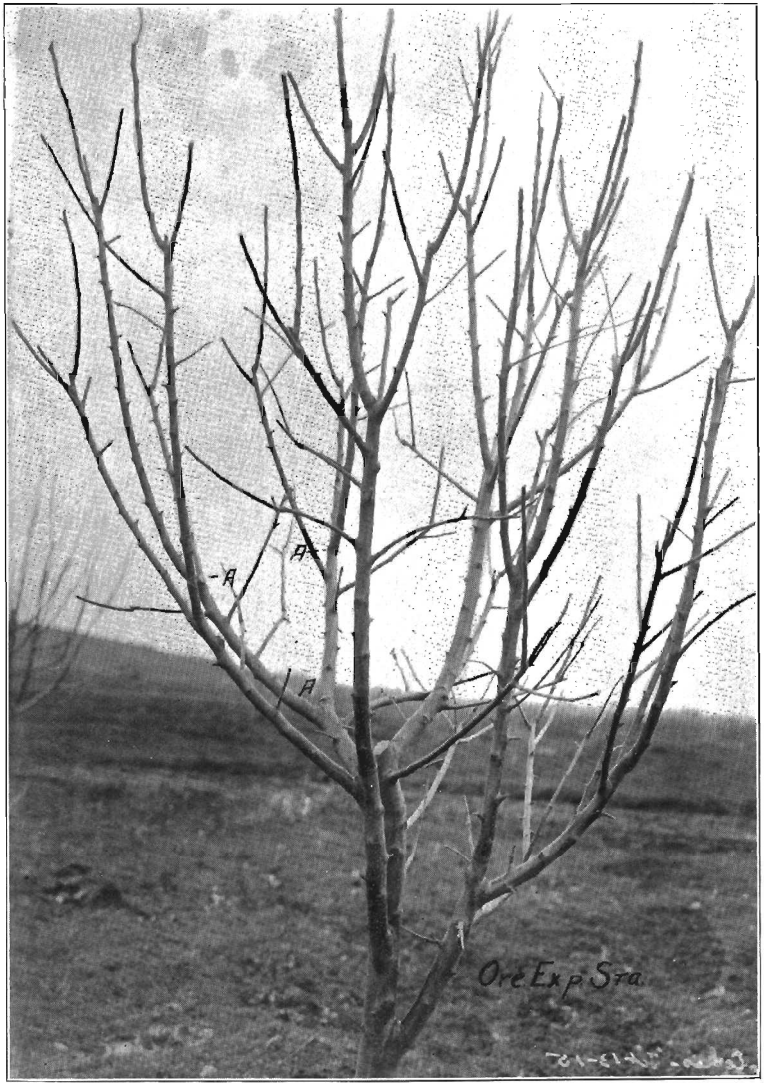

Figure 31. A good example of proper balance between branches. Note wherever there is a crotch in most cases one branch is stronger than the other. At *AA* is a bad fork due to even cutting.

view of apple pruning. Nevertheless, the recommendations apply equally well to all of our deciduous fruits and nuts, such as prunes, pears, cherries,

Figure 32. A five-year-old Winter Nelis pear tree begun as an open center but typical of the leader type. The lower branches are not keeping pace with the upper and are becoming weak in comparison. To save or restore balance the upper branches must be suppressed.

and walnuts. There are a few special recommendations, however, that we wish to give for fruits other than apples.

Special Recommendations for Pears

We never recommend pruning the pear to the leader type. Growers generally feel that it is harder to fight the blight with the leader than with the open type of tree, so we generally recommend that either the open type or the modified leader be chosen. We would caution growers, however, that many of the open trees are very easily damaged from blight and are often ruined, because the crotches are poorly formed. An effort should be made to have the branches spaced as far apart as possible, so that if a branch is lost from blight, the remainder of the tree can easily be saved. It should always be borne in mind that fire blight works in succulent growth, and that in handling pear trees one should avoid excessive wood growth. Pears begin their growth earlier in the spring and cease it earlier in the sum-

Figure 33. At left: A typical five-year-old Winter Nelis.
At right: Same tree after pruning. Note that the center is being suppressed. This tree gives indication of bearing a crop and if it should, will stand heavier cutting back next season.

mer than is the case with apples. This should be specially borne in mind with young trees, if summer pruning is to be practiced. Some varieties of pears, especially the Bartlett, have a tendency to form fruit-buds, and to bear fruit on the ends of the terminals. They will do this quite often while the trees are still very young, and they should be discouraged from bearing in this way. The tendency to bear on such terminals should be overcome by summer pruning. The crooked growth of the Winter Nelis and Bosc is very troublesome to the beginner in pear growing. Our advice would be not to worry too much about the crooked growth, for as the trees become older they

Figure 34. At left: A five-year-old Winter Nelis showing one branch growing at the expense of the rest of the tree.
At right: Same tree pruned. Note that the strongest branches have been cut the hardest.

Figure 35. At left: A five-year-old Bartlett pear tree before pruning.
At right: The same tree after pruning. This is a splendid type of modified leader.

will take care of themselves very largely, and this crooked growth will cease to be troublesome. Prune the trees in practically the same way as those that grow straight.

Pears can carry more lateral wood than apples. They relatively spread farther when they produce a heavy crop, so that one should avoid thinning the young trees excessively. Keep all spurs or fruits from the main trunks and low down on the scaffold branches, as these are a source of infection from the blight. It is also wise in pruning in any district where fire blight is troublesome to see that the pruning tools are carefully sterilized before the cuts are made.

Special Recommendations for Cherries

Formerly the cherry was headed about 35 inches. There are many growers

in the state now that practice heading from 20 to 25 inches, who are building very nice trees. There seems to be a prejudice against pruning a cherry tree. Our advice would be to prune it the first six years just about the same as has been directed for apples. We would urge, however, the summer pruning, as we have felt that splendid results could be obtained with cherries by summer pruning. The cherry has a tendency to shoot up in the air very rapidly, making an enormous growth the first two years. The result is that the average grower has not the nerve in the winter to cut this back severely, and he leaves his trees too leggy. One way to overcome this leggy, high type of growth is to cut back the terminals in the summer. A very good type of tree to get would be the Mazzard body, making the trunk and main scaffold branches of the Mazzard, later budding these over. This will give a stronger crotch, and there will be less gumming and loss from trees of this type. Should your cherry trees need heavy cutting, do not hesitate to take out large branches. However, you should take care to protect the wounds carefully as cherry wood is softer than that of most of the pomaceous fruits.

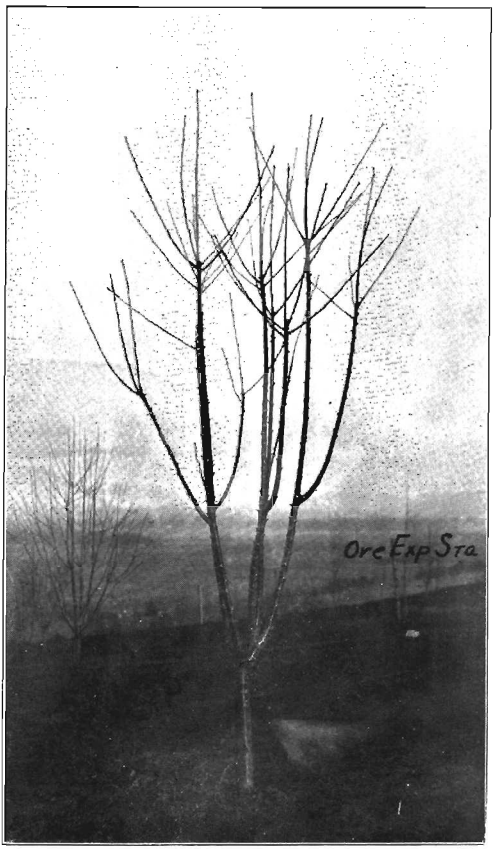

Figure 36. A typical cherry tree of extremely poor type, all of the main branches issuing at one point. Note how leggy the tree is due to the fact that there was insufficient heading-in the first two years. Heading this tree back twice a year might have been helpful.

Special Recommendations for Prunes

There is very little additional that can be said which will be helpful in the handling of young prune trees. The recommendations for the apple trees apply very closely. The trees are generally headed higher than any of our other fruits, 30 to 35 inches. Some growers, however, are heading about 20 to 25 inches, and we have seen some very pretty trees headed at this height. The tree never be-

comes extremely high headed, and since most of the fruit, which is to be evaporated, is allowed to drop on the ground before harvesting, the height of head from the harvesting point of view does not need any consideration. However, we believe that the growers will get better results by constantly suppressing terminal growth and thinning out the centers where they become too dense, so as to allow the development of strong wood. Do not overdo this, however, by removing all small laterals, spurs and secondary branches. We would urge, also, that not too much wood be taken from the outside of the tree, and that it be kept fairly open. Many growers of young trees practice cutting off considerable wood on the outside of the tree, and leave the centers a little dense. We would recommend just the reverse of this policy. Try to keep the trees low headed, broad and spreading, so as to build a large framework for fruiting wood in succeeding years.

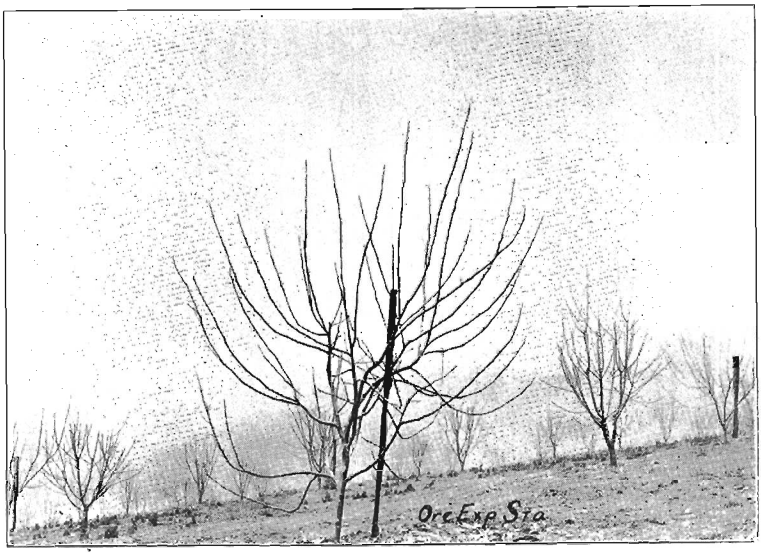

Figure 37. A three-year-old English walnut tree properly staked. The pruning of these trees should consist, first of the removal of two lower laterals, and second the cutting back strongly of last year's growth. This tree was headed at thirty inches. It would have been better to head five inches higher.

The alternate trees are three-year-old cherries which were summer pruned the previous season. Note how much stronger and better spread the trees are than the cherry tree shown in Fig. 36.

Special Recommendations for English Walnuts

We would recommend that the trees be headed at about 35 inches, and at the time they are headed, that a good heavy stake, 7 or 8 feet in length be driven down close to the body of the tree. The first summer choose the four or five laterals that will give a good scaffold framework and tie these to the stake. If you do not do this, they will tend to droop to the ground

too much, but by careful tying you can keep them well in shape. The following spring cut back the trees exactly as though they were apples. We find in many walnut trees that one branch may grow up six or eight feet. It may grow three or four feet higher than any of the other branches. Cut this one back hard so as to bring on the other branches. We generally recommend the pruning to be done just before the starting of the sap flow. Formerly the trees were allowed to grow three or four years and all laterals were taken off and the trees grown to poles. We find that when they are handled as though they were apples, we get a more spreading tree, one with larger fruiting area, and one which will be much more easy to handle from the orchard management point of view.

Special Recommendations for Peaches

The peach has an entirely different fruiting habit from any of the other

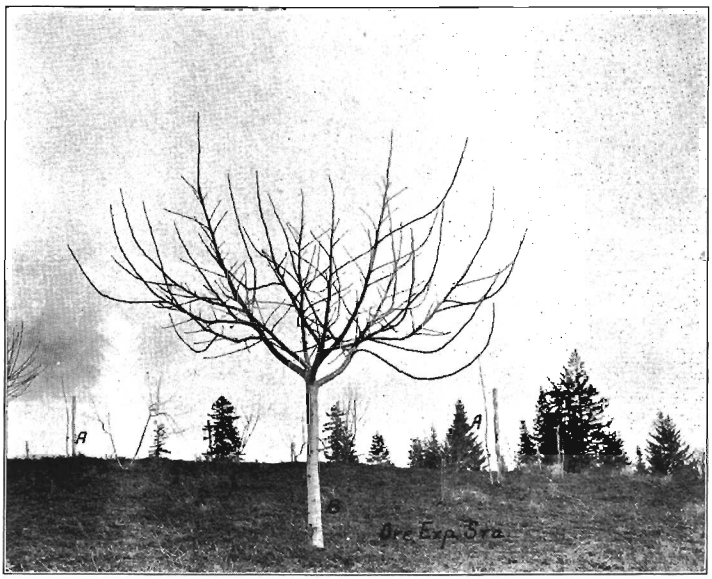

Figure 38. This illustrates two methods of pruning the English walnut tree. The trees pruned to "fish poles" at *AA* are exactly the same age as tree *B*, the only difference being that on trees *AA* all lateral growth has been kept off for several years, the trees being given summer as well as winter pruning to remove laterals, while with tree *B* all laterals have been allowed to remain.

trees we have mentioned. The fruit is all borne on the one-year-old wood. However, the aim in pruning such trees the first few years is very much the same as that for other types of fruit; namely, the building up of a good strong framework for future years of fruiting. The peach when it is secured from the nursery is generally too large and has a large number of branches. An

Figure 39. A young peach tree just coming into heavy bearing.

ideal tree would be a straight whip, but it is almost impossible to buy such trees, and under our soil and climate conditions they tend to grow very vigorously in the nursery. We would recommend a general heading to about 18 to 20 inches. If whips can be secured they should be pruned as is customary with the other trees. If there are a few weak laterals we would recommend their removal, but if the trees have strong laterals instead of removing all the lateral growth, which is practiced by some growers, we would advise choosing half a dozen well-spaced branches, and cutting them back to one or two buds. This will give a larger leaf surface the first year, will remove the danger of having a tree stand with only one or two branches, and also will remove much of the danger of the trees dying. We have found that under our climatic conditions a great many peach trees, when they are pruned back to whips after they have once formed strong laterals, never start to grow at all. Some trees will force out new buds and shoots, but on the other hand

Figure 40. The same tree shown in Figure 39 after pruning, showing desirable heavy pruning.

there are others which will not. If after the buds start on the short laterals there are found to be too many, it will be a simple matter to thin out undesirable growth. It is customary to try to head the peaches as low as possible; to have the first branch come out very close to the ground, and to get the crotches as well spaced as is consistent with the amount of area one can work with. At the end of the first year choose four or five of the best-spaced branches, and cut them back on an average of 8 to 12 inches in length. Not much summer pruning is practiced for peaches. By the end of the second year the tree should be cut back again so that it will vary in height from about 3½ to 4½ feet. Constantly train the tree to spread by cutting to outside buds, constantly forcing the tree to make a broad spreading top, rather than to allow it to shoot up in the air. It takes more nerve than the average grower has to cut the trees as hard as indicated, but it is necessary if one is to keep the tree near the ground, and have a profitable fruiting tree. It will be neces-

sary to cut off about two-thirds of the last year's wood from the inside of the tree. Practice this constantly with the peach. The aim will be to keep the center completely open, so as to give light and develop strong wood. Cut out all weak wood and limit the amount of annual wood so that what is left can grow strong. It will be only on the strong wood that large peaches will grow. We would caution the growers, however, that they can go to extremes in growing vigorous wood. If the wood becomes too vigorous, the first few crops will be borne entirely on the ends of the shoots, and it will be almost impossible to prune the trees and still have any fruit. The medium-sized wood will be more desirable. If you find the wood is getting too vigorous, be sparing in the pruning, and it will tend to check the trees. A little summer pruning might be used to advantage where the wood tends to become excessive. Not much fruit should be taken off peaches until about the fourth year.

PRUNING THE BEARING APPLE AND PEAR TREE

V. R. GARDNER

In presenting this subject it is assumed that the trees have been brought to bearing age. They have been trained as open-center, closed-center, or modified-leader trees, as the case may be. They have been given their general shape and consequently little attention will need to be devoted to the question of training them. The little training that will be required will be incidental to the main problem of pruning to influence fruit production. After trees have been brought to bearing age there is little argument as to what the main objects of pruning should be. They are: first, to obtain large quantities of fruit, full yields for the size of the trees in question; second, to obtain better fruit, the best that can be grown under the conditions in question; third, to obtain these large yields and high grade at the lowest possible cost.

The Ideal Fruit-Spur System

As has already been pointed out, in a previous paper, the fruit grower obtains the most of his fruit through the medium of fruit-spurs. In other words, fruit-spurs are the main fruiting mechanism, or main fruit-producing machinery, of the trees. The questions, then, to consider, are: what constitutes an ideal fruit-spur system, and when is that fruit-spur system in an ideal producing condition. In the first instance, we want many spurs. This does not mean, necessarily, the largest possible number of fruit-spurs for any given space, but we must have a great many or else we cannot obtain a large number of fruits, for ordinarily a single spur does not produce more than one high grade fruit in one season. Frequently several fruits set on a single spur, but in the better-managed orchards these are thinned to one, which is allowed to mature. We want not only many spurs, but it is desirable that each spur be strong and vigorous. It seems reasonable that a strong, vigorous spur not only will produce better fruit than one which is weak, but it will also be more regular in its bearing; and regularity of bearing of individual fruit-spurs is as important from the viewpoint of annual yields, as the number of fruit-spurs present. A regularly bearing fruit spur in the case of apples and pears is one that bears once in every two years. It cannot be expected to bear every year, for normally a fruit is produced from a terminal bud one season, and the next season is required to prolong the spur from a lateral leaf bud so another terminal flower bud can be formed the following year. The spur which bears in 1915 can reasonably be expected to bear again in 1917. However, the trouble with a large percentage of fruit-spurs, especially in older trees, is that they do not bear every other year. Instead, they bear but once in three, four, five, or in some cases, eight or ten years. This irregularity of bearing generally is due to a lack of vigor on the part of the individual spur, though perhaps the tree as a whole would be regarded as vigorous. The case is one of trees possessing fruit-producing machinery, but the machinery is in poor condition, unable to turn out its full quota of work.

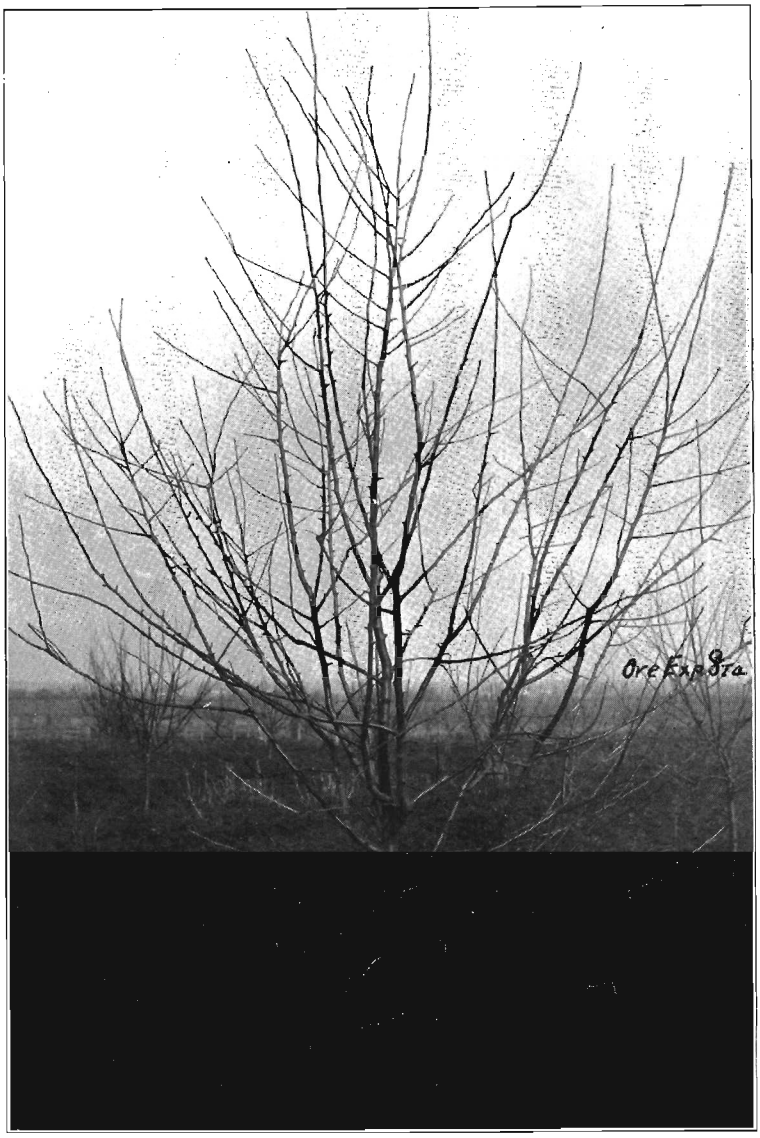

Figure 41. A five-year-old Yellow Newtown tree. It was pruned rather heavily each year until a year ago, when no winter pruning was afforded. When compared with Figure 43, a tree of the same variety and same age, it shows how light as opposed to heavy pruning, tends to throw a tree into bearing. Note the many fruit-spurs on the two-year-old wood. During the preceding season a large part of the energies of the tree were devoted to fruit-spur formation.

Figure 42. A closer view of a portion of the top of the tree shown in Figure 41. It shows the tendency of unheaded shoots to develop large numbers of fruit-spurs. Notice that a spur has developed from nearly every node on the two-year-old wood, and this in the top of a young tree of a variety normally slow in coming into bearing.

Furthermore, we desire not only many, and regularly bearing fruit-spurs, but they must be long-lived. Even if there are some spurs formed each year, and if these were to bear regularly for three or four seasons, the large bearing

tree might soon come to have too little fruit-producing machinery for large yields, if the spurs died when four or five years old. Furthermore, the rapid dying off of spurs in the older parts of trees would soon result first, in a large amount of barren wood, and second, in the clustering of the live spurs near the ends of the smaller branches, where the load of fruit can least easily be supported. Ordinarily the fruit-spur that lives for twenty years and produces ten fruits is twice as valuable as one that lives half as long and produces five fruits.

The Influence of Pruning Practices upon the Fruit-Spur System of the Tree

With the ideal fruit-spur system in mind, we are ready to ask these questions: how do pruning practices, as commonly employed upon bearing trees, affect this mechanism for fruit production? What is their influence upon the formation, regularity of bearing, and length of life of the individual fruit-spurs?

Light Heading-back vs. Heavy Heading-back

Pruning of bearing trees almost necessarily consists in one or another of two practices, heading-back or thinning-out, or in a combination of the two. In regard to heading-back, two questions arise at once: first, what is its influence upon the number of fruit-spurs that will develop; and, second, what is its influence upon the length of life and regularity of bearing of already-formed fruit spurs? As heading-back may be either light or heavy, and as we would naturally expect different results from a heavy than from a light pruning, let us first consider the probable effect of a light heading-back. By light heading-back we will assume that there is meant a thirty per cent cutting back of the shoot growth of the past season. This would mean that a shoot having ten equally-spaced lateral buds would have the upper three removed under ordinary circumstances. The probable effect of this light heading-back would be that one to three, probably two, of the uppermost buds remaining would be forced out into shoots the following summer. Some of the lower buds, let us assume three, would be forced out into fruit spurs; and still others, two, in the case that has been assumed as typical, would remain dormant. That these probable results of a light heading-back may be more easily compared with the probable results of other types of pruning, let us multiply the figures by one hundred, giving us the growth record from one hundred shoots, each with ten lateral buds.[1]

From the one hundred old shoots we would obtain two hundred new shoots, three hundred new fruit-spurs, and have left two hundred dormant buds. It would seem that the net result of a light heading-back is practically to

[1]It is of course not imagined that any bearing tree would present exactly the conditions here assumed. The shoots of trees are not of uniform length; all do not respond in the same way, even though pruned back relatively the same amount. Many factors enter to cause individual variation, and the pruner will, to a certain extent, take these factors into consideration, pruning one shoot heavily to check or subordinate it, another lightly to encourage it, etc. Nevertheless, there seems to be no good reason for believing that our theoretical example of a tree with one hundred shoots, each shoot having ten equally-spaced lateral buds, would behave in a manner materially different from trees as we find them. Indeed, it is believed that *on the average* they would behave alike. It is only by taking theoretical cases of this sort that a simple comparison of results between different methods of pruning may be readily made.

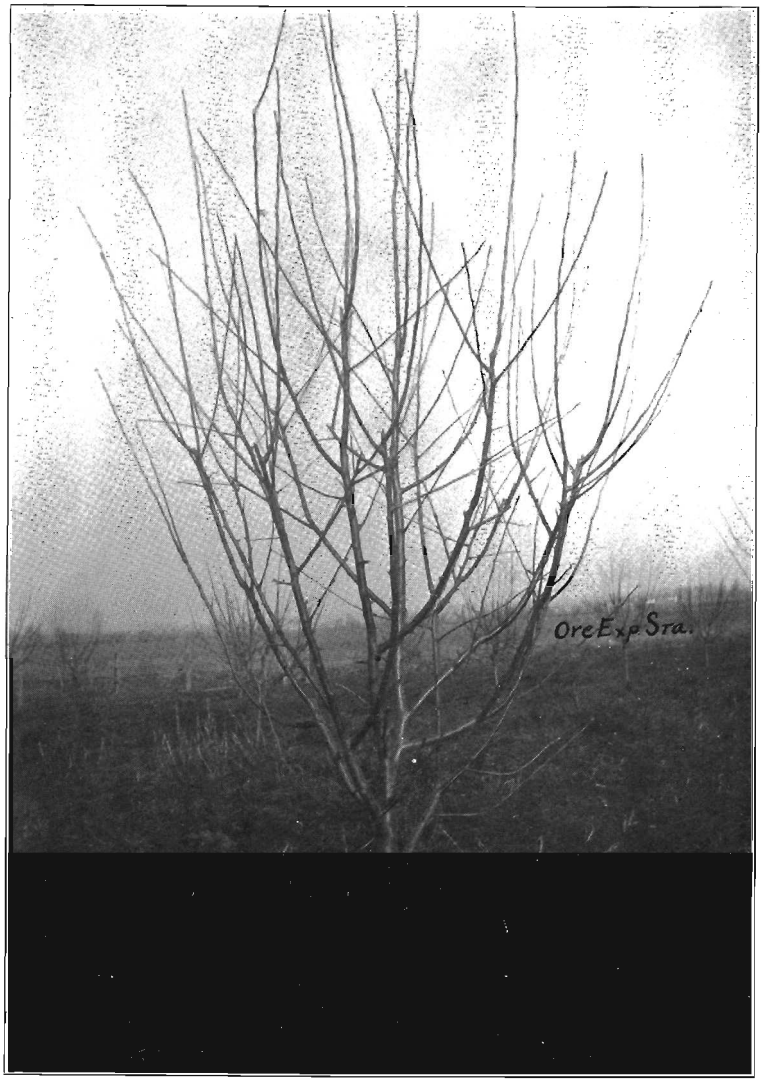

Figure 43. A five-year-old Yellow Newtown tree. It has been pruned rather heavily each year. Last year it received a light thinning-out and a comparatively heavy heading-back. When compared with Figure 41, a tree of the same variety and same age, it shows how heavy pruning tends to stimulate vegetative growth as opposed to fruit production. Note that there are comparatively few fruit-spurs on the two-year-old wood. It has been made to devote its energies mainly to shoot formation.

double the original number of shoots, and also to develop quite a large number of new fruit-spurs.

Next, let us see what results we may expect from a heavy heading-back. By heavy heading-back we will assume that there is meant the removal of the terminal sixty per cent of the shoot growth of the season. Again assuming a tree with one hundred shoots, each possessing ten equally-spaced lateral buds, heavy heading-back would leave four hundred lateral buds on the shoot growth of the past season. The comparatively heavy heading that these shoots would receive would have a tendency to force out a larger number of the buds left into shoot growth, thus leaving a smaller number for the development of the spurs, and a still smaller number to remain dormant, than in the case of light heading-back. Probably a year's growth on the one hundred heavily pruned shoots would result in approximately two hundred fifty new shoots, one hundred fifty spurs—fifty buds remaining dormant.

Comparing the results from light with those from heavy heading-back, it will be seen that both practices result in a great increase in the number of shoots, and also a moderate increase in the total number of fruit-spurs. Of the two practices, heavy heading-back affords the greater stimulus to vegetative growth, but less of a stimulus to spur formation.

Light Thinning-out vs. Heavy Thinning-out

A light thinning-out of the theoretical tree (we are assuming a thinning-out that is equal in the amount of growth removed to the light heading-back) would leave seventy of the one hundred shoots, and these seventy shoots would not be pruned in any way. Each of these seventy shoots possesses not only ten equally-spaced lateral buds, as was assumed before, but a terminal bud as well. When growth begins in the spring the terminal buds are usually the first to start, and it is a matter of common observation that the *main* shoot growth of the season, in trees with non-headed shoots, develops from these terminal buds. In fact, comparatively few of the lateral buds develop into shoots, most of them starting, but only growing out into spurs. Were we to assume that from seven hundred seventy buds, seven hundred lateral and seventy terminal, on the seventy shoots remaining after a light thinning, we obtain one hundred forty shoots and four hundred ninety spurs, leaving one hundred forty dormant buds, we would probably not come far from what would be actually obtained.

A heavy thinning-out of this same theoretical tree we are considering, a thinning-out that would remove sixty per cent of the shoot growth of the season, would leave forty untouched shoots. Each of these would have a terminal bud and ten equally-spaced lateral buds, and would probably behave the following season in much the same manner as the unpruned shoots of the lightly-thinned tree. Were this the case the result would be eighty new shoots (forty from the terminal buds and forty from as many lateral buds), about three hundred twenty spurs, and forty dormant buds. The individual shoots might be longer and stronger, and the individual spurs thicker and more vigorous in appearance, but probably the proportion of buds to develop into fruit-spurs would remain about the same.

When the results to be expected from a light thinning-out are compared

Figure 44. A branch of a young Yellow Newtown tree. The lower (left hand) fork was headed-back rather heavily, the upper (right hand) fork only moderately. From the upper one have developed three shoots and nine fruit-spurs; from the lower one four shoots and three fruit-spurs. The photograph shows that heading-back, whether heavy or light, tends to increase the amount of shoot growth in the tree. However, heavy heading-back is seen to afford a greater stimulus to shoot formation and less of a stimulus to spur formation than a more moderate heading-back.

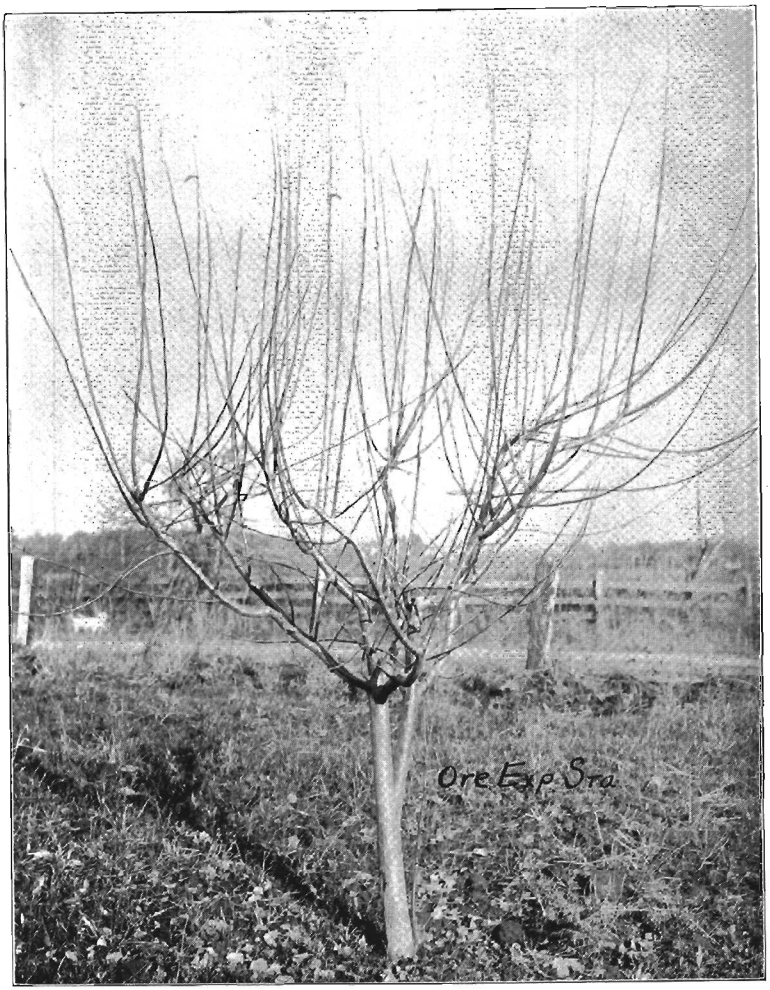

Figure 45. A young apple tree showing the effect of very heavy heading-back. In this case the pruner cut back into two-year and three-year old wood. Fruit-spurs that had started to form were forced out into shoots. The entire energies of the tree have been temporarily turned into shoot formation. Age of bearing has probably been delayed two years by the treatment.

with those to be expected from a heavy thinning-out, it is seen that the light thinning affords a larger number of both spurs and shoots, though it is reasonable to assume that the shoots will be shorter and the spurs somewhat less vigorous than those of the heavily thinned trees.

That the probable effects of these different pruning practices may be more readily compared, they are presented in tabular form.

TABLE II. SHOWING PROBABLE RESULTS FROM DIFFERENT METHODS OF PRUNING ONE HUNDRED SHOOTS, EACH HAVING TEN EQUALLY SPACED LATERAL BUDS

	Light (30%) heading-back	Heavy (60%) heading-back	Light (30%) thinning-out	Heavy (60%) thinning-out
Number terminal buds left.....	0	0	70	40
Number lateral buds left.....	700	400	700	400
Number new shoots formed.....	200	250	140	80
Number new spurs formed.....	300	150	490	320
Number buds remaining dormant.....	200	50	140	40

Heading-back vs. Thinning-out

If the results from heading-back are compared with those from thinning-out, it becomes evident that both processes tend to stimulate the formation of both new shoots and new fruit-spurs. However, heading-back affords the greater stimulus to fruit-spur formation. This is true whether it is light heading-back and light thinning-out, or heavy heading-back and heavy thinning-out that are being compared.

What has just been said regarding the influence of different pruning practices upon the formation of new fruit-spurs applies with almost equal force to their influence upon the longevity and regularity of bearing of already-formed fruit-spurs. It might be reasoned that heading-back in general, and especially heavy heading-back, because of its limiting the formation of new fruit-spurs, would tend to divert food material into those already formed and cause them to be more vigorous, more long-lived, more regular in bearing. On the other hand, heading-back seems to show a tendency to divert food material into new shoots rather than the old spurs. These new shoots develop mainly in the outer and upper parts of the tree, leaving the spurs in the lower and inner portion in a weakened condition. The result is that they will probably bear less regularly and die earlier than spurs which have an abundant food supply. Furthermore, very heavy heading-back will even force into shoot growth some of the already-formed spurs.

Thinning-out, on the other hand, will not only divert an extra amount of food material into the older fruit-spurs on account of its reduction of shoot growth, but it also lets light into the center of the trees, so that the leaves of each spur are better able to manufacture the food materials needed to keep these spurs vigorous and thrifty. This should enable them to live longer and bear more regularly. Light thinning-out probably affords the larger number of fruit-spurs, and heavy thinning-out the stronger, more vigorous and long-lived ones.

The Application of Pruning Principles to Particular Problems

The application of these principles to the particular pruning problems presented by individual trees is a matter requiring good judgment. However, if some of the principles underlying pruning practices are understood,

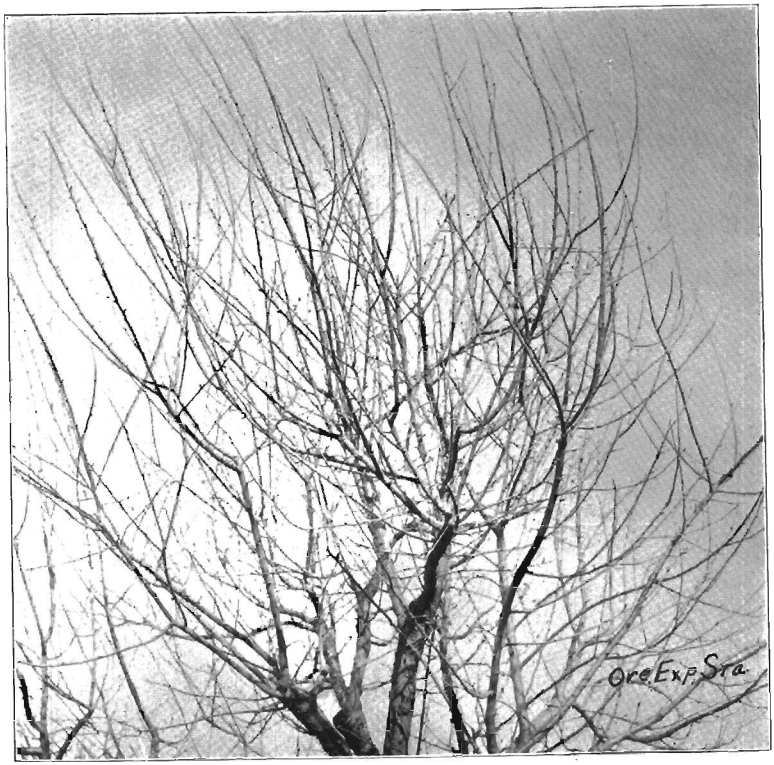

Figure 46. The top of an old Tompkins King tree. Moderate pruning two and three years ago stimulated the formation of a rather large number of medium long shoots. These shoots have not been headed-back and have consequently developed large numbers of fruit-spurs. A number of these small spur-bearing branches should now be removed in order to afford those remaining an abundant supply of light throughout their length. Thinning-out is more needed than heading-back in this tree top, though a limited amount of heading-back will tend to keep the tree from growing so high.

serious mistakes are much less apt to be made. From the discussion of these principles, it would seem that one of the first things to observe before pruning a tree is whether or not it already possesses a fairly good balance between vegetative growth and fruit production. If it possesses this balance, it should be maintained. This would probably mean a moderate heading-back of some of the new shoots, especially the more wayward ones, with the idea of maintaining and developing the shape of the tree and mildly stimulating vegetative growth. It would also mean a moderate thinning-out to encourage the development of a reasonable number of fruit spurs, and to afford conditions favorable to the long life and regular bearing of those already formed. If the tree has been growing too vigorously; if it possesses a large number of

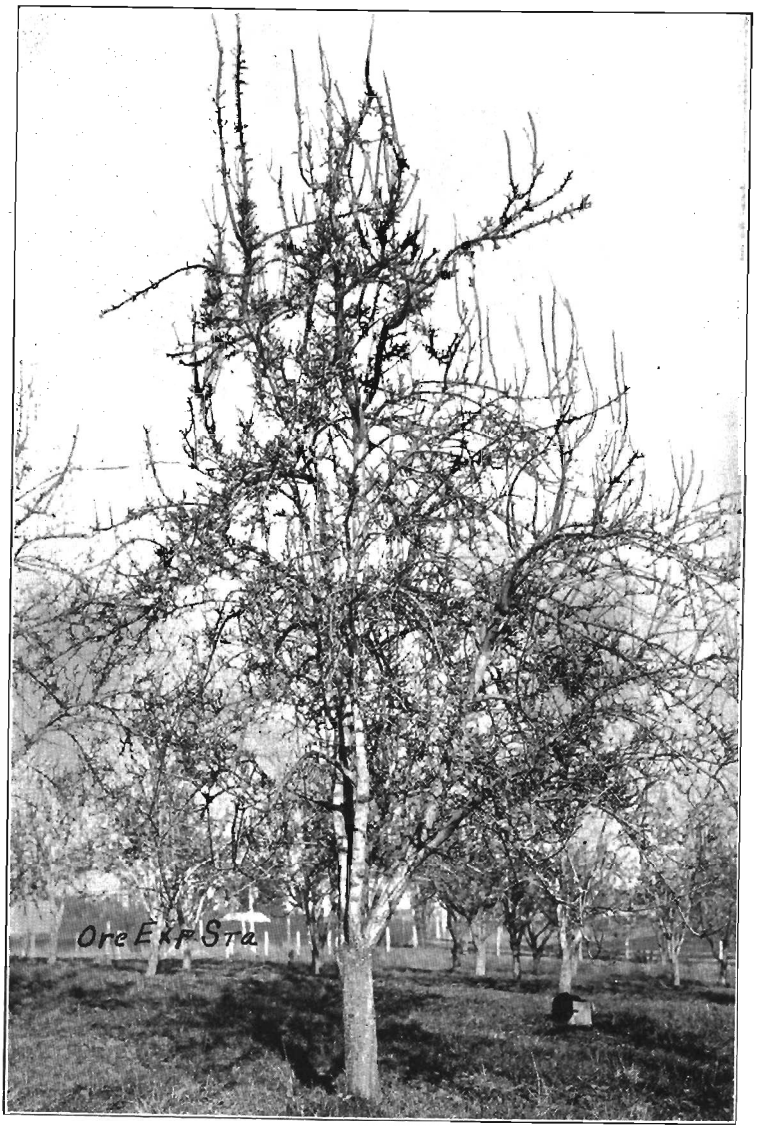

Figure 47. An old Bartlett pear tree that has become filled with much-branched fruit-spurs. Many of these spurs are very weak and lacking in vigor and produce flowers and fruit very irregularly, only once in five and ten years.

strong shoots; if it has been producing many watersprouts; if its fruit-spurs are few in number and irregular in bearing, the practice in pruning should be such as will develop new fruit-producing machinery—fruit-spurs—and invigorate and strengthen that already in its possession. This probably means very little heading-back and only a light thinning-out the first season. This treatment would stimulate the development of a large number of new spurs and could be followed one or two years later with a somewhat heavier thinning of branches, to strengthen and invigorate the older spurs. Many would object to this method of treating over-vigorous trees, fearing that if they were not to head back the shoots generally, it would result in their growing "beyond bounds," or becoming "rangy." It is believed, nevertheless, that it is the most certain method of correcting the over-vigorous condition of many fruit trees. A year or two later, when the tree has become fruitful, its top can be gradually brought "within bounds." The willowy or pole-like character of some of its branches can be corrected by heading some of them back severely, cutting into two- or even three-year-old wood. It would probably be a mistake to cut back a large proportion of the branches in any one year thus severely, but if the practice is extended over several years, it is reasonable to believe that little injury would follow.

On the other hand, if the tree shows evidence of continued neglect, if it possesses large numbers of old but irregular-bearing fruit-spurs; if it has been making very little shoot growth, pruning should be such as to stimulate vegetative processes. Thinning-out in this case will take the form of removing old branches with their fruit-spurs so as to divert a larger amount of food material into those remaining, and also into new shoot growth. It will also be desirable to head-back the remaining limbs and shoots more or less severely so as to stimulate still further vegetative activities of the tree. That heading-back alone will not prove a corrective for trees of the type just described is well illustrated by Figure 48, showing a tree upon which the experiment was tried. The spurs that have since formed upon the new growth are strong and vigorous, but apparently the new growth drew so heavily upon the energies of the tree and shaded so completely the old spurs lower down in it that the latter have profited very little by the treatment.

The fact is, it is difficult to conceive of trees of bearing age in which it would be desirable to stimulate fruit production alone and absolutely check vegetative growth, or, conversely, to stimulate vegetative growth alone and completely stop the work of the fruiting machinery. We desire a proper balance between the two kinds of growth. To maintain it, or even to restore it when it is lacking, usually requires a certain amount of both kinds of pruning, heading-back and thinning-out. The desirability of the results obtained from mainly heading-back or mainly thinning-out in restoring the balance in an unfruitful tree of bearing age, depends upon how correctly its present over-vigorous, or under-vigorous condition is estimated, as well as upon a knowledge of the probable effect of the different pruning practices.

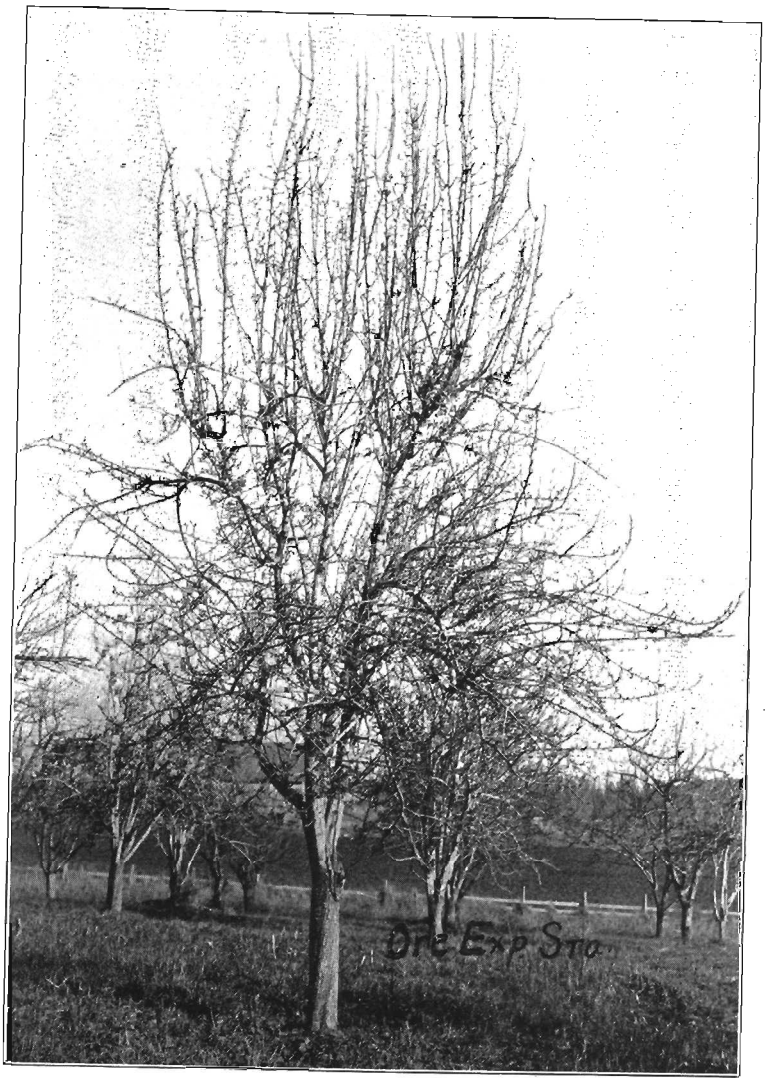

Figure 48. An old Bartlett pear tree that several years ago was in the condition of that shown in Figure 47. An attempt was made to re-invigorate its old weak spurs by "dehorning," a very heavy heading-back of the top part of the tree. The result has been the formation of a large number of strong vigorous shoots that in turn have developed many vigorous fruit-spurs. However, the old spurs in the lower part of the tree have remained much as they were. They have not been invigorated to any marked extent. Thinning-out instead of heavy heading-back would probably have afforded very different results.

PRUNING THE BEARING PRUNE TREE

V. R. GARDNER

Until the prune tree reaches bearing age there seems to be very little need for training or pruning it in a way different from that commonly employed with the apple or pear. The aim in each case is to develop quickly a good strong framework to support the fruiting wood and the fruit crops of later years. When the time comes, however, to bring the tree into bearing, its pruning should be somewhat different from that of the pomaceous fruits, for it has a fruiting habit that is quite distinct from theirs.

How the Fruit-Spurs of the Prune are Formed

In order to explain why certain pruning practices are desirable with the prune, it is necessary that there first be a correct understanding of its fruiting habits. Accordingly at this point it will be well to consider how and where the fruit-spurs of the prune tree are formed. A well-grown prune tree four or five years old will have, before its winter pruning, from ten to twenty-five or thirty strong vigorous shoots of the past season's growth. These will vary in length from eight or ten to fifty or sixty inches. Some spring from three or four-year-old wood, or even from the main trunk. Most of them, however, spring from last year's branches. As a rule, trees of the age indicated possess more shoots than it seems desirable to retain, and it is generally considered good practice to remove some of them. We will assume that this is done and that, in accordance with the common practice, most of those that are to remain are headed-back moderately. When growth begins in the spring the terminal buds of all the unheaded shoots are almost certain to start to vegetate and from them are produced new shoots, thus increasing the spread and height of the tree. In the case of the headed shoots, usually several of the lateral buds near the end start to develop new shoots that increase the height and spread of the tree in the same way as shoots from terminal buds. But it is not only terminal buds and a *few* lateral buds near the upper end of last year's shoots that start in the spring. A *great many* of the lateral buds start, though generally it is only a few of the more favorably placed ones near the ends of last year's growth, or near the end of what is left of it after the winter's pruning, that are able to develop new shoots. From the other buds are produced only short branches, that, because of their position, the shortness of their internodes (closeness of their joints) and their subsequent behavior, we call spurs. These spurs may become several inches long the first season, though as a rule they are much shorter.

If these spurs are examined during the growing season they will be found to possess several leaves apiece, and in the axil of each leaf is a bud. Their leaves are of normal size, and the buds in the axils of these leaves are of normal appearance. The only difference between the spur and the ordinary leafy shoot apparently is in length. However, examination of one of these spurs during the dormant period will show that some of its buds are leaf buds, and some are flower buds. Invariably its terminal bud is a leaf bud. Some of

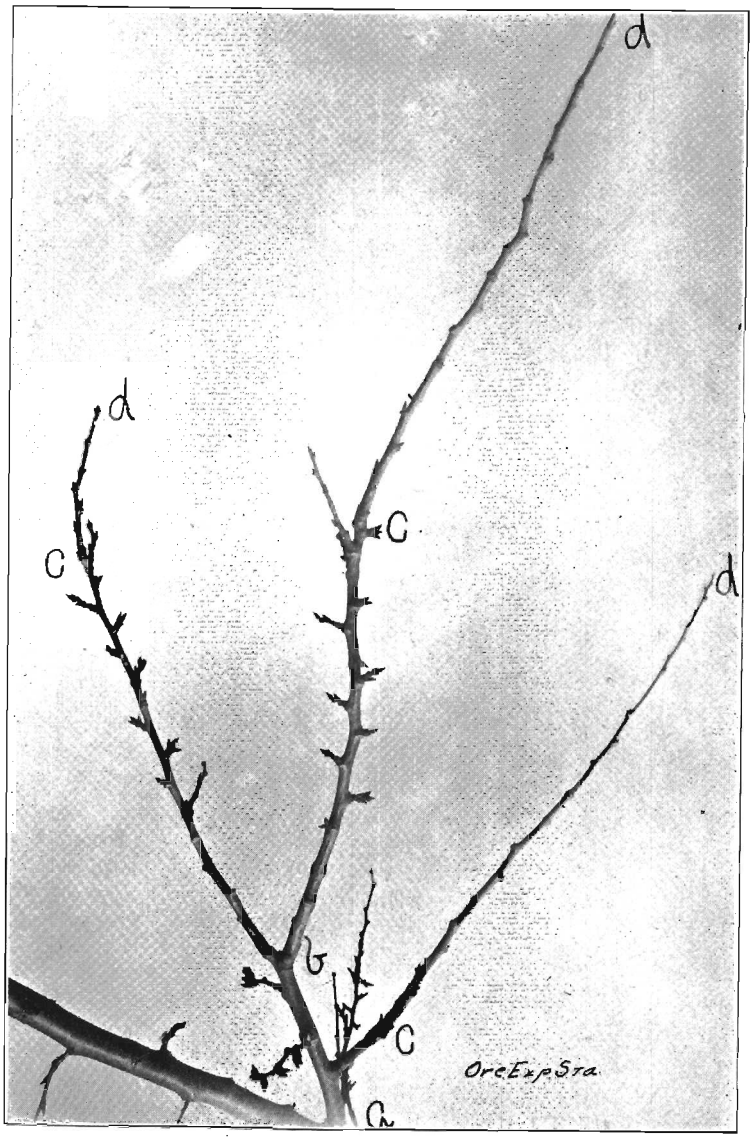

Figure 49. A small limb from the top of an Italian prune tree, showing how spurs develop from the shoots of the preceding season. From *a* to *b* is three-year-old wood. Two years ago three shoots, *b* to *c*, and two fruit spurs were formed. Last year three shoots, *c* to *d*, developed from the terminal buds of the preceding season's growth and a number of fruit-spurs from its lateral buds. The lateral buds on these fruit-spurs are fruit-buds; the terminal buds are leaf-buds.

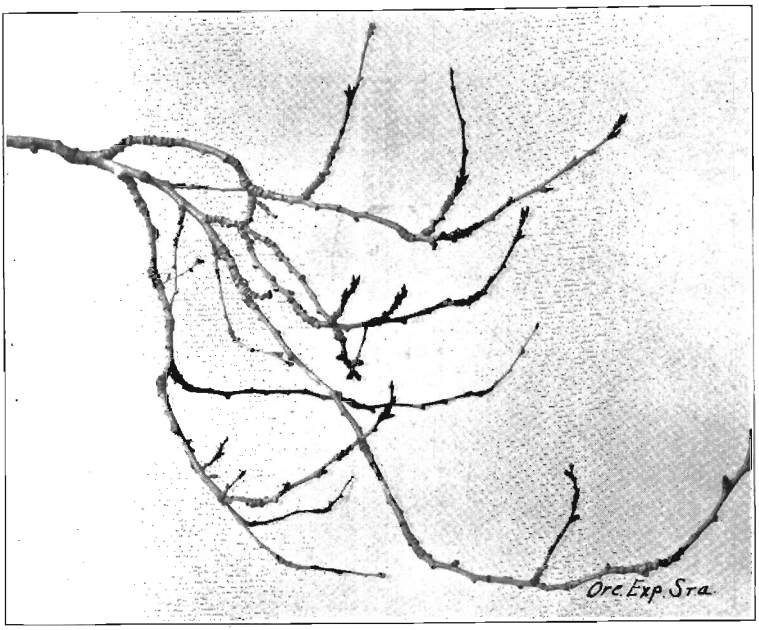

Figure 50. An old, much-branched fruit-spur in an Italian prune tree. Note that some of its branches are dead; the living ones are slender and lacking in vigor. There are present only a few fruit-buds and these are near the ends of the branches. It is probably only a matter of a short time before the whole spur will die. Its present condition is the result of too much shading by the branches above it.

its lateral buds are likely to be leaf-buds, but a large proportion of them are flower-buds. Here, then, is the mechanism by means of which the prune tree bears its fruit. It occurs as a short branch, lateral to the main direction of growth of the limb from which it springs, and terminating in a leaf-bud. The flower-buds themselves are lateral, being borne singly in the axils of leaves. When the leaves are very close together, the internodes being very short, the flower-buds may seem to be clustered, but an examination of the spur during the summer shows that each bud is subtended by a leaf. It will thus be seen that the fruit of the prune is borne laterally on spurs.

It should be explained here that this is intended as a description of only the ordinary fruiting habit of the prune. Some varieties frequently show some variation from this method of fruit bearing. Especially is this true of young trees growing vigorously and of watersprouts on older trees. With them there is a tendency to produce lateral fruit-buds near the base of the new shoots, and at the sides of the regular axillary leaf-buds, after the manner of the peach. However, these are to be regarded as rather special, though not abnormal, cases. The majority of prunes are borne on spurs.

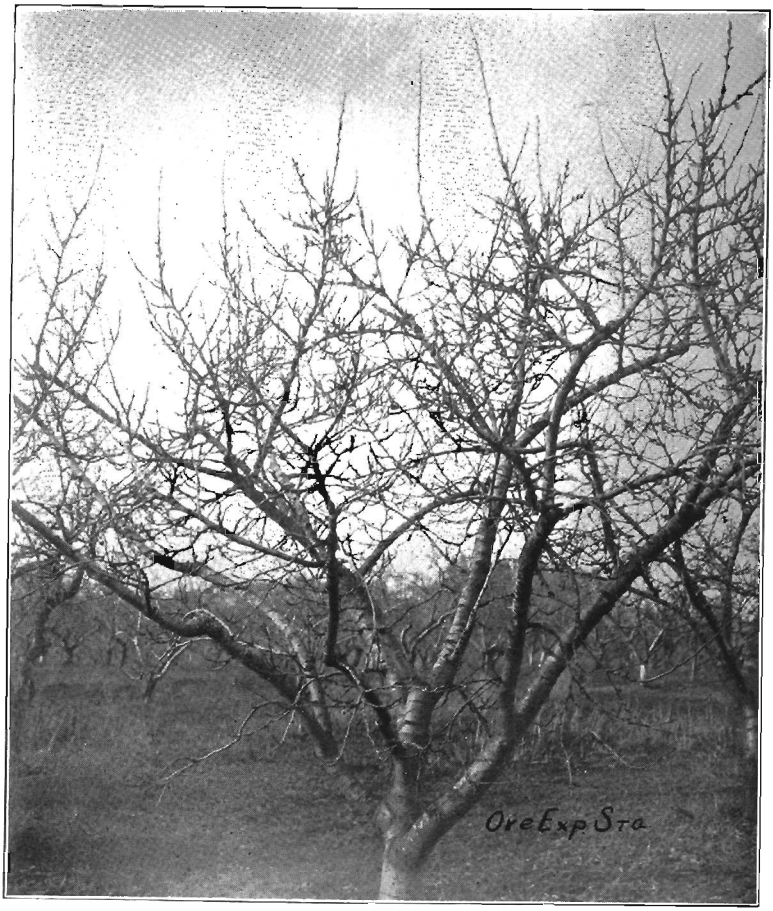

Figure 51. An old Italian prune tree whose top has been kept thinned-out fairly well. Note the presence of small fruiting branches well down on the scaffold limbs, as a result. Note also that a arge portion of the fruit-spurs and small fruiting limbs in this tree are stocky and vigorous.

How the Fruit-Spur Grows from Year to Year

Since the fruit-spur of the prune terminates in a leaf-bud that starts to vegetate about the same time that its lateral flower-buds open, the spur increases in length at the same time that it is producing fruit. By the end of the second season it consists of an older portion that has borne fruit, and of a newer portion that possesses a terminal leaf bud and a number of lateral flower- and leaf-buds, these lateral buds having been borne in the axils of the leaves of the preceding season. The fruit-spur is thus ready to bear fruit

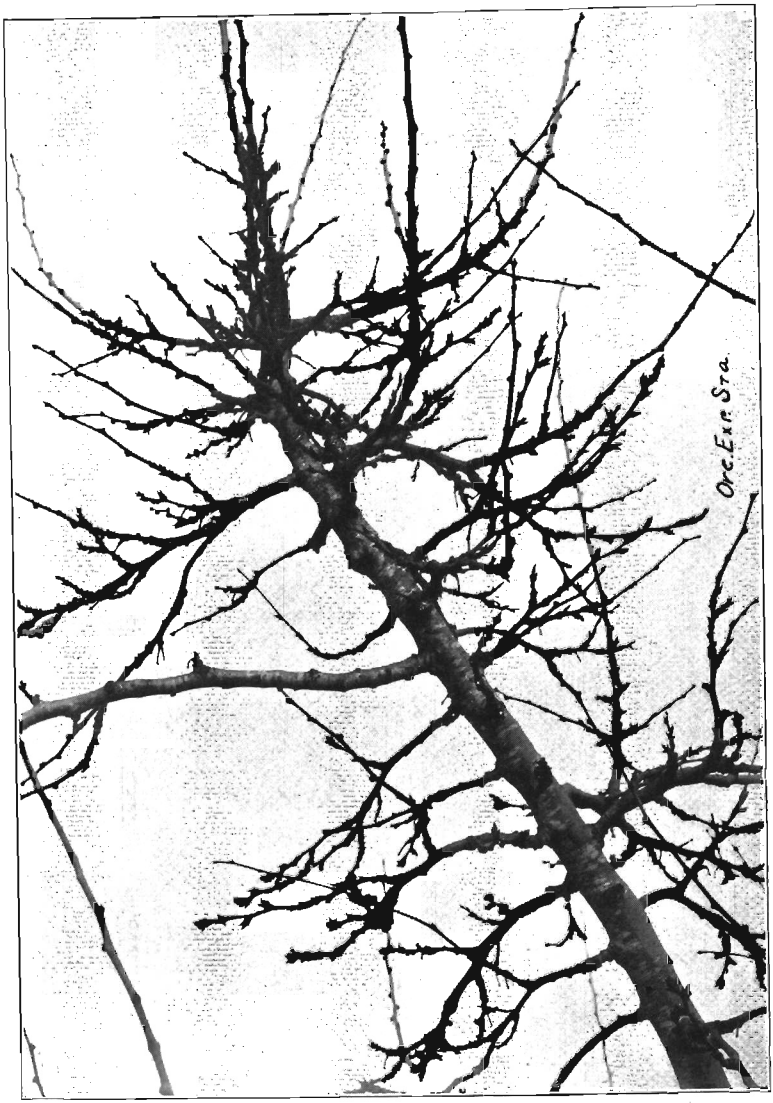

Figure 52. A limb in the upper part of an Italian prune tree. The individual spurs have had an abundant supply of light. Note that not only the individual spurs hut also the small fruiting limbs are short, stocky and vigorous. However, it would be desirable to remove a few of the smaller branches to prevent too heavy shading of those lower in the tree.

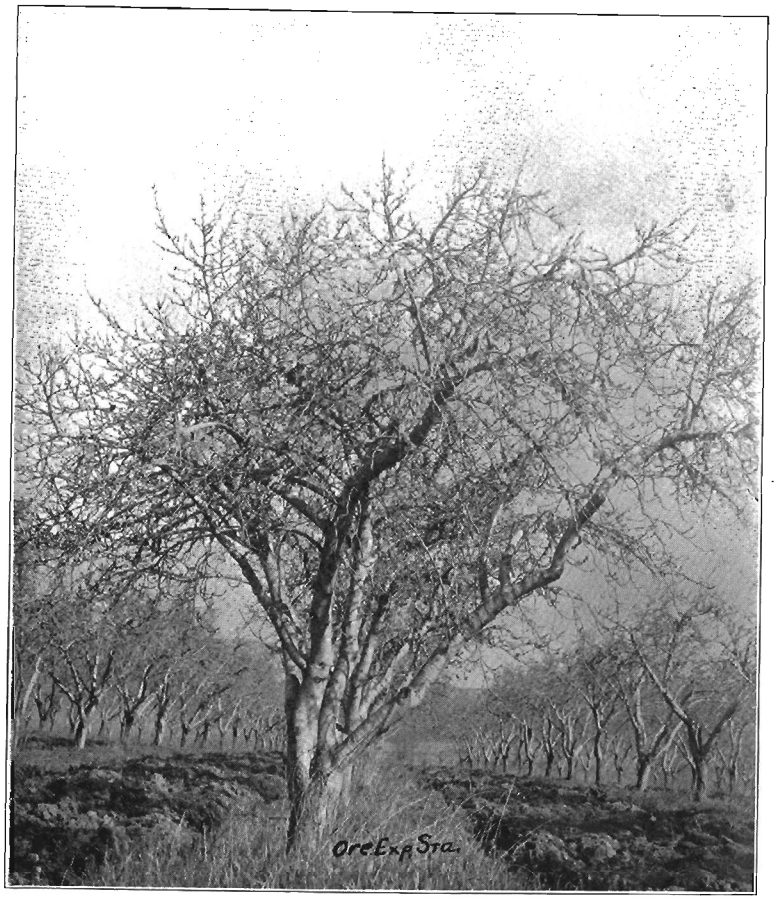

Figure 53. An old Italian prune tree that has not been pruned for a number of years. The scaffold limbs and lower branches have become barren through the dying off of their fruit-spurs. The top of the tree is very thick and bushy and consists mainly in long, slender, weak fruit-spurs and fruiting branches, like those shown in Figure 50.

again the following year. Under normal conditions it may be expected to fruit and elongate during the third, and fourth, and during succeeding years in the same way it fruited and increased in length during the second season. A fruit-spur, once formed, tends to live a good many years. So far as we know, there is no factor connected with its manner of growth to set a definite limit to its age. It is possible that as it becomes older it loses some of its vigor and finally becomes unable to produce good fruit. To prolong the life of the individual fruit-spur, or more accurately, the period during which it is capable of producing good fruit, should be one of the main objects of pruning

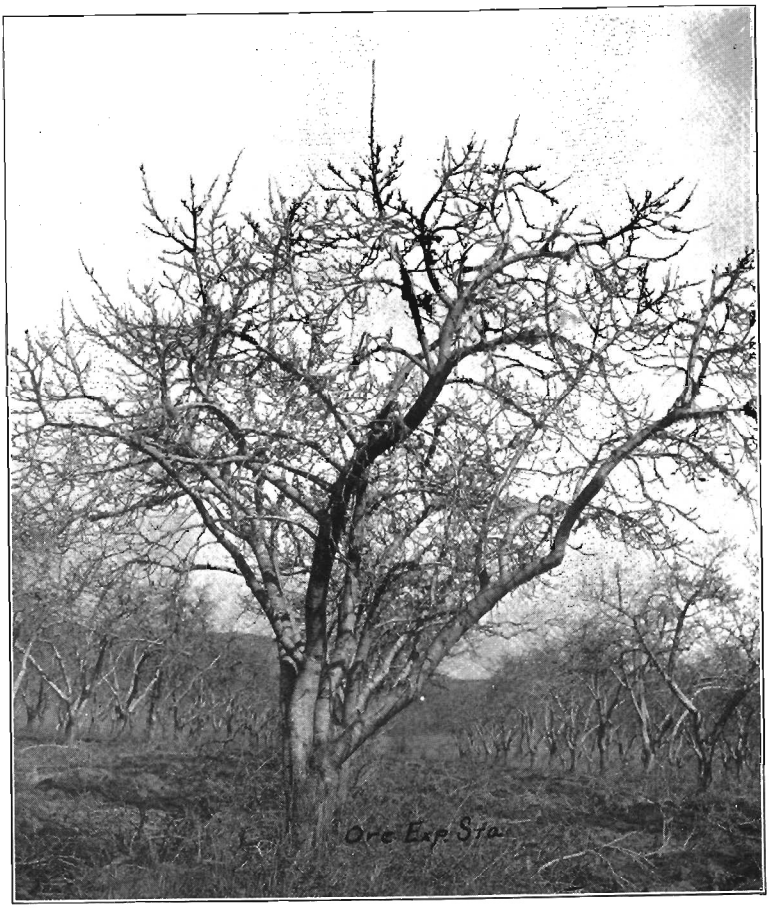

Figure 54. The same tree shown in Figure 53 after pruning. Pruning has consisted mainly in the removal of dead branches and dead fruit-spurs and a rather severe thinning-out of the remaining live ones.

practice. The prune orchard is maintained for the prunes it will produce, and if a very large percentage of its fruit is borne upon fruit-spurs their number and productiveness should be studied with reference to every orchard operation, and particularly with reference to pruning, for obviously the various pruning practices directly affect them.

The Difference Between Good and Poor Fruit-Spurs

In describing the manner of growth of the fruit-spur of the prune, one important characteristic was not noted. It is that the portion of the spur that bears fruit any one season produces only very small leaves during that

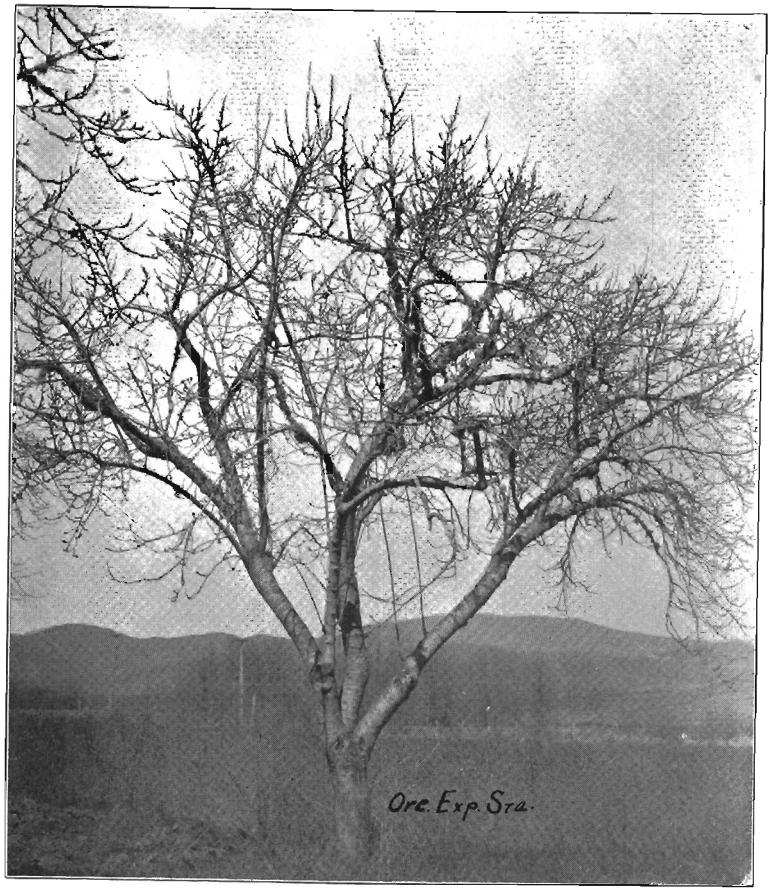

Figure 55. An old Italian prune tree that one year ago was in much the same condition as that shown in Figure 53. At that time it was pruned in the same manner as the tree shown in Figure 54. Note the increased vigor and stockiness of the old fruiting branches and fruit-spurs; and the new watersprouts springing from the scaffold limbs. Good fruiting wood can be developed easily from these watersprouts.

season and no leaves at all during succeeding seasons. The only part of the individual fruit-spurs producing leaves during any summer is the new portion developing from the bud that terminated last season's growth. This is because the flower-buds of the prune are practically flower-buds only and not mixed buds like those of the apple and pear. As the spur elongates year after year, it comes to consist of a long barren basal portion, and a short terminal productive and growing portion. Examination of the fruit-spur system in almost any old prune tree will disclose many fruit-spurs that have become very long, slender, and willowy. It is not uncommon to find individual spurs

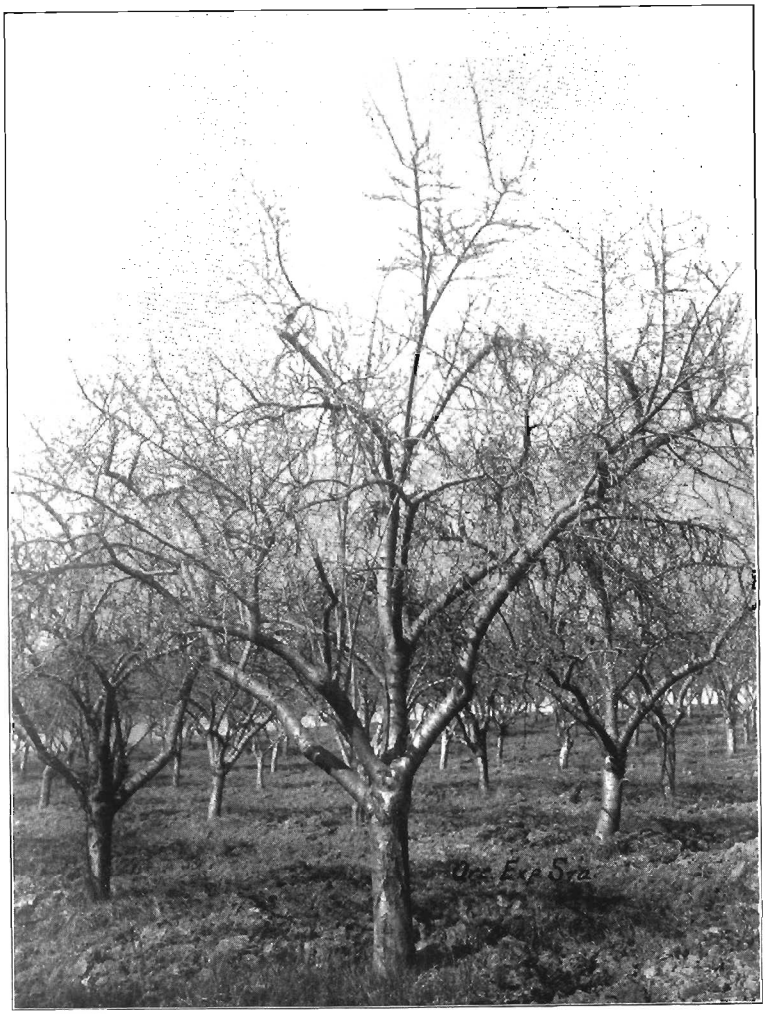

Figure 56. An old Italian prune tree that two years ago was in much the same condition as that shown in Figure 53. At that time it was pruned in the same manner as the tree shown in Figure 54. Note that not only have the old fruiting branches and their fruit-spurs been invigorated and made more stocky, but a considerable amount of new fruiting wood has been developed. Renovation can hardly be said to be complete, but considerable progress has been made in that direction, and that without sacrificing a single fruit crop.

eighteen or twenty inches long, only the terminal one or two inches of which produce leaves and fruit and possess fruit- and leaf-buds for the following season. In the same tree will be found short, stocky spurs, sometimes not more than one or two inches long. It hardly need be pointed out that of the

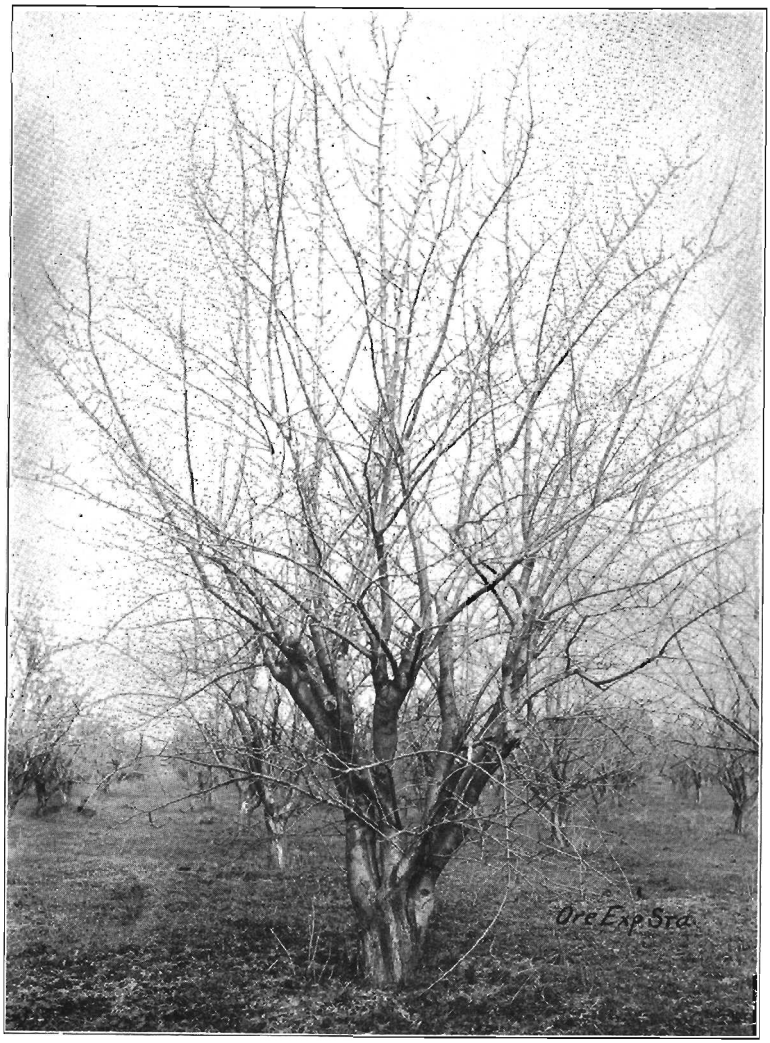

Figure 57. An old Italian prune tree that four years ago was "dehorned" for purposes of renovation. Since that "dehorning" little or no pruning has been done. Last year the tree bore a small crop of prunes on spurs that developed on the watersprouts stimulated by the "dehorning." There is promise of a medium crop this year; but the newly formed spurs in the lower part of the tree are already showing signs of weakened vigor, because of too much shading. To keep them from becoming long and willowy and finally dying, considerable thinning-out is necessary. Heading-back, which would stimulate the formation of more watersprouts, would increase the trouble. This figure and its explanation should be compared with Figures 53-56 and the explanations accompanying them.

two kinds the latter are greatly to be preferred. They usually average more fruit to the spur, hold their fruits from being blown about so much by the wind, keep them from becoming limb-rubbed, and are themselves less subject to accident. In fact, it is the long slender spurs that are usually the first to become weak, produce smaller fruits, and finally die. It may almost be said that a marked lengthening of the spur instead of its remaining short and stocky is a sign of weakened vitality, the first indication of approaching death. Though generally weaker, the long, slender spurs are by no means always older than the shorter ones. Stockiness or slenderness of spurs in the prune tree is very largely dependent upon the light received by individual spurs. An abundant light supply permits the elongating spur to develop a good, well-lighted leaf system with short internodes (joints close together). A poor light supply forces the spurs to grow out long and slender in order properly to expose their leaf surface. This is probably the main reason why the spurs in the very top of the tree average much shorter and stockier than those in the interior of the tree.

The Ideal Distribution of Fruit-Spurs in the Prune Tree

We want not only a large number of short, vigorous fruit-spurs in the prune tree, but it is desirable that those spurs be well distributed. A good distribution of fruit-spurs means having a considerable amount of small fruiting branches in the lower part of the tree and not having them all crowded together in its upper and outer portion. The trees of many bearing prune orchards consist mainly of barren scaffold limbs, terminating in large numbers of small spur-bearing branches that occupy a comparatively narrow space around the outside and that quite completely shade the interior. In these trees the load of fruit is borne at a considerable distance from the main trunk, thereby placing the greatest possible strain upon the scaffold limbs and crotches. Were this load more evenly distributed over the scaffold limbs, as it would be if there was fruiting wood in the lower and interior portion of the tree, there would be much less breaking of limbs and splitting at the crotches than we now find in our prune orchards.

The same factor, limited light supply, that causes individual fruit-spurs to become weak and finally die, acts in the same way upon fruiting branches. It first forces them to grow long and slender in order to reach up to the light. Finally finding themselves outdistanced in the struggle for existence, these branches die off and the scaffold limbs are left with longer and longer barren stretches.

Pruning that Keeps Individual Fruit-Spurs Stocky and Well Distributed

It will be inferred from the statements that have been made that the most important thing to do in pruning the bearing prune tree is to thin it sufficiently to admit an abundant light supply to the small fruiting branches and to the individual fruit-spurs. There is certainly good reason to believe that this practice is one that most closely harmonizes with, and tends to improve its natural fruiting habits. This is far from stating that prune trees should never be headed-back. Without doubt, the strong vegetative shoots that frequently appear even in old trees should be judiciously headed-back. Like-

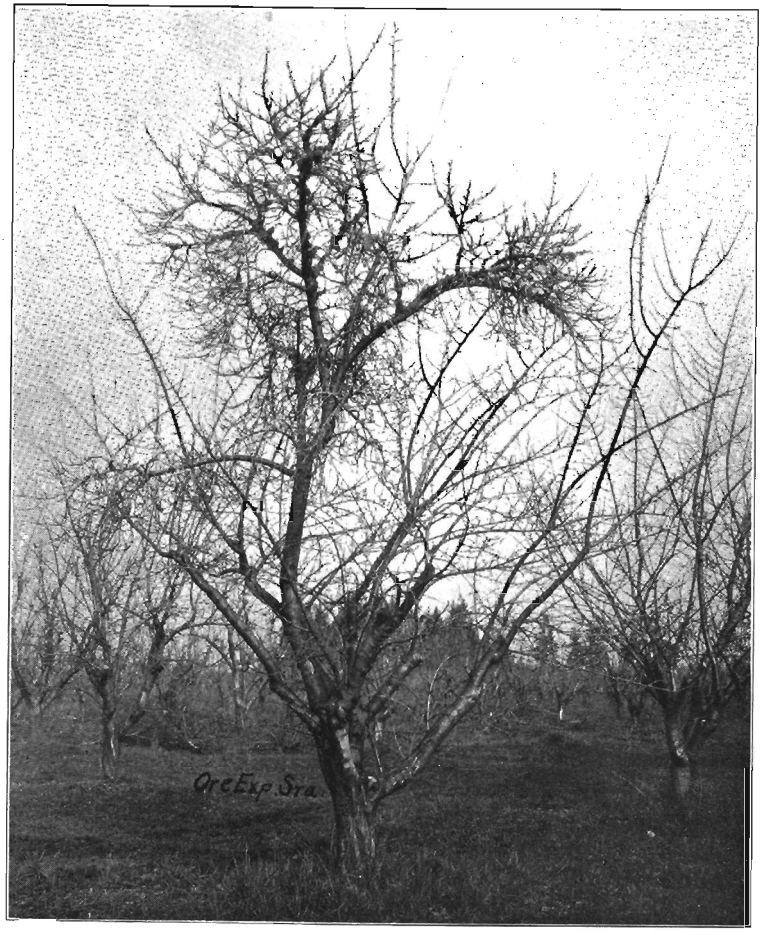

Figure 58. An old Italian prune tree that four years ago was partially "dehorned." Note that the treatment apparently had little influence upon the vigor of the small fruiting branches and individual fruit-spurs of the limb not cut back.

wise, individual fruit-spurs can often be headed-back to a lateral branch of the same spur and thus be made more stocky, and rather long, slender fruiting limbs may be cut back to make them more stocky. Nevertheless, it would seem that a large part of the pruning of bearing prune trees should be a judicious thinning-out of the smaller branches (branches one-half inch or less in diameter). This necessarily involves the removal of a certain amount of bearing wood; but if the amount removed is not too great, the loss will be more than compensated by the increased stockiness and vigor of the remaining fruit-spurs, and by the increased size of the fruits that they bear.